FOR CONTRACT NO.: 04-163744

INFORMATION HANDOUT

WATER QUALITY

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY SECTION

CIWQS Place No. 728683 (BT)
401 Database Site No. 02-38-C0122

PERMITS

UNITED STATES ARMY CORPS OF ENGINEERS
NATIONWIDE 14 PERMIT

AGREEMENTS

BAY CONSERVATION AND DEVELOPMENT COMMISSION
LETTER OF AGREEMENT FOR CONSISTENCY DETERMINATION NO. CN 2-08

MATERIALS INFORMATION

CONCEPTUAL STORMWATER POLLUTION PREVENTION PLAN FOR DOYLE DRIVE REPLACEMENT PROJECT

STATE OF CALIFORNIA DEPARTMENT OF INDUSTRIAL RELATIONS
UNDERGROUND CLASSIFICATION NO C003-075-10T
UNDERGROUND CLASSIFICATION NO C004-075-10T

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION OCIP MANUAL

2009 BUILT ENVIRONMENT PLANS

TRANSPORTATION MANAGEMENT PLAN GUIDELINES

DEVELOPMENT OF PRESIDIO-WIDE CLEANUP LEVELS FOR SOIL, SEDIMENT, GROUNDWATER ANS SURFACE WATER

DEPARTMENT OF TOXIC SUBSTANCES CONTROL INFORMATION ADVISORY FOR CLEAN IMPORTED FILL MATERIAL

DOYLE DRIVE REPLACEMENT PROJECT – ENVIRONMENTAL SOIL INVESTIGATION

ASBESTOS AND LEAD-CONTAINING PAINT SURVEY – DOYLE DRIVE ACM AND LCM PROJECT

BARRIER SYSTEMS PRICE QUOTE FOR QUICKCHANGE MOVABLE BARRIER

VMS HANDOUTS

FOUNDATION REPORT FOR RETAINING WALL No. 6

FOUNDATION REPORT FOR RETAINING WALL No. 8 (Revision)

FOUNDATION REVIEW FOR RETAINING WALL No. 8

FOUNDATION RECOMMENDATIONS FOR PRESIDIO VIADUCT SUBSTATION
(Br No 34-0157W)

FOUNDATION REVIEW FOR PRESIDIO VIADUCT SUBSTATION
(Br No 34-0157W)

FOUNDATION REVIEW FOR SOUTHBOUND BATTERY TUNNEL
(Br No 34-0161L)

DOYLE DRIVE REPLACEMENT PROJECT SOUTHBOUND BATTERY TUNNEL
FOUNDATION REPORT

ROUTE: 04-SF-101-8.2/9.2

California Regional Water Quality Control Board
San Francisco Bay Region

Linda S. Adams
Agency Secretary

1515 Clay Street, Suite 1400, Oakland, California 94612
(510) 622-2300 • Fax (510) 622-2460
http://www.waterboards.ca.gov/sanfranciscobay

Arnold Schwarzenegger
Governor

June 3, 2009
CIWQS Place No. 728683 (BT)
401 Database Site No. 02-38-C0122

Sent via electronic mail: No hard copy to follow

California Department of Transportation
Attn: Mr. Nidal Tuquan
Nidal_Tuquan@dot.ca.gov
111 Grand Ave.
Oakland, CA 94612-3717

Subject: Water Quality Certification for the Doyle Drive Golden Gate Bridge South Access Project, San Francisco, San Francisco County

Department Project No.: EA 04-16370

Dear Mr. Tuquan:

We have reviewed and hereby issue water quality certification to the California Department of Transportation (Department) for the project referenced above (hereinafter Project). The Department has applied for and received a U.S. Army Corps of Engineers (Corps) Nationwide Permit No. 14, *Linear Transportation*, pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344). As such, the Department has applied to the Water Board for a Clean Water Act Section 401 water quality certification that the Project will not violate State water quality standards.

Project: The Department proposes to replace the seismically-deficient, existing viaduct structure that carries traffic to and from the Golden Gate Bridge through the Presidio (Doyle Drive). The existing structure will be replaced with a six-lane facility and a southbound auxiliary lane between the Park Presidio Interchange and the new Presidio access at Girard Road. The Project involves construction of eight sections, listed here sequentially from west to east: an at-grade roadway, the "Presidio" elevated viaduct, another at-grade roadway, the "Battery Tunnel," another section of an at-grade roadway, the "Marina Boulevard Tunnel," a low causeway, and an at-grade roadway near the Palace of Fine Arts.

Impacts: Project implementation will permanently fill approximately 0.81 acres of jurisdictional seasonal freshwater wetlands and due to construction access and staging, temporarily impact approximately 0.16 acres of jurisdictional seasonal freshwater wetlands. Project implementation will also result in approximately 1,391 linear feet (0.11 acres) of

temporary impacts to jurisdictional waters as a result of restoration activities in Dragonfly Creek, the Battery East bluffs, and at Tennessee Hollow.

Project implementation would result in added impervious area. Stormwater runoff from impervious areas may contain hydrocarbons, metals, volatile organic compounds, trash, and sediment at levels that may significantly impact waters of the State if left untreated.

Construction of the Project tunnel(s) may disrupt the flow of groundwater resulting in indirect impacts to approximately 1.77 acres of down-gradient wetlands that are sustained by groundwater (wetlands 4, 6d, and 7, upon the Battery-Blaney bluffs—the bluffs are north of Doyle Drive and south of Crissy Field).

Future Project-Related Impacts: Prior to Project completion, two existing outfalls shall be upgraded to provide drainage to San Francisco Bay from the Project area. The new outfalls may have larger diameters and be lengthened into the Bay to prevent sand drifts from blocking the outlets. At the time of issuance of this certification, the Department did not yet have design plans beyond the conceptual level and therefore, impact information was not available. This certification does not certify construction of these new outfall structures. The outfall structures must be certified in the future, either as a modification to this certification, or as a new certification.

Mitigation: To mitigate for permanent impacts to jurisdictional wetlands, the Department shall provide wetland creation, and wetland and riparian restoration and enhancement on National Park Service land and land subject to Presidio Trust's jurisdiction within the Presidio. Because the Department is receiving economic stimulus funding for the Project and on an accelerated schedule, the Final Mitigation and Monitoring Plans (MMPs) are not yet available and will be submitted subsequent to certification issuance. As such, exact levels of compensatory mitigation available at each mitigation location will not be available until the Final MMPs are completed.

The Department shall mitigate for the 0.81 acres of permanent impacts to jurisdictional wetlands by creating 1.6 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of riparian habitat by removing creeks from culverts. A combination of these creation and restoration may be approved provided restoration activities are provided in greater quantities than creation.

Mitigation activities are proposed at the following locations:

- *Upper Dragonfly Creek*: Dragonfly Creek is a perennial stream. The Department proposes to restore approximately 0.78 acres of freshwater wetland and willow/oak riparian habitats. Invasive species removal at this location began in 2006 in anticipation of the Project.

- *Middle Dragonfly Creek*: Dragonfly Creek is currently underground at this location. The Department proposes to create approximately 0.41 acres of willow/oak riparian habitat at this location.

- *Lower Dragonfly Creek*: The Department proposes to create approximately 0.64 acres of willow riparian habitat and enhance approximately 0.26 acres of freshwater wetland. Planting of native riparian plantings have already commenced at this location.

- *Quartermaster Reach Connection*: The Department proposes to create approximately 0.17 acres of willow riparian habitat and restore the creek by day-lighting 280 feet of the creek.

- *North Fort Scott*: The Department proposes to enhance approximately 0.44 acres of freshwater wetland meadow at this location.

- *West Crissy Bluffs*: The Department proposes to enhance approximately 0.19 acres of freshwater wetland at this location.

- *Battery East/Marine Drive*: The Department proposes to enhance approximately 0.62 acres of freshwater wetland at this location.

- *Tennessee Hollow*: At this location, the Department proposes to restore by day-lighting approximately 800 linear feet of the eastern tributary of Tennessee Hollow and restore an additional 250 linear feet of a degraded creek section.

Temporary impacts to wetlands shall be mitigated by in-kind, in-place restoration after construction. Because riparian habitats shall be restored and/or enhanced, mitigation for temporary impacts at these locations is not required.

As mitigation for increased pollutant loads associated with impervious areas, the Department shall provide treatment of stormwater runoff from an area equivalent to the added and reworked impervious areas (26.9 acres). Additionally, the Department shall provide permanent stormwater treatment for an additional 0.4 acres of Project impervious area to compensate for absence of treatment during the operation of the 4.1 acre temporary detour structure.

The Department shall implement a long-term hydrogeologic and biological monitoring plan to evaluate potential impacts to the hydrogeology and biological resources at wetlands 4, 6d, and 7 as a result of any up-gradient disturbance of groundwater flow. Impacts to wetlands shall be subject to additional mitigation requirements.

CEQA Compliance: An Environmental Impact Report was prepared and approved for this project pursuant to the provisions of the California Environmental Quality Act by the San Francisco Transportation Authority (SFTA). The SFTA filed a Notice of Determination on December 17, 2008 (SCH No. 2000032006).

Wetland Tracker System: It has been determined through regional, state, and national studies that tracking of mitigation/restoration projects must be improved to better assess the performance of these projects, following monitoring periods that last several years. In addition, to effectively

carry out the State's No Net Loss Policy for wetlands, the State needs to closely track both wetland losses and mitigation/restoration project success. Therefore, we require that the Department use a standard form to provide Project information related to impacts and mitigation/restoration measures. An electronic copy of the form and instructions can be downloaded at: http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml. Project information concerning impacts and mitigation/restoration will be made available at the web link: http://www.wetlandtracker.org.

Certification: I hereby issue an order certifying that any discharge from the referenced project will comply with the applicable provisions of sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality Standards and Implementation Plans), 306 (National Standards of Performance), and 307 (Toxic and Pretreatment Effluent Standards) of the Clean Water Act, and with other applicable requirements of State law. This discharge is also regulated under State Water Resources Control Board Order No. 2003 - 0017 – DWQ, "General Waste Discharge Requirements for Dredge and Fill Discharges That Have Received State Water Quality Certification" which requires compliance with all conditions of this Water Quality Certification. The following conditions are associated with this certification:

1. The Department shall adhere to the Standard conditions imposed by Nationwide Permit No. 14, issued to the Department by the Corps;

2. All jurisdictional wetlands and waters temporarily impacted by construction activities shall be immediately returned to pre-construction or improved conditions upon cessation of construction activities in these locations. Native seed and plantings shall be used for all revegetation activities, except where the Presidio Trust mandates certain plant varieties;

3. The Department shall provide post-construction treatment of stormwater runoff from no less than 27.3 acres of impervious area within the Project limits using vegetation-based treatment systems (e.g., biofiltration strips, biofiltration swales);

4. All permanent stormwater treatment controls shall be fully operational by the completion of Contract #7 which will build the Northbound High Viaduct, Northern Park Presidio Interchange and Northbound roadway to Merchant Road;

5. The Department shall submit, acceptable to the Executive Officer, a long-term hydrogeologic and biological monitoring plan to evaluate the extent of impacts to the hydrogeology and biological resources at wetlands 4, 6d, and 7, no later than July 15, 2009. The plan shall include a minimum monitoring period of five years. Any long-term hydrogeologic and biological impacts to wetlands 4, 6d, and/or 7 shall be subject to additional mitigation requirements;

6. The Department shall submit, subject to acceptance by the Executive Officer, final, post-construction stormwater treatment plans including details on design, installation, regular

inspections, and long-term operation and maintenance for Contract No. 3 (Southbound High Viaduct/Southern Park Presidio Interchange), no later than August 1, 2009;

7. The Department shall submit, subject to acceptance by the Executive Officer, final, post-construction stormwater treatment plans including details on design, installation, regular inspections, and long-term operation and maintenance for Contract Nos. 4-7 (Southbound Battery Tunnel; Girard Road Under-Crossing/Main Post Tunnels/Low Viaduct; Northbound Battery Tunnel; Northbound High Viaduct/Northern Park Presidio Interchange/Northbound Roadway to Merchant Road), no later than November 1, 2009;

8. The Department shall mitigate for the 0.81 acres of permanent impacts to jurisdictional wetlands by creating 1.6 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of either freshwater seasonal or perennial wetlands, or riparian habitat by means of day-lighting culverted portions of creek within the Presidio. A combination of creation and restoration mitigation may be approved by the Executive Officer. All required mitigation shall be fully constructed by completion of the final roadway construction contract, "Contract #7: Northbound Presidio Viaduct, Northern Park Presidio Interchange, Northbound Roadway to Merchant Road." Failure to construct the abovementioned level of mitigation, by the abovementioned deadline, shall result in additional mitigation requirements and/or enforcement action by the Water Board;

9. Final MMPs for the following mitigation projects shall be submitted by the following dates:

    - *Battery East/Marine Drive*: October 1, 2009
    - *West Crissy Bluffs*: October 1, 2009
    - *Upper, Middle, and Lower Dragonfly Creek*: April 1, 2010
    - *North Fort Scott*: July 1, 2010
    - *Quartermaster Reach Connection*: July 1, 2011
    - *Tennessee Hollow*: October 1, 2011

Final MMPs shall be subject to the acceptance of the Executive Officer. Any of the proposed mitigation areas identified in this certification may be replaced or complemented with another project on land subject to the jurisdiction of the Presidio Trust, subject to the acceptance of the Executive Officer. Failure to fully implement mitigation by the dates and at the amounts noted in the Final, Water Board Executive Officer-accepted MMP, shall result in enforcement action and/or additional mitigation requirements from the Water Board. Because the Final MMPs have not yet been reviewed and accepted by the Executive Officer, there is a possibility the proposed mitigation may not be considered acceptable. In

the event that all, or any portion of the Final MMPs are not accepted by the Executive Officer, the Department shall still be required to fully comply with condition number 8 of this certification;

10. Construction of the following mitigation projects shall be completed by whichever occurs first; either the dates listed below, or by completion of the final roadway construction contract (see certification condition 8):

    - *Upper, Middle, and Lower Dragonfly Creek*: April 1, 2011;
    - *North Fort Scott*: April 1, 2011;
    - *Quartermaster Reach Connection*: April 1, 2012;
    - *Tennessee Hollow*: April 1, 2013 and,
    - *Battery East/Marine Drive and West Crissy Bluffs*: Mitigation construction has been completed at these two mitigation sites. Adequacy of the mitigation shall be determined by the Executive Officer upon submission of the Final Mitigation and Monitoring Plans.

    Any delays in mitigation construction shall be subject to additional mitigation requirements and/or enforcement action by the Water Board.

11. All Final MMPs shall include:
    a. Detailed success criteria;
    b. Final success criteria shall not be considered achieved until ten years have passed from the time of completion of mitigation construction;
    c. A proposal to implement contingency measures if mitigation monitoring data demonstrates mitigation goals have not been met;
    d. A time schedule for submittal of periodic monitoring reports to the Water Board;
    e. Pre-established photographic monitoring points be marked on a map and used during the monitoring period, with color photos included in every monitoring report;
    f. Planting plans incorporating native plant species, using locally-gathered nursery stock when available; and,
    g. Grading details based on survey data for all areas where wetland creation and creek realignment or day-lighting is proposed.

12. The discharge of sediment to San Francisco Bay, or to areas where sediment may discharge to San Francisco Bay, is prohibited. The Department shall implement all appropriate sediment and erosion control construction best management practices;

13. The Department is required to use the standard Wetland Tracker form to provide Project information describing impacts and mitigation/restoration measures no later than November 1, 2010. The completed Wetland Tracker form shall be submitted electronically to wetlandtracker@waterboards.ca.gov, or, shall be submitted as a hard copy to both: 1) San Francisco Bay Regional Water Quality Control Board (see letterhead for address), to the attention of Wetland Tracker, and, 2) San Francisco Estuary Institute, 7770 Pardee Lane, Oakland, CA 94621-1424, to the attention of Mike May;

14. Not later than 30 days prior to the beginning of construction of any Project component, the Department shall submit, acceptable to the Executive Officer, a final SWPPP to address the Project's expected construction stage impacts, prepared pursuant to the State Water Resources Control Board Water Quality Order No. 99-06-DWQ, the NPDES Statewide Permit for Storm Water Discharges From the State of California Department of Transportation Properties, Facilities, and Activities. If the Department is proposing rainy season construction activities, the Department shall provide a detailed schedule of activities and the associated pollution prevention measures that shall be in place to protect State waters;

15. This certification does not allow for the take, or incidental take, of any special status species. The Department shall use the appropriate protocols, as approved by the California Department of Fish and Game and the U.S. Fish and Wildlife Service, to ensure that Project activities do not impact the Beneficial Use of the Preservation of Rare and Endangered Species;

16. The Department shall maintain a copy of this water quality certification at the Project site so as to be available at all times to site operating personnel. It is the responsibility of the Department to assure that all personnel (employees, contractors, and subcontractors) are adequately informed and trained regarding the conditions of this certification;

17. Except as expressly allowed in this Certification, the discharge, or creation of the potential for discharge, of debris, rubbish, or any soil materials including fresh concrete, cement, silts, clay, sand and other organic materials to waters of the State is prohibited. Any of these materials placed within or where they may enter waters of the State by the Department or any party working under contract, or with the permission of the Department, shall be removed immediately. When construction is completed, any excess material shall be removed from the work area and any areas adjacent to the work area where such material may be washed into waters of the State. During construction, the Department and the contractor shall not dump any litter or construction debris within the riparian/stream zone. All such debris and waste shall be picked up daily and properly disposed of at an appropriate site;

18. This Certification applies to the Project as proposed in the application materials. Please be advised that failure to implement the Project as proposed is a violation of this water quality certification;

19. This certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to Section 13330 of the California Water Code (CWC) and Section 3867 of Title 23 of the California Code of Regulations(23 CCR);

20. This certification action does not apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license, unless the pertinent certification application was filed pursuant to California Code of Regulations (CCR) Title 23, Subsection 3855(b) and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought; and,

21. Certification is conditioned upon total payment of the full fee required in State regulations (23 CCR Section 3833). Water Board staff received full payment of $2869.00 on May 26, 2009.

We anticipate your cooperation in implementing these conditions. However, please be advised that any violation of water quality certification conditions is a violation of State law and subject to administrative civil liability pursuant to California Water Code (CWC) section 13350. Failure to respond, inadequate response, late response, or failure to meet any condition of this certification may subject you to civil liability imposed by the Water Board to a maximum of $5,000 per day per violation or $10 for each gallon of waste discharged in violation of this certification.

Conditions 5-7, 9, 13, and 14 are requirements for submission of a report. Any requirement for a report made as a condition to this action is a formal requirement pursuant to CWC section 13267, and failure or refusal to provide, or falsification of such required report is subject to civil liability as described in CWC section 13268.

We anticipate no further action on this request. Should new information come to our attention that indicates a water quality problem with this project, the Water Board may issue Waste Discharge Requirements pursuant to 23 CCR Section 3857.

If you have any question, please contact Brendan Thompson at (510) 622-2506, or via e-mail to BThompson@waterboards.ca.gov.

Sincerely,

Bruce H. Wolfe
Executive Officer

cc (via e-mail): Mr. Bill Orme SWRCB-DWQ
Mr. Hal Durio, Regulatory Branch, USACE
Ms. Jane Hicks, Regulatory Branch, USACE
Ms. Holly Costa, Regulatory Branch, USACE
Mr. Cameron Johnson, Regulatory Branch, USACE
Mr. Dale Bowyer, Water Board
Ms. Melissa Escaron, Fish and Game, Yountville
Mr. Hardeep Takhar, Caltrans
Ms. Jayshree Chauhan, Caltrans
Mr. David Smith, USEPA

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

MAY 14 2009

REPLY TO

Regulatory Division

SUBJECT: File Number SPN-2006-30009 S

Mr. Jeffery Jensen
Division of Biological Sciences and Permits
California Department of Transportation
111 Grand Avenue
PO Box 23660
Oakland, California 94623-0660

Dear Mr. Jensen:

This letter is written in response to your submittal of February 2, 2009, concerning Department of the Army authorization for the Doyle Drive Project. The project is located on Highway 101, south of the Golden Gate Bridge, in the Presidio of San Francisco, San Francisco County, California.

The proposed project would replace Doyle Drive (a segment of Highway 101) with a new roadway facility: the Presidio Parkway. The Presidio Parkway would include a high-viaduct between the Highway 101/Park Presidio Interchange and the San Francisco National Cemetery. Shallow cut-and-cover tunnels would extend from the cemetery to east of Battery Blaney. The facility would then continue towards the Main Post in the Presidio with an open at-grade roadway with a wide, heavily landscaped median. A retaining wall would be constructed along the south side of the facility between the Battery and Main Post tunnels. A landscaped berm would be constructed along the north side of the facility to shield park visitors from the proposed facility. From Building 106 in the Presidio, cut-and-cover tunnels would extend east of Halleck Street. The facility would then rise slightly on a low causeway and then pass over Girard Road. East of Girard Road, the new facility would then return to an existing grade north of the Gorgas warehouses where it would connect to Richardson Avenue.

Constructing the new roadway facility would result in direct impacts to 0.35 acres of waters of the U.S. These permanent impacts would occur as a result of fill from constructing the new viaduct and at-grade roadway.

Based on a review of the information you submitted, your project qualifies for authorization under Department of the Army Nationwide Permit 14 for Linear Transportation Projects (72 Fed. Reg. 11092, March 12, 2007), pursuant to Section 404 of the Clean Water Act (33 U.S.C. Section 1344). See Enclosure 1. All work shall be completed in accordance with the plans and drawings titled "Preferred Alternative Refined Presidio Parkway" Layout sheets L-1

through L-4, dated January 2009, and "Figure 1, Project and Existing Wetland Locations, Doyle Drive Replacement", dated March 23, 2009.

The project must be in compliance with the General Conditions cited in Enclosure 2 for this Nationwide Permit authorization to remain valid. Non-compliance with any condition could result in the suspension, modification or revocation of the authorization for your project, thereby requiring you to obtain an Individual Permit from the Corps. This Nationwide Permit authorization does not obviate the need to obtain other State or local approvals required by law.

This authorization will remain valid for two years from the date of this letter unless the Nationwide Permit is modified, suspended or revoked. If you have commenced work or are under contract to commence work prior to the suspension, or revocation of the Nationwide Permit and the project would not comply with the resulting Nationwide Permit authorization, you have twelve (12) months from that date to complete the project under the present terms and conditions of the Nationwide Permit. Upon completion of the project and all associated mitigation requirements, you shall sign and return the Certification of Compliance, Enclosure 3, verifying that you have complied with the terms and conditions of the permit.

This authorization will not be effective until you have obtained a Section 401 water quality certification from the San Francisco Bay Regional Water Quality Control Board (RWQCB) and concurrence from the S.F. Bay Conservation and Development Commission (BCDC) that your project complies with the Coastal Zone Management Act. You shall submit a copy of the RWQCB 401 water quality certification and the BCDC consistency determination to the Corps prior to the commencement of work.

To ensure compliance with this Nationwide Permit authorization, the following special conditions shall be implemented:

1. A Detailed Final Mitigation Plan, including information on the proposed Tennessee Hollow restoration work, shall be submitted to our office prior to the start of construction. The plan must be reviewed and approved by our office before the start of construction.

2. Compensation for unavoidable impacts to waters of the U.S., including wetlands, within the project area shall be conducted pursuant to the Conceptual Mitigation Plan. Specifically:

    a. You shall revegetate the 0.001 acres of temporarily impacted intermittent stream/emergent wetland at Battery Howe-Wagner.

    b. To mitigate for direct/permanent impacts to 0.02 acres of the wetland at Battery Howe-Wagner, 0.18 acres of W-2, and 0.15 of W-3, you shall restore 0.23 acres of perennial stream/riparian wetland at Middle Dragonfly Creek, Lower Dragonfly Creek, and Quartermaster Reach as shown on "Figure 2-1, Proposed Mitigation Sites in Project Study Area", and listed in "Table 201, Proposed Mitigation Sites",

in the Conceptual Mitigation Plan. You shall also restore 800 feet of Tennessee Hollow that is currently underground in a culvert south of Lover's Lane Bridge and under Morton Street Field as shown on "Figure 4-2, Tennessee Hollow Eastern Tributary", in the Conceptual Mitigation Plan. You shall also enhance areas along Upper Dragonfly Creek, Lower Dragonfly Creek, the wetland at North Fort Scott, the willow scrub wetland at West Crissy bluffs, and the willow scrub wetland at Battery East/Marina Drive as shown on Figure 2-1, in the Conceptual Mitigation Plan.

c. Work on these mitigation areas shall be done concurrently with project construction.

d. The restoration and enhancement areas would be deemed successful when tree and shrub plantings provide at least 80 % total cover and herbaceous species provide 75% total cover on the sites.

e. The mitigation areas shall be monitored for success for 10 years. Monitoring reports shall be submitted annually to our office to determine if mitigation is succeeding. At the end of the ten-year monitoring period, you shall submit a final monitoring report to our office to determine if the above success criteria have been met.

3. Environmentally sensitive areas (ESA) shall be clearly delineated on the construction plans and demarcated in the field with high-visibility fencing prior to commencement of construction activities. ESA fencing shall be properly maintained throughout the duration of the project. The ESA shall be off limits to construction activity and personnel at all times.

4. All project staging and equipment storage shall be limited to the staging areas shown in "Exhibit 2-44, Construction Staging Areas – Preferred Alternative", in the "South Access to the Golden Gate Bridge – Doyle Drive FEIS/FEIR", dated September 2008.

5. No debris, oil, petroleum products or other organic material resulting from construction activities shall be allowed to enter or be placed where it may be washed by rainfall or runoff into areas subject to the jurisdiction of the Corps.

6. In the event of any unanticipated discoveries of potential cultural/historic resources, you shall immediately halt work in the vicinity of the discovery and contact the appropriate regulatory authorities. You shall complete consultation pursuant to 36 CFR 800 to the satisfaction of the SHPO prior to resuming work. The primary Corps point of contact for notification of unanticipated discoveries is Richard Stradford. His phone number is 415-503-6845.

Should you have any questions regarding this matter, please call Andrea Meier of our Regulatory Division at 415-503-6798. Please address all correspondence to the Regulatory Division and refer to the File Number at the head of this letter. If you would like to provide comments on our permit review process, please complete the Customer Survey Form available online at http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

Jane M. Hicks
Chief, Regulatory Division

Enclosures

Copy furnished without enclosures:

US EPA, San Francisco, CA
CA DFG, Napa, CA
CA RWQCB, Oakland, CA
SF BCDC, San Francisco, CA

Enclosure 3

Permittee:

Mr. Jeffery Jensen
Division of Biological Sciences and Permits
California Department of Transportation
111 Grand Avenue
PO Box 23660
Oakland, California 94623-0660

File Number: SPN-2006-30009 S

Certification of Compliance
for
Nationwide Permit

"I hereby certify that the work authorized by the above referenced File Number and all required mitigation have been completed in accordance with the terms and conditions of this Nationwide Permit authorization."

_____ _____

(Permittee) (Date)

Return to:

Andrea Meier
U.S. Army, Corps of Engineers
San Francisco District
Regulatory Division, CESPN-OR-R
1455 Market Street
San Francisco, CA 94103-1398

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans PROJECT DEVELOPMENT

	DESIGN OVERSIGHT
CALCULATED/DESIGNED BY	E. LAM
CHECKED BY	J. KARN
DATE REVISED BY	06/07
DATE REVISED	

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-13.7 KP 10.9-11.4		

REGISTERED CIVIL ENGINEER

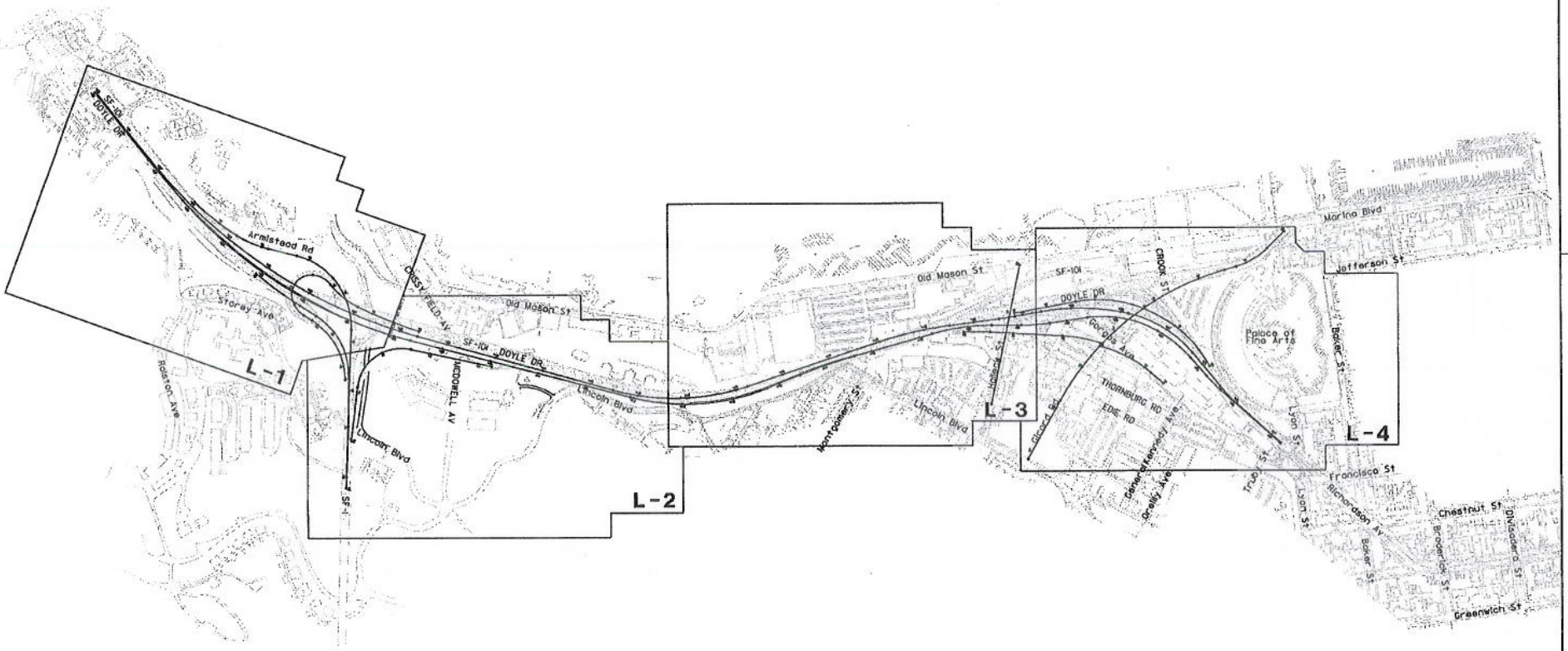
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — CIVIL — STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

Caltrans now has a web site! To get to the web site, go to: http://www.dot.ca.gov

ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103



ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE
REFINED PRESIDIO PARKWAY
KEYMAP

K-1

SCALE 1:4000

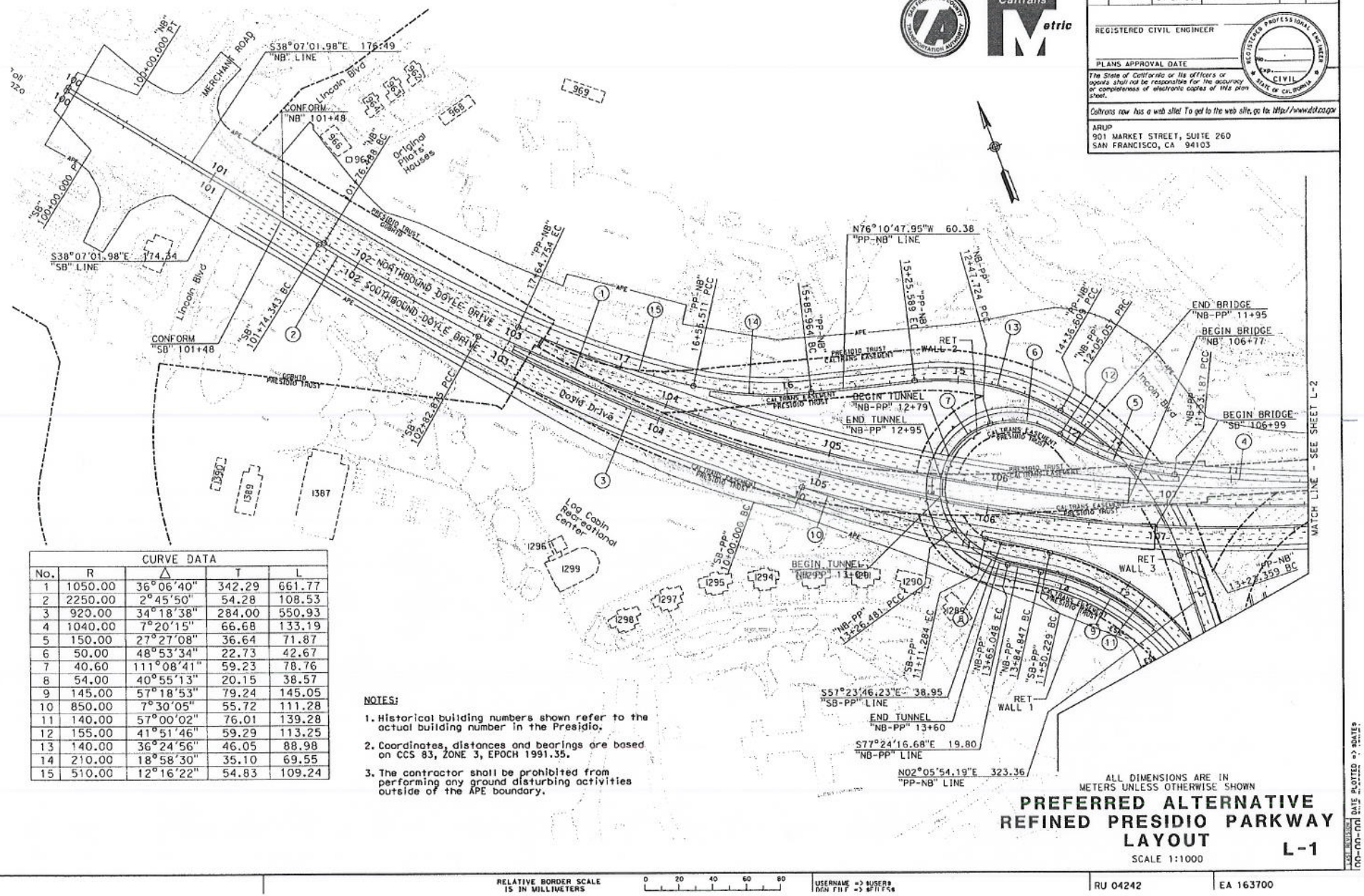
RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

USERNAME => %USER%
DGN FILE => %FILE%

RU 04242

EA 163700

LAST REVISION 00-00-00 DATE PLOTTED => %DATE%



CURVE DATA				
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3	920.00	34°18'38"	284.00	550.93
4	1040.00	7°20'15"	66.68	133.19
5	150.00	27°27'08"	36.64	71.87
6	50.00	48°53'34"	22.73	42.67
7	40.60	111°08'41"	59.23	78.76
8	54.00	40°55'13"	20.15	38.57
9	145.00	57°18'53"	79.24	145.05
10	850.00	7°30'05"	55.72	111.28
11	140.00	57°00'02"	76.01	139.28
12	155.00	41°51'46"	59.29	113.25
13	140.00	36°24'56"	46.05	88.98
14	210.00	18°58'30"	35.10	69.55
15	510.00	12°16'22"	54.83	109.24

NOTES:

1. Historical building numbers shown refer to the actual building number in the Presidio.
2. Coordinates, distances and bearings are based on CCS 83, ZONE 3, EPOCH 1991.35.
3. The contractor shall be prohibited from performing any ground disturbing activities outside of the APE boundary.

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-1

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-15.7 KP 10.9-11.4		

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

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ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103

DATE	REVISED BY
06/07	DATE REVISED

CALCULATED/DESIGNED BY: E. LAM
CHECKED BY: J. KARN

DESIGN OVERSIGHT

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans PROJECT DEVELOPMENT

RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

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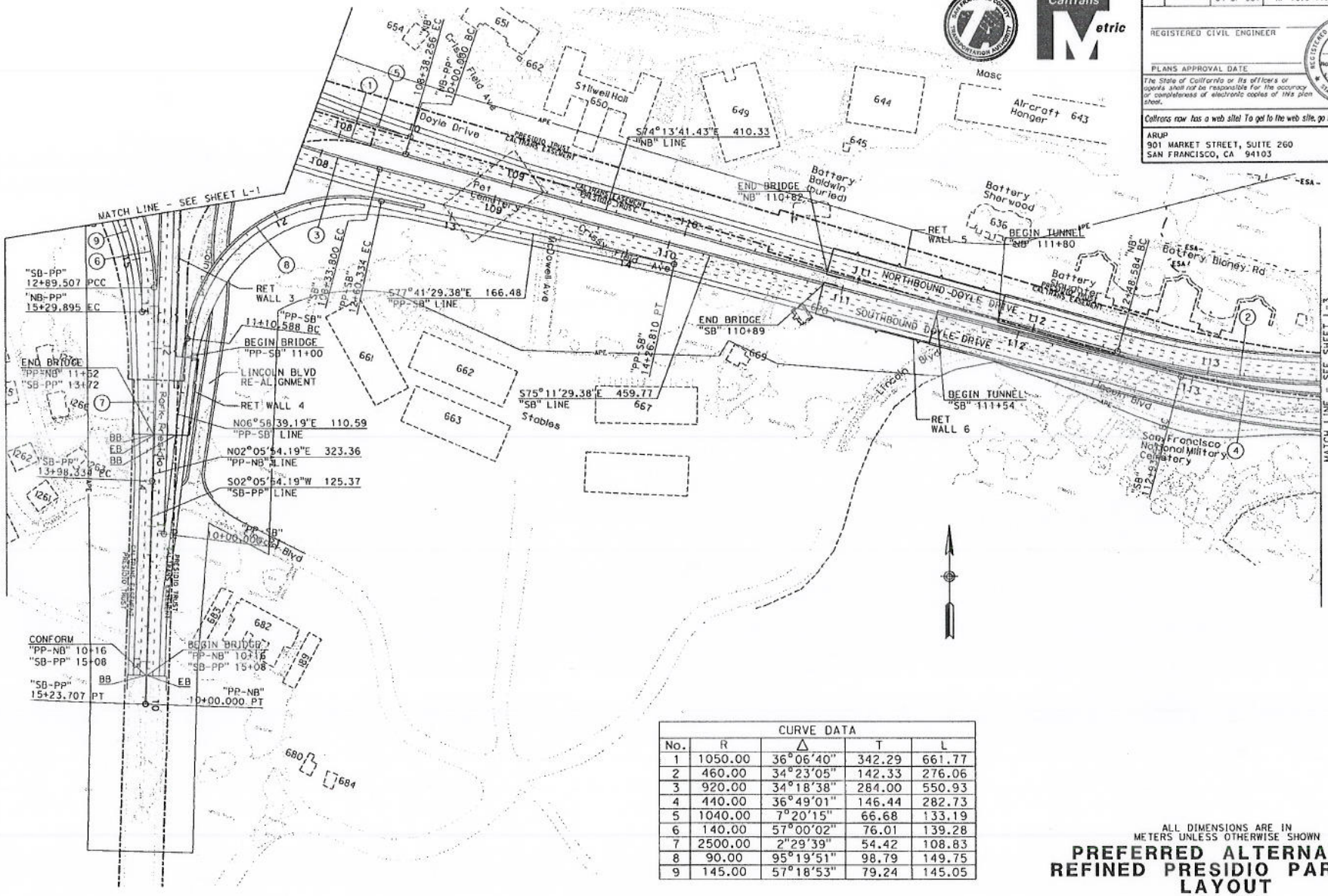
DGN FILE => $FILE$

RU 04242

EA 163700

LAST REVISED mm-dd-yy DATE PLOTTED => $DATE$



CURVE DATA				
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2	460.00	34°23'05"	142.33	276.06
3	920.00	34°18'38"	284.00	550.93
4	440.00	36°49'01"	146.44	282.73
5	1040.00	7°20'15"	66.68	133.19
6	140.00	57°00'02"	76.01	139.28
7	2500.00	2°29'39"	54.42	108.83
8	90.00	95°19'51"	98.79	149.75
9	145.00	57°18'53"	79.24	145.05

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-2

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No.	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-15.7 KP 10.9-11.4		

REGISTERED CIVIL ENGINEER

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06/07	DATE REVISED

CALCULATED/DESIGNED BY: E. LAW
CHECKED BY: J. KARN
DESIGN OVERSIGHT

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans PROJECT DEVELOPMENT

RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

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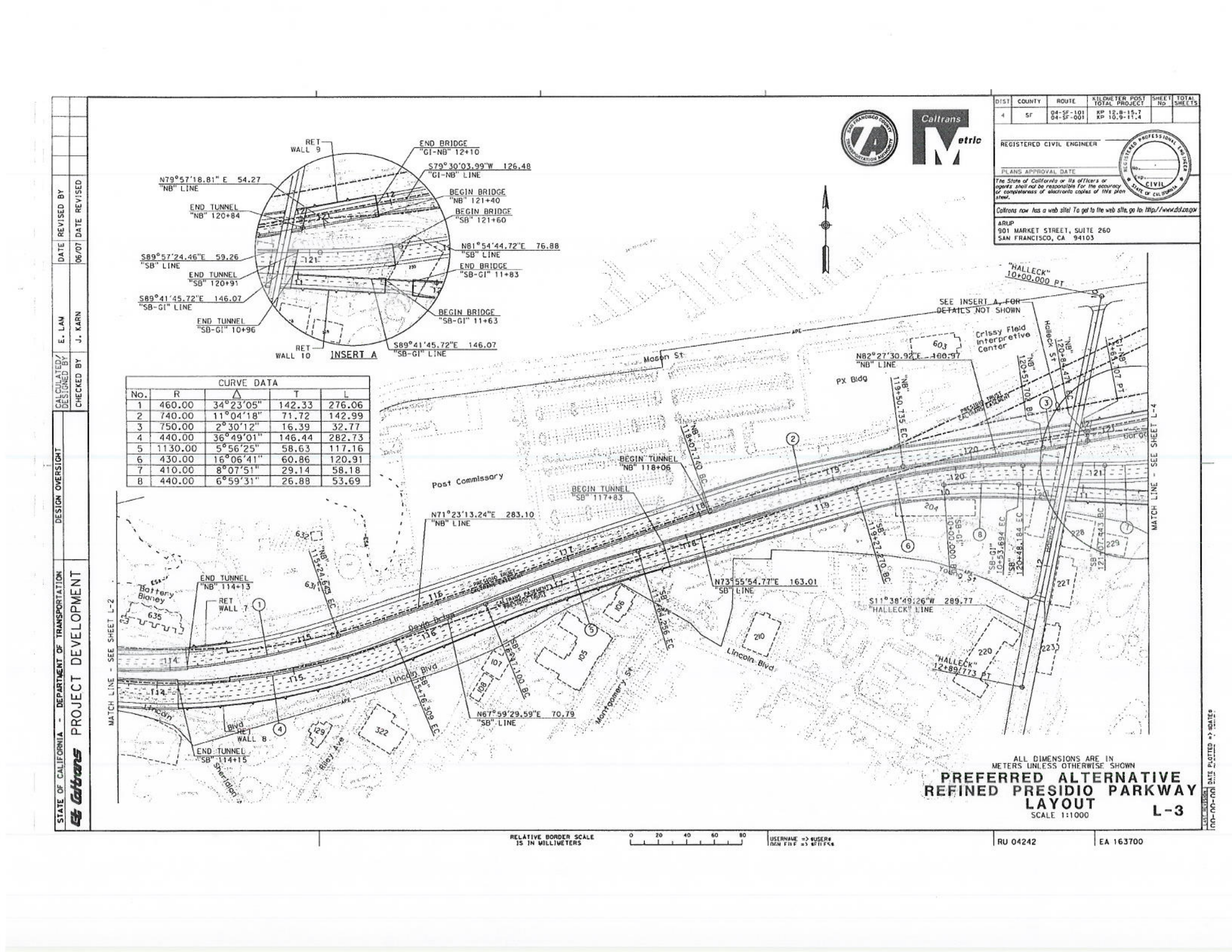
DGN FILE => $FILE$

RU 04242

EA 163700

LAST REVISED: 00-00-00 DATE PLOTTED => $DATE$



CURVE DATA				
No.	R	Δ	T	L
1	460.00	34°23'05"	142.33	276.06
2	740.00	11°04'18"	71.72	142.99
3	750.00	2°30'12"	16.39	32.77
4	440.00	36°49'01"	146.44	282.73
5	1130.00	5°56'25"	58.63	117.16
6	430.00	16°06'41"	60.86	120.91
7	410.00	8°07'51"	29.14	58.18
8	440.00	6°59'31"	26.88	53.69

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-15.7 KP 10.9-11.4		

REGISTERED CIVIL ENGINEER

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DATE	REVISED BY
06/07	DATE REVISED

CALCULATED/DESIGNED BY: E. LAW
CHECKED BY: J. KARN

DESIGN OVERSIGHT

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans PROJECT DEVELOPMENT

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PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-3

RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

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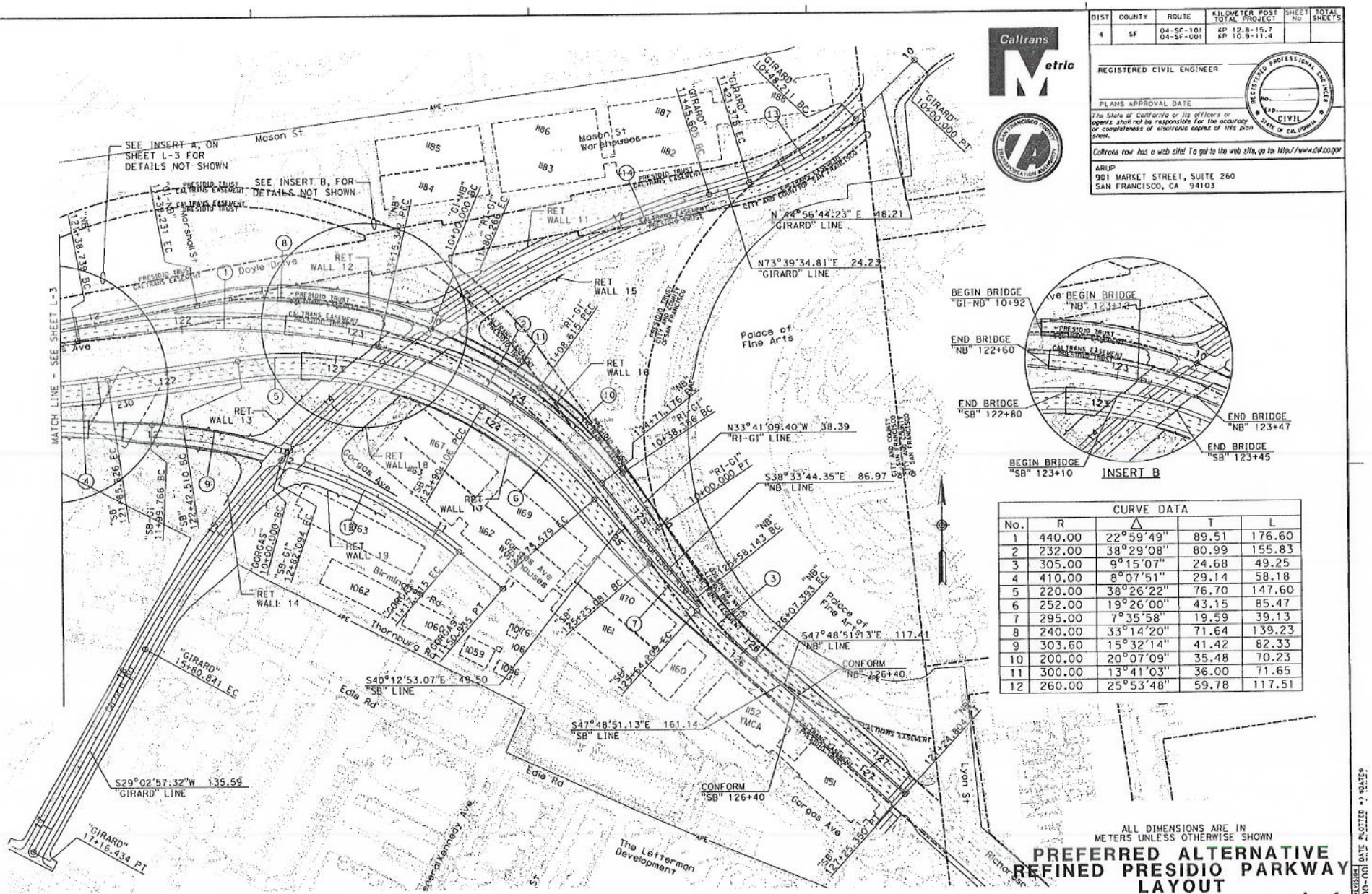
DGN FILE => $FILES$

RU 04242

EA 163700

LOCK MOTION

DATE PLOTTED => $DATE$



CURVE DATA				
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3	305.00	9°15'07"	24.68	49.25
4	410.00	8°07'51"	29.14	58.18
5	220.00	38°26'22"	76.70	147.60
6	252.00	19°26'00"	43.15	85.47
7	295.00	7°35'58"	19.59	39.13
8	240.00	33°14'20"	71.64	139.23
9	303.60	15°32'14"	41.42	82.33
10	200.00	20°07'09"	35.48	70.23
11	300.00	13°41'03"	36.00	71.65
12	260.00	25°53'48"	59.78	117.51

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-15.7 KP 10.9-11.4		

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

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SAN FRANCISCO, CA 94103

DATE	REVISED BY
06/07	DATE REVISED

CALCULATED/DESIGNED BY: E. LAW
CHECKED BY: J. KARN
DESIGN OVERSIGHT

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans PROJECT DEVELOPMENT

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PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-4

RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

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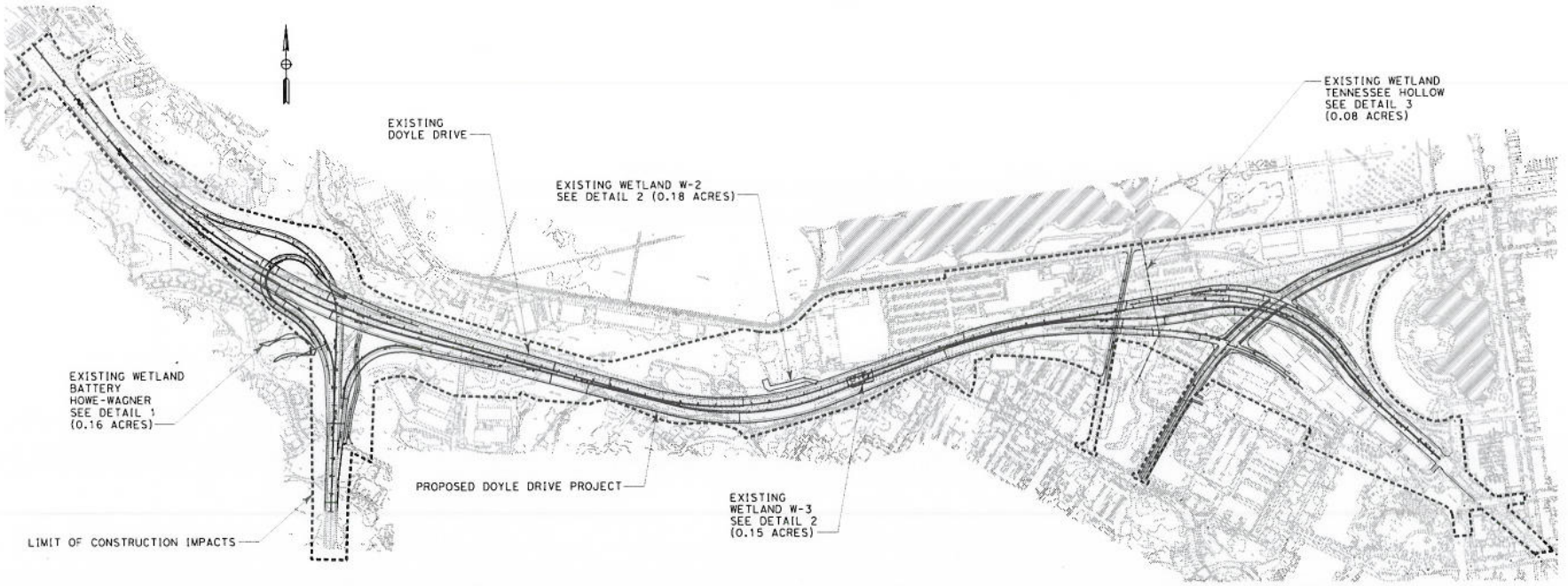
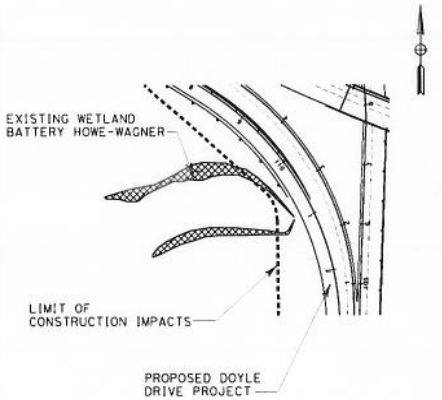
RU 04242

EA 163700

LAST REVISION 00-00-00 DATE PLOTTED => &DATE$

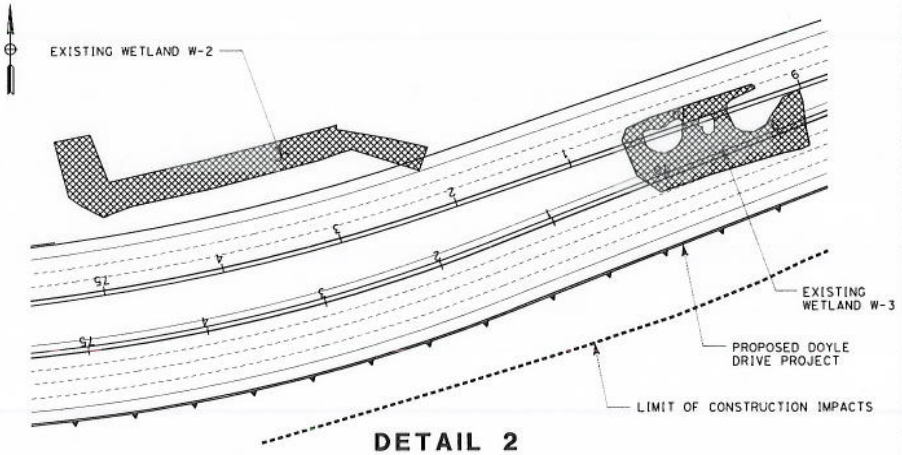




DETAIL 1

0 200'

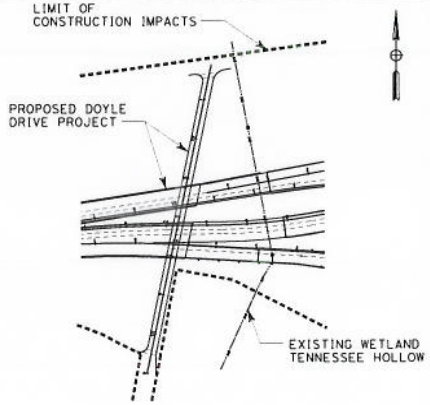
SCALE: 1"=200'



DETAIL 2

0 100'

SCALE: 1"=100'



DETAIL 3

0 300'

SCALE: 1"=300'

FIGURE 1
PROJECT AND EXISTING WETLAND LOCATIONS

DOYLE DRIVE REPLACEMENT
CONTACT: JOHN YEAKEL, CALTRANS
ADDRESS: 111 GRAND AVENUE, OAKLAND, CA 94612

DELINEATION OF WATERS OF THE UNITED STATES AT THE CITY AND COUNTY OF SAN FRANCISCO, DOYLE DRIVE REPLACEMENT
IN: ALL LOCATIONS IN THE PRESIDIO OF SAN FRANCISCO
AT: CITY AND COUNTY OF SAN FRANCISCO, DOYLE DRIVE REPLACEMENT
COUNTY: SAN FRANCISCO ROUTE: 101
STATE: CALIFORNIA

PURPOSE: TO IMPROVE THE SEISMIC, STRUCTURAL, AND TRAFFIC SAFETY OF DOYLE DRIVE WITHIN THE SETTING AND CONTEXT OF THE PRESIDIO OF SAN FRANCISCO.

DELINEATORS: YOLANDA MOLETTE, MARTHA LOWE (ESA)

DATE OF DELINEATION: MAY 15, 2007

FILE NO.: SPN-2006-3000905

LAST REVISION 00-00-00 | DATE PLOTTED => 5/24/2007 | TIME PLOTTED => 12:24:04 PM

BORDER LAST REVISED 11/12/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => cfilly

DGN FILE => T:\13145\ns\Presentation\Doyle wetlands for ESA 070907\Figure 1 - Wetland Locations.dgn

(With corrections from: Fed. Reg. Vol. 72, No. 88, page 26082, Tuesday, May 8, 2007)

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as appropriate, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP.

1. Navigation. (a) No activity may cause more than a minimal adverse effect on navigation.
(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.
(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. Culverts placed in streams must be installed to maintain low flow conditions.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety.

15. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

16. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

17. Endangered Species. (a) No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements.
(c) Non-federal permittees shall notify the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that may be affected by the proposed work or that utilize the designated critical habitat that may be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed.
(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.
(e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, explaining the degree of damage to the integrity of any historic properties affected, and Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the U.S. FWS or the NMFS, both lethal and non-lethal "takes" of protected species are in violation of the ESA. Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide Web pages at http://www.fws.gov/ and http://www.noaa.gov/fisheries.html respectively.

18. Historic Properties. (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.
(b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements.
(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.
appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties which the activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.
(d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR 800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non-Federal applicant that he or she cannot begin work until Section 106 consultation is completed.
(e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic preservation

19. Designated Critical Resource Waters. Critical resource waters include, NOAA-designated marine sanctuaries, National Estuarine Research Reserves, state natural heritage sites, and outstanding national resource waters or other waters officially designated by a state as having particular environmental or ecological significance and identified

by the district engineer after notice and opportunity for public comment. The district engineer may also designate additional critical resource waters after notice and opportunity for comment.
(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, and 50 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.
(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 27, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

20. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:
(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).
(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.
(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10 acre and require pre-construction notification, unless the district engineer determines in writing that some other form of mitigation would be more environmentally appropriate and provides a project-specific waiver of this requirement. For wetland losses of 1/10 acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.
(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream restoration, to ensure that the activity results in minimal adverse effects on the aquatic environment.
(e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2 acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2 acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.
(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.
(g) Permittees may propose the use of mitigation banks, in-lieu fee arrangements or separate activity-specific compensatory mitigation. In all cases, the mitigation provisions will specify the party responsible for accomplishing and/or complying with the mitigation plan.
(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

21. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

22. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

23. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

24. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum

acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

25. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:
"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate
the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

_____
(Transferee)

_____
(Date)

26. Compliance Certification. Each permittee who received an NWP verification from the Corps must submit a signed certification regarding the completed work and any required mitigation. The certification form must be forwarded by the Corps with the NWP verification letter and will include:
(a) A statement that the authorized work was done in accordance with the NWP authorization, including any general or specific conditions;
(b) A statement that any required mitigation was completed in accordance with the permit conditions; and
(c) The signature of the permittee certifying the completion of the work and mitigation.

27. Pre-Construction Notification. (a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, as a general rule, will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:
(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or
(2) Forty-five calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 17 that listed species or critical habitat might affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 18 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) is completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee cannot begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:
(1) Name, address and telephone numbers of the prospective permittee;
(2) Location of the proposed project;
(3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the project and when provided result in a quicker decision.);
(4) The PCN must include a delineation of special aquatic sites and other waters of the United States on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters of the United States, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, where appropriate;
(5) If the proposed activity will result in the loss of greater than 1/10 acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.
(6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

(7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

(d) Agency Coordination: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(2) For all NWP 48 activities requiring pre-construction notification and for other NWP activities requiring pre-construction notification to the district engineer that result in the loss of greater than 1/2-acre of waters of the United States, the district engineer will immediately provide (e.g., via facsimile transmission, overnight mail, or other expeditious manner) a copy of the PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will then have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame, but will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(4) Applicants are encouraged to provide the Corps multiple copies of pre-construction notifications to expedite agency coordination.

(5) For NWP 48 activities that require reporting, the district engineer will provide a copy of each report within 10 calendar days of receipt to the appropriate regional office of the NMFS.

(e) District Engineer's Decision: In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. If the proposed activity requires a PCN and will result in a loss of greater than 1/10 acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for projects with smaller impacts. The district engineer will consider any proposed compensatory mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects to the aquatic environment of the proposed work are minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects on the aquatic environment are minimal, after considering mitigation, the district engineer will notify the permittee and include any conditions the district engineer deems necessary. The district engineer must approve any compensatory mitigation proposal before the permittee commences work. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure no more than minimal adverse effects on the aquatic environment. If the net adverse effects of the project on the aquatic environment (after consideration of the compensatory mitigation proposal) are determined by the district engineer to be minimal, the district engineer will provide a timely written response to the applicant. The response will state that the project can proceed under the terms and conditions of the NWP.

If the district engineer determines that the adverse effects of the proposed work are more than minimal, then the district engineer will notify the applicant either: (1) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (2) that the project is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level; or (3) that the project is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse effects occur to the aquatic environment, the activity will be authorized within the 45-day PCN period. The authorization will include the necessary conceptual or specific mitigation or a requirement that the applicant submit a mitigation plan that would reduce the adverse effects on the aquatic environment to the minimal level. When mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan.

28. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

Making San Francisco Bay Better

June 12, 2009

California Department of Transportation
111 Grand Avenue
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Jeff Jensen, Office Chief

AND

San Francisco County Transportation Authority
100 Van Ness Avenue, 25th Floor
San Francisco, California 94102

ATTENTION: Leroy L. Saage, PE, Doyle Drive Project Manager

SUBJECT: Consistency Determination No. CN 2-08

Ladies and Gentlemen:

On February 14, 2008, the California Department of Transportation and the San Francisco County of Transportation submitted a description of the project and requested that the Commission concur that the proposed project is consistent with its Amended Coastal Zone Management Program for San Francisco Bay. The Commission concurs with the determination of the California Department of Transportation and the San Francisco County of Transportation that seismically retrofit, use and maintain the roadway along an approximately 1.6-mile-long, 105-foot-wide section of Doyle Drive/Highway 101, at the southern approach to the Golden Gate Bridge, between the Merchant Road and Girard Road access ramps, in the Golden Gate National Recreation Area's Presidio, in the City and County of San Francisco, is consistent with the Commission's Amended Management Program for San Francisco Bay.

The Commission's Letter of Agreement for the subject consistency determination is attached. If you should have any questions regarding the attached Letter of Agreement or need any further assistance, please contact Karen Wolowicz of my staff at 415/352-3669 or karenw@bcdc.ca.gov.

Sincerely,

WILL TRAVIS
Executive Director

WT/KW/ra
Enc.
cc: U.S. Army Corps of Engineers, Attn: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn: Certification Section
Environmental Protection Agency
Federal Highway Administration, Attn: Lanh Phan
Presidio Trust, Attn: Michael Boland

Making San Francisco Bay Better

LETTER OF AGREEMENT FOR CONSISTENCY DETERMINATION NO. CN 2-08

June 12, 2009

California Department of Transportation
111 Grand Avenue
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Jeff Jensen, Office Chief

AND

San Francisco County Transportation Authority
100 Van Ness Avenue, 25th Floor
San Francisco, California 94102

ATTENTION: Leroy L. Saage, PE, Doyle Drive Project Manager

Ladies and Gentlemen:

I. Agreement

A. The San Francisco Bay Conservation and Development Commission agrees with the determination of the California Department of Transportation and the San Francisco County Transportation Authority that the following project is consistent with the Commission's Amended Management Program for San Francisco Bay:

Location: Along an approximately 1.6-mile-long, 105-foot-wide section of Doyle Drive/Highway 101, at the southern approach to the Golden Gate Bridge, between the Merchant Road and Girard Road access ramps, in the Golden Gate National Recreation Area's (GGNRA) Presidio, a Waterfront Park/ Beach Priority Use Area as designated by Bay Plan Map No. Four, in the City and County of San Francisco.

Description: Seismically retrofit, use and maintain the roadway to include the following: (1) an approximately 1,804-foot-long, at-grade roadway, East of the Golden Gate Bridge toll plaza; (2) an approximately 1,279-foot-long, 66- to 115-foot-high viaduct located between the Park Presidio Interchange and the San Francisco National Cemetery; (3) an approximately 213-foot-long at-grade roadway; (4) an approximately 853-foot-long Battery Tunnel with landscaping above the tunnel; (5) an approximately 1,214-foot-long, at-grade roadway with a 13- to 26-foot-high berm along the north side to shield the roadway from park visitors; (6) an approximately 1,017-foot-long Main Post Tunnel with landscaping above the tunnel; (7) an approximately 394-foot-long, 10-foot-high causeway; (8) an approximately 1,460-foot-long, at-grade roadway; and (6) reconfiguration of the Park Presidio

Interchange at the west end of Doyle Drive and the South Doyle Drive exit. The northbound roadway will consist of two 11-foot-wide lanes, one 12-foot-wide lane, one 10-foot-wide outside shoulder, and one 4-foot-wide inside (along the median) shoulder in both directions. The southbound roadway would be configured similarly and include an additional 11-foot-wide lane from the Park Presidio Interchange to Lyon Street. An approximately 122- to 146-foot-wide median will be between the north- and south-bound roadways.

B. This agreement is given based on the information submitted by or on behalf of the Department of Transportation and the San Francisco County of Transportation in their letter dated February 14, 2008.

II. Special Conditions

The authorization made herein shall be subject to the following special conditions:

A. Specific Plans and Plan Review

1. **Plan Review.** No work whatsoever shall be commenced pursuant to this authorization until final precise site, demolition, engineering, architectural, grading, public access, landscaping, and best management practices plans and any other relevant criteria, specifications, and plan information for that portion of the work have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The specific drawings and information required will be determined by the staff. To save time, preliminary drawings should be submitted and approved prior to final drawings.

   a. **Site, Architectural, Grading, and Landscaping Plans.** Site, demolition, architectural, grading, public access, and landscaping plans shall include and clearly label property lines, grading, details showing the location, types, dimensions, and materials to be used for all structures, irrigation, landscaping, drainage, seating, parking, signs, lighting, fences, paths, trash containers, utilities and other improvements.

   b. **Engineering Plans.** Engineering plans shall include a complete set of contract drawings and specifications and design criteria. The design criteria shall be appropriate to the nature of the project, the use of any structures, soil and foundation conditions at the site, and potential earthquake-induced forces. Final plans shall be signed by the professionals of record and be accompanied by:

      (1) Evidence that the design complies with all applicable codes; and

      (2) Evidence that a thorough and independent review of the design details, calculations, and construction drawings has been made.

   c. **Preliminary and Final Plans.** Plans submitted shall be accompanied by a letter requesting plan approval, identifying the type of plans submitted, the portion of the project involved, and indicating whether the plans are final or preliminary. Approval or disapproval shall be based upon:

(1) completeness and accuracy of the plans in showing the features required above, particularly property lines, existing and proposed public access improvements, and any other criteria required by this authorization;

(2) consistency of the plans with the terms and conditions of this authorization;

(3) the provision of the amount and quality of public access to and along the shoreline and in and through the project to the shoreline required by this authorization;

(4) consistency of the plans with the recommendations of the Design Review Board;

(5) assuring that appropriate provisions have been incorporated for safety in case of seismic event; and

(6) assuring that appropriate elevations have been met to prevent overtopping, flooding, and 100-year storm events in all public access areas.

Plan review shall be completed by or on behalf of the Commission within 45 days after receipt of the plans to be reviewed.

2. **Conformity with Final Approved Plans**. All work, improvements, and uses shall conform to the final approved plans. Prior to any use of the facilities authorized herein, the appropriate design professional(s) of record shall certify in writing that, through personal knowledge, the work covered by the authorization has been performed in accordance with the approved design criteria and in substantial conformance with the approved plans. No noticeable changes shall be made thereafter to any final plans or to the exterior of any constructed structure, outside fixture, lighting, landscaping, signage, landscaping, or parking area, without first obtaining written approval of the change(s) by or on behalf of the Commission.

3. **Discrepancies between Approved Plans and Special Conditions.** In case of any discrepancy between final approved plans and Special Conditions of this authorization or legal instruments approved pursuant to this authorization, the Special Condition or the legal instrument shall prevail. The permittees are responsible for assuring that all plans accurately and fully reflect the Special Conditions of this authorization and any legal instruments submitted pursuant to this authorization.

4. **Appeals of Plan Review Decisions**. Any plan approval, conditional plan approval or plan denial may be appealed by the permittees or any other interested party to the Design Review Board or, if necessary, subsequently to the Commission. Such appeals must be submitted to the Executive Director within 30 days of the plan review action and must include the specific reasons for appeal. The Design Review Board shall hold a public hearing and act on the appeal within 60 days of the receipt of the appeal. If subsequently appealed to the Commission, the Commission shall hold a public hearing and act on the appeal within 90 days of the receipt of the subsequent appeal.

B. **Public Access Areas and Trails**

1. **Restoring Access Areas and Paths**. At project completion, all public access trails existing as of the date of this consistency shall be maintained, replaced, or enhanced to conditions that are equal to or better than those existing at the time of issuance of

this consistency determination. Adequate signage shall be installed to inform park users of all new and existing public access areas and trails.

2. **Minimizing Construction Interruptions**. The Department of Transportation shall make every effort to minimize closures and impacts to existing public access areas adjacent to Doyle Drive during project construction. Every effort shall be made to keep the existing public access areas affected by work described in the consistency determination open to the public after 5 p.m. and on weekends, whenever possible. The existing public access areas affected by authorized work may be closed temporarily to the public during part or all of the construction for public safety. Any public paths closed temporarily due to construction activities authorized shall be clearly identified on signs notifying the public of suitable detour(s). In addition, signs shall be installed at all affected public access entrances informing the public of why the road or path is closed, when the road or path is open, possible detours, and when project construction will be completed.

C. **Construction Best Management Practices**

1. **Debris Removal**. All construction debris shall be removed to and disposed at an authorized location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the permittee, its assigns, or successors in interest, or the owner of the improvements, shall remove such material, at its expense, within ten days after it has been notified by the Executive Director of such placement.

2. **Construction Operations**. All construction operations shall be performed to prevent construction materials from falling into the Bay and Crissy Marsh. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the permittee shall immediately retrieve and remove such material at its expense.

III. Findings and Declarations

A. On February 14, 2008, the Department of Transportation and the San Francisco County Transportation Authority submitted a description of the project and requested that the Commission concur that the project is consistent with its Amended Coastal Zone Management Program for San Francisco Bay.

The project to seismically retrofit Doyle Drive will be funded by the Federal Highway Administration and involves a similar activity, as defined by Commission Regulation Section 10601(e)(3) to the placement of small amounts of inert inorganic fill that would not have a significant adverse effect on present or possible future maximum feasible public access to the Bay or on the environment as defined by Commission Regulation Section 10601(b)(1). Overall, the project will preserve existing recreational opportunities at and to the waterfront. Additionally, the retrofitted highway would pass partly underground, reducing the highway's impact on the Presidio and providing an opportunity to develop a new, approximately 6.0-acre public park area above the proposed Main Post Tunnel. This new 6.0-acre park area will provide a direct pedestrian connection from the Presidio's Main Post area to Crissy Field. The retrofitted project will also result in extending public transit (bus) bays along both sides of Richardson Avenue.

At project completion, access between areas separated by Doyle Drive will be different but equal to existing access between these areas, yet a variety of vehicle roads and recreational trails in the vicinity of the project will be closed for varying lengths of time during project construction. The Construction Traffic Management Plan has not yet been completed, but the Department of Transportation intends to keep the public informed about construction-related vehicle traffic impacts (e.g., road closures and detours) using outreach tools, e.g., press releases, websites, signage, and public service announcements. According to the Department of Transportation, recreational trails would experience short-term, intermittent closures during low traffic periods only, and alternative recreational trail routes would be provided. Special Conditions have been included to ensure that all roadway and trail closures are adequately signed and noticed, that alternative routes are provided, that once construction is complete that similar or superior public access areas and trails to those existing at the date of this consistency determination are provided, and that best construction management practices are used.

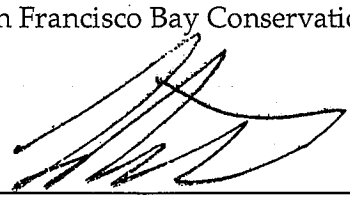
According to the Department of Transportation, the park experience will be enhanced, as portions of the roadway will be in tunnels or shielded from view by berms. Views of the Bay for vehicles driving through the proposed tunnels and along the at-grade roadway (between the tunnels) where a berm alongside the north-edge shoulder will be constructed will be obstructed, but the Department of Transportation maintains that the benefits of road reconfiguration to park users outweighs the loss of views from vehicles on Doyle Drive, that the road will be much safer than the existing Doyle Drive, and that the newly configured Doyle Drive will also afford superb view.

B. An environmental review conducted by the Department of Transportation to seismically repair, maintain and use the approximately 1.6 mile long section of Doyle Drive resulted in approval of an Environmental Impact Report/ Statement under the California Environmental Quality Act (CEQA) and the National Environmental Protection Act (NEPA) on October 14, 2008.

C. The Commission, pursuant to the Coastal Zone Management Act of 1972, as amended (16 USC Section 1451), and the implementing Federal Regulations in 15 CFR Part 930, is required to review Federal projects within San Francisco Bay and agree or disagree with the Federal agency's determination that the project is consistent with the Commission's Amended Coastal Zone Management Program for San Francisco Bay. This letter constitutes such review and comment.

D. Pursuant to Regulation Section 10620, the project was listed with the Commission on May 7, 2009.

Executed in San Francisco, California, on behalf of the San Francisco Bay Conservation and Development Commission on the date first above written.



WILL TRAVIS
Executive Director
San Francisco Bay Conservation and
Development Commission

WT/KW/ra

cc: U.S. Army Corps of Engineers, Attn: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn: Certification Section
Environmental Protection Agency
Federal Highway Administration, Attn: Lanh Phan
Presidio Trust, Attn: Michael Boland

CONCEPTUAL
STORMWATER POLLUTION PREVENTION PLAN
for
DOYLE DRIVE REPLACEMENT PROJECT

04-163744

Prepared for:

CALIFORNIA DEPARTMENT OF TRANSPORTATION
111 GRAND AVENUE
OAKLAND, CA 94623
DAVE PANG
(510)774-4396

Submitted by:
To be determined

Project Site Address
On Route 101 From 0.7 Mile to 0.3 Mile South Of Route 101/1 Separation In The City and County of San Francisco

Contractor's Water Pollution Control Manager
To be determined

Contractor's Designated Water Pollution Control Inspector (if different from WPCM)
To be determined

SWPPP Prepared by:
To be determined

SWPPP Preparation Date
October 19, 2009

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Attachment B.....Water Pollution Control Drawings
Attachment C.....Amendments
Attachment D ..... Computation Sheet for Determining Runoff Coefficients
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Attachment F..... Notice of Construction (NOC) / Notice of Intent (NOI)
Attachment G ..... Maintenance, Inspection, and Repair of Construction Site BMPs
Attachment H ..... Stormwater Quality Construction Site Inspection Checklist
Attachment I..... Trained Contractor Personnel Log
Attachment J ..... Subcontractor Notification Letter and Log
Attachment K.....Notice of Discharge
Attachment L.....(Intentionally Left Blank)
Attachment M ..... Annual Certification of Compliance Form
Attachment N ..... Other Plans/Permits/Agreements
Attachment O.....(Intentionally Left Blank)
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Attachment Q .....(Intentionally Left Blank)
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Attachment S..... Pollutant Testing Guidance Table
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Section 100
SWPPP Certifications and Approval

100.1 Initial SWPPP Certification

Project Name: **DOYLE DRIVE REPLACEMENT PROJECT**

Caltrans Contract Number: **04-163744**

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Contractor's Signature	Date
Contractor's Name and Title	Contractor's Telephone Number

100.2 SWPPP Approval

Is a Local Agency / Private Entity administering the project?

☐ Yes ☒ No

The Caltrans Resident Engineer is the authorized representative of the Department for approving, signing, and certifying the SWPPP in conformance with Section H, Provision 8.b; and Section M, Provision 10 of the Caltrans Permit (CAS000003, Order No. 99-06-DWQ). The SWPPP was prepared by the Contractor and submitted for review and approval to the Resident Engineer, pursuant to the Special Provisions, the SWPPP/WPCP Preparation Manual, and the Standard Specifications Section 7-1.01G – Water Pollution. The Contractor is responsible and liable at all times for compliance with applicable requirements for which compliance is ultimately determined by the Regional Water Quality Control Board (RWQCB), the State Water Resources Control Board (SWRCB), and/or the U.S. Environmental Protection Agency (EPA).

For Caltrans Use Only
Resident Engineer's Approval and
Caltrans Certification of the
Stormwater Pollution Prevention Plan

Project Name: **DOYLE DRIVE REPLACEMENT PROJECT**

Caltrans Contract Number: **04-163744**

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Resident Engineer's Signature	Date
Dave Pang	(510)774-4396
Resident Engineer's Name	Resident Engineer's Telephone Number

100.3 Annual Compliance Certification

By June 15 of each year, the contractor shall submit an Annual Certification of Compliance to the Resident Engineer (and Oversight Engineer if applicable) stating compliance with the terms and conditions of the Permits and the SWPPP. The Annual Certification of Compliance Form and Resident Engineer Approval Form are included in Attachment M.

Section 200
SWPPP Amendments

200.1 SWPPP Amendment Certification and Approval

This SWPPP shall be amended:

- Whenever there is a change in construction or operations which may affect the discharge of pollutants to surface waters, groundwater(s), or a municipal separate storm sewer system (MS4); or
- If any condition of the Permits is violated or the general objective of reducing or eliminating pollutants in stormwater discharges has not been achieved. If the RWQCB determines that a Permit violation has occurred, the SWPPP shall be amended and implemented within 14 calendar days after notification by the RWQCB;
- Annually, prior to the defined rainy season, when required by the project's Special Provisions; and
- When deemed necessary by the Resident Engineer.

The following items shall be included in each amendment:

- Who requested the amendment;
- The location of proposed change;
- The reason for change;
- The original BMP proposed, if any; and
- The new BMP proposed.

The amendments for this SWPPP, along with the Contractor's Certification and the Resident Engineer's Approval, can be found in Attachment C. Amendments are listed in the Amendment Log in Section 200.2 and a copy is also included in Attachment C.

SWPPP amendments to also include:

1. When and where dewatering operations are to be utilized on the project site.

2. Asphalt and concrete crushing/recycling or production plants to be mobilized to the project site.

200.2 Amendment Log

Project Name: **DOYLE DRIVE REPLACEMENT PROJECT**

Caltrans Contract Number: **04-163744**

Amendment No.	Date	Brief Description of Amendment	Prepared By

Section 300
Introduction and Project Description

300.1 Introduction and Project Description

The existing Doyle Drive, United States (U.S.) Highway 101, is an elevated freeway aligned from approximately, east to west, Girard Road (near the Palace of Fine Arts) to the Golden Gate Bridge approach within the Presidio National Park, in the City and County of San Francisco. Doyle Drive is at its design life, and may not be structurally safe during a future seismic event. Short-term improvements are no longer cost effective and existing structures, such as, the Marina Viaduct (Low Viaduct), Presidio Viaduct (High Viaduct) and Ruckman Undercrossing have structural sufficiency ratings below recommended levels. The proposed improvements would address structural deficiencies and bring Doyle Drive to current design and safety standards.

In the proposed replacement scheme, the existing footprint of the Presidio Parkway (Parkway) will be realigned. Included in this proposal are the following general elements: the modifications to the interchanges at Girard Road and California State Route (SR) 1; two elevated structures: Low Causeway and High Viaduct; two cut-and-cover tunnels: Main Post and Battery Tunnels; multiple at-grade roadway sections; and a temporary detour to facilitate traffic movement during construction. The detour is anticipated to be in use for two winter seasons.

Contract 4 of the Doyle Drive Project extends from, east to west, post-mile (PM) 8.8 to PM 9.2 along U.S. Highway 101. Contract 4 consists of the Southern Battery Tunnel, at-grade roads, and a temporary roadway detour. The overall Parkway project has an approximate disturbed soil and net increased impervious areas of 42 acres and 27.3 acres, respectively. Within Contract 4, the impervious areas are approximately 1.6 acres for the new Doyle Drive alignment, 1.8 acres for the new Presidio roadways, and 7.1 acres for the temporary detour.

300.2 Unique Site Features

The Presidio is situated within the jurisdiction of the San Francisco Bay Regional Water Quality Ccontrol Board (Region 2). Specifically, the Parkway is located within Hydrologic Sub-Area (HSA) 203.40, as part of the larger San Francisco Bayside Hydrologic Area. Within this HSA, the direct downstream receiving water body is the San Francisco Bay-Central, which is also included as part of the Federal Clean Water Act (CWA) Section 303(d) List of Water Quality Limited Segments. Within Contract 4, Crissy Marsh is also a receiving water body.

The San Francisco Bay-Central is listed for the following pollutants/stressors of concern: chlordane, DDT, dieldrin, dioxin compounds, exotic species, furan compounds, mercury, polychlorinated biphenyls (PCBs), PCBs (dioxin-like), and selenium. Of these, only mercury has been approved as Total Maximum Daily Load; PCBs are awaiting concurrence by the U.S. EPA.

The overall drainage system within Presidio property is divided into separate stormwater and sanitary pipe networks. The sanitary network in proximity to the Parkway is metered to the City of San Francisco combined sewer system, and is ultimately treated at the Southeast Water Pollution Control Plant. Conversely, the stormwater network discharges to the San Francisco Bay. During high flow events, sanitary sewer flows from the Presidio, commingled with combined sewer from the City, enter the North Shore Outfall Consolidation storage basin. Presently, stormwater flows from Doyle Drive are not treated.

According to the National Resource Conservation Service, the predominant Hydrologic Soil Group (HSG) within the limits of Contract 4 is rated "D." A HSG rating of "D" indicates that the surface, and shallow depth, soils are high in clay content and are impermeable.

Soil throughout Contract 4 is non-hazardous for lead. Currently, it is anticipated that excess soil will be given to the Contractor; however, reuse of the soil on the project may be feasible if concurrence is provided by the Presidio Trust. Beneath the non-hazardous soil is bedrock. The bedrock contains serpentine and is hazardous. Excavation will include bedrock, thus disposal of the hazardous bedrock at a class I facility will be required.

The general land use is for Presidio National Park purposes. Many of the neighboring structures to the Parkway are low-level buildings of varying historical significance.

300.3 Construction Site Estimates

The following are estimates of the construction site:

Construction site area	47.2	acres
Percentage impervious area before construction	68	%
Runoff coefficient before construction [(1), (3)]	0.79	
Percentage impervious area after construction	73	%
Runoff coefficient after construction [(1), (3)]	.81	
Anticipated stormwater flow onto the construction site [(2), (3)]	attachm't E	cfs

(1) Calculations are shown in Attachment D.
(2) Calculations are shown in Attachment E.
(3) Reference any Hydrology and Hydraulic reports available for the project in Attachment D and E and also add the reference list in Section 400.

300.4 Project Schedule/Water Pollution Control Schedule

A hard copy of the water pollution control schedule is attached in this section. The construction schedule, included as part of this conceptual SWPPP, considers the amount and duration of soil exposed to erosion by wind, rainfall and vehicle tracking, and attempts to minimize disturbed soil areas during each rainy season. The Contractor will be prepared with sufficient quantities of

temporary water pollution control practices, year-round, to deploy soil stabilization and sediment control practices, in response to seasonal and unseasonal rainfall.

Annual SWPPP amendments will need to include a separate SWPPP implementation schedule to show when soil stabilization, sediment control and other SWPPP measures will be completed at 25, 50 and 100 % prior to the beginning of the wet season.

300.5 Contact Information/List of Responsible Parties

The Water Pollution Control Manager (WPCM) assigned to this project is:

To be determined

To be determined

The WPCM shall have primary responsibility and significant authority for the implementation, maintenance, inspection and amendments to the approved SWPPP. The WPCM will be available at all times throughout duration of the project. Duties of the Contractor's WPCM include but are not limited to:

Ensuring full compliance with the SWPPP and the Permit;

Implementing all elements of the SWPPP, including but not limited to:

- Implementing prompt and effective erosion and sediment control measures; and
- Implementing all non-stormwater management, and materials and waste management activities such as: monitoring discharges (dewatering, diversion devices); general site clean-up; vehicle and equipment cleaning, fueling and maintenance; spill control; ensuring that no materials other than stormwater are discharged in quantities, which will have an adverse effect on receiving waters or storm drain systems, etc.;

Conducting pre-storm inspections;

Conducting post-storm inspections;

Conducting storm event inspections;

Conducting routine inspections as specified in the Special Provisions or described in the SWPPP;

Preparing annual compliance certification;

Ensuring elimination of all unauthorized discharges;

Mobilizing crews in order to make immediate repairs to the control measures (the Contractor's WPCM shall be assigned authority by the Contractor to mobilize crews);

Coordinating with the Resident Engineer to assure all of the necessary corrections/repairs aremade immediately, and that the project complies with the SWPPP, the Permit and approved plans at all times; and

Submitting Notices of Discharge and reports of Illicit Connections or Illegal Discharges.

Conducting daily storm inspections at 24-hour intervals during extended rain events lasting longer than 24 hours.

Submitting a rain event action plan to the RE prior to each rain event as attached in NSSP-07-345.

Section 400
References, Other Plans, Permits, and Agreements

The following documents are made a part of this SWPPP by reference:

- Standard Plans and Specifications, dated May 2006.
- Contract Plans and specifications No. 04-163744, dated October x, 2009, prepared by CALTRANS.
- SWRCB Order No. 99-06-DWQ, NPDES No. CAS000003 ("Permit"), National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans), July 1999.
- Modification of SWRCB Order 99-08-DWQ, NPDES General Permit No. CAS000002 ("General Permit"), WDRs for Discharges of Storm Water Runoff Associated with Construction Activity to include Small Construction Activity (One to Five Acres).
- SWRCB Resolution No. 2001-046, "Modification of Water Quality Order 99-08-DWQ State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General *Permit For Storm Water Discharges Associated With Construction Activity (CGP)*" to amend the monitoring provisions of the General Permit for sampling and analysis requirements.
- SWRCB Order No. 99-08-DWQ, NPDES General Permit No. CAS000002 ("General Permit"), WDRs for Discharges of Storm Water Runoff Associated with Construction Activity, August 1999.
- Caltrans Statewide Storm Water Management Plan (SWMP), dated 2003.
- Caltrans SWPPP/WPCP Preparation Manual, dated March 2007.
- Caltrans "Construction Site Storm Water Quality Sampling Guidance Manual"
- Caltrans "Water Quality Data-Reporting Protocols" Water Quality Control Plan for the San Francisco Bay Basin
- Clean Water Act Section 401 Water Quality Certification for the Doyle Drive Replacement Project, issued by the San Francisco Bay RWQCB, dated 06/03/09.
- Clean Water Act Section 404 Nationwide Permit issued by the U.S. Army Corps of Engineers, dated 05/14/09.
- Bay Conservation and Development Commission, Consistency Determination, dated 06/12/09.
- Traffic Mangement Plan.

Attachment N includes copies of the Caltrans Statewide Permit, the Construction General Permit, and other local, state, and federal plans and permits. Following is a list of the other local, state, and federal plans and permits included in Attachment N:

Section 500
Body of SWPPP

500.1 Objectives

This SWPPP has six main objectives:

- Identify all pollutant sources, including sources of sediment that may affect the quality of stormwater discharges associated with construction activity (stormwater discharges) from the construction site;
- Identify non-stormwater discharges;
- Identify, construct, implement in accordance with a time schedule, and maintain BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction;
- Develop a maintenance schedule for BMPs installed during construction designed to reduce or eliminate pollutants after construction is completed (post-construction BMPs);
- Identify a sampling and analysis strategy and sampling schedule for discharges from construction activity which discharge directly into water bodies listed on Attachment 3 of the Construction General Permit (Clean Water Act Section 303(d) [303(d)] Water Bodies listed for Sedimentation); and
- For all construction activity, identify a sampling and analysis strategy and sampling schedule for discharges that have been discovered through visual monitoring to be potentially contaminated by pollutants not visually detectable in the runoff.

This SWPPP conforms with the required elements of the Permit and with the required elements of the Construction General Permit issued by the State of California, State Water Resources Control Board (SWRCB). This SWPPP will be modified and amended to reflect any amendments to the Permits, or any changes in construction or operations that may affect the discharge of pollutants from the construction site to surface waters, groundwaters, or the municipal separate storm sewer system (MS4). The SWPPP will also be amended if it is in violation of any condition of the Permit or has not achieved the general objective of reducing pollutants in stormwater discharges. The SWPPP shall be readily available onsite for the duration of the project.

500.2 Vicinity Map

The construction project vicinity map showing the project location, surface water boundaries, geographic features, construction site perimeter, staging areas, storage yards, and general topography, is located in Attachment A. The project's Title Sheet provides more detail regarding the project location and is also included in Attachment A.

500.3 Pollutant Sources and BMP Identification

500.3.1 Inventory of Materials and Activities that May Pollute Stormwater

The following is a list of construction materials that will be used and activities that will be performed that will have the potential to contribute pollutants, other than sediment, to stormwater runoff (control practices for each activity are identified in the WPCDs provided in Attachment B and/or in Sections 500.3.4 through 500.3.8.2):

- Vehicle fluids, including oil, grease, petroleum, and coolant;
- Asphaltic emulsions associated with asphalt-concrete paving operations;
- Cement materials associated with PCC paving operations, drainage structures, median barriers, and bridge construction;
- Base and subbase material;
- Joint and curing compounds;
- Concrete curing compounds (e.g. methacrylate and epoxy resin products);
- Paints;
- Solvents, thinners, acids;
- Sandblasting materials;
- Mortar Mix;
- Raw landscaping materials and wastes (topsoil, plant materials, herbicides, fertilizers, pesticides, mulch);
- BMP materials (sandbags, liquid copolymer);
- Treated lumber (materials and wastes);
- PCC rubble;
- Masonry block rubble; and
- General litter

Potential non-stormwater and waste management related discharges are described in Sections 500.3.8.1 and 500.3.8.2, respectively.

The following is a list of construction activities that have the potential to contribute sediment to stormwater discharges include: (control practices for each activity are identified in the WPCDs provided in Attachment B and/or in Sections 500.3.4 through 500.3.7):

- Clearing and grubbing operations;
- Grading operations;
- Soil import operations;
- Storm drain and structure excavation operations;
- Sandblasting operations;
- Landscaping operations

Sections 500.3.4 to 500.3.8.2 lists all Best Management Practices (BMPs) that are contract requirements, including details used for this project. Implementation and location of BMPs, including details, are shown on the WPCDs in Attachment B. Narrative descriptions of BMPs to be used during the project are listed by category in each of the following SWPPP sections.

500.3.2 Existing (Pre-Construction) Control Measures

The following are existing (pre-construction) control measures encountered within the project site:

- Slopes within the construction site are protected with native vegtation.
- There are vegetated ditches within the construction site.
- Installed soil reinforcing fabric and rock as an all weather surfacing for contractor staging areas.
- Deployed perimeter fencing and barriers.

500.3.3 Nature of Fill Material and Existing Data Describing the Soil

Existing site features that, as a result of past usage, may contribute pollutants to stormwater (e.g., toxic materials that are known to have been treated, stored, disposed, spilled, or leaked onto the construction site) include:

- Soil within Contract 4 is contaminated with lead, but not considered hazardous. The present strategy is to off-haul all excavated material. Excavated soil may be re-used; however, the Presidio must concur. Bedrock beneath the soil contains serpentine and is hazardous. Excavated bedrock material will required disposal at a class I facility.

500.3.4 Soil Stabilization (Erosion Control)

Soil stabilization, also referred to as erosion control, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in stormwater runoff. Soil stabilization BMPs protect the soil surface by covering and/or binding soil particles. This project will incorporate minimum temporary soil stabilization requirements, temporary soil stabilization measures required by the contract documents, and other measures selected by the contractor. The steps outlined in the instructions for this section for identifying soil stabilization BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B.

1) Preserve existing vegetation where required and when feasible.

2) Apply temporary soil stabilization (erosion control) to remaining active and non-active areas as required by the Contract Specifications and Special Provisions and the SWPPP/WPCP Preparation Manual, Tables 1-3 and 1-4, and Appendix D. Reapply as necessary to maintain effectiveness.

3) Implement temporary soil stabilization measures at regular intervals throughout the defined rainy season to achieve and maintain the contract's disturbed soil area requirements. When the Contract Special Provisions require it, temporary soil stabilization will be implemented 20 days prior to the defined rainy season.

4) In accordance with Table 1-3 of the SWPPP/WPCP Preparation Manual, stabilize non-active areas within 14 days of cessation of construction activities, or one day prior to all predicted rain events, whichever comes first.

5) Control erosion in concentrated flow paths by applying erosion control blankets, check dams, erosion control seeding, and lining swales as required in the Special Provisions and/or as shown on plans.

6) Apply seed to areas deemed substantially complete by the Resident Engineer during the defined rainy season.

7) At completion of construction, apply permanent erosion control to all remaining disturbed soil areas as required in the Special Provisions and/or as shown on plans.

Sufficient soil stabilization materials will be maintained onsite to allow implementation in conformance with Caltrans requirements and described in this SWPPP. This includes implementation requirements for active and non-active areas that require deployment before the onset of rain.

The following soil stabilization BMP implementation table indicates the BMPs that shall be implemented to control erosion on the construction site. Locations and details of temporary soil stabilization BMPs are shown on the WPCDs in Attachment B. The following list of BMPs and narrative explain how the selected BMPs will be incorporated into the project.

TEMPORARY SOIL STABILIZATION BMPs						
CONSTRUCTION BMP ID NO [1]	BMP NAME	MINIMUM REQUIRE-MENT [3]	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
SS-1	Scheduling	✓		☒	☐	
SS-2	Preservation of Property/ Preservation of Existing Vegetation	✓	☒	☒	☐	
SS-3	Temporary Hydraulic Mulch (Bonded Fiber Matrix)	✓(2)	☒	☒	☐	
	Temporary Hydraulic Mulch (Polymer Stabilized Fiber Matrix)	✓(2)	☐	☐	☒	Used SS-3
SS-4	Temporary Erosion Control (With Temporary Seeding)	✓(2)	☒	☒	☐	
SS-5	Temporary Soil Stabilizer	✓(2)	☐	☐	☒	Used SS-3
SS-6	Temporary Erosion Control (Straw Mulch with Stabilizing Emulsion)	✓(2)	☐	☐	☒	Used SS-3
SS-7	Temporary Erosion Control Blanket (On Slope)	✓(2)	☒	☒	☐	
	Temporary Erosion Control Blanket (In swale or ditch)		☒	☒	☐	
SS-7	Temporary Cover (Plastic Covers)	✓(2)	☒	☒	☐	
SS-8	Temporary Mulch (Wood)		☐	☐	☒	Not applicable
SS-9	Earth Dikes / Drainage Swales & Lined Swales		☐	☒	☐	
SS-10	Outlet Protection / Velocity Dissipation Devices		☐	☒	☐	
SS-11	Slope Drains		☐	☒	☐	

TEMPORARY SOIL STABILIZATION BMPs						
SS-12	Streambank Stabilization		☐	☒	☐	
ALTERNATIVE SOIL STABILIZATION BMPs USED[4] ☒ Yes ☐ No						**IF USED, STATE REASON**
CONSTRUCTION BMP ID NO [1]	**BMP NAME**					
SS-2	Temporary Fence (Type ESA)					To preserve existing vegetation and natural resources through out the project site

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] The Contractor shall ensure implementation of one of the two measures listed or a combination thereof to achieve and maintain the contract's rainy and non-rainy season requirements.
[3] Not all minimum requirements may be applicable to every project. Applicability to a specific project shall be determined by the Contractor and approved by the Resident Engineer.
[4] Use of alternative BMPs will require writtern approval by the Resident Engineer.

The Contractor shall monitor the National Weather Service weather forecast on a daily basis throughout duration of the contract. The Contractor may use an alternative weather forecasting service, if approved by the Resident Engineer. Active areas where soil disturbance has occurred, and will continue to occur, during the ensuing 21 days shall be protected using appropriate water pollution control practices within 15 days, or before predicted precipitation, whichever occurs first.

Temporary soil stabilization and sediment control practices will be implemented during the rainy season between October 15 and April 15. The Contractor shall implement soil stabilization and sediment control practices a minimum of 10 days before the start of the rainy season using Temporary Hydraulic Mulch, Temporary Silt Fences, Temporary Fiber Rolls and Temporary Drainage Inlet Protection. The Contractor shall maintain soil stabilization and sediment control materials on site to protect disturbed soil areas.

SCHEDULING:

The construction schedule included in this Conceptual SWPPP considers the amount and duration of soil exposed to erosion by wind, rainfall and vehicle tracking, and minimizes disturbed soil areas during any rainy season. The Contractor will be prepared with sufficient quantities of temporary water pollution control practices, year-round, to deploy soil stabilization and sediment control practices, in response to seasonal and unseasonal rainfall.

Annual SWPPP amendments will need to include a separate SWPPP implementation schedule to show when soil stabilization, sediment control and other SWPPP measures will be completed at 25, 50 and 100 % prior to the beginning of the wet season.

PRESERVATION OF EXISTING VEGETATION:

Temporary Fence Type ESA (TFESA) will be installed prior to clearing and grubbing or soil disturbing activities, in order to preserve existing vegetation throughout the project site. TFESA locations have been delineated after consideration of impacts from grade changes to existing vegetation and root zone.

TEMPORARY HYDRAULIC MULCH:

Temporary Hydraulic Mulch (Bonded Fiber Matrix - BFM) will be applied to active and non-active disturbed soil areas that require temporary protection until permanent vegetation is established, or areas that must be redistributed following an extended period of inactivity. Prior to application, embankments and fill areas will be roughened by rolling with a crimping- or punching-type roller or by track-walking. BFM requires 12 to 24 hours to dry to become effective.

TEMPORARY EROSION CONTROL BLANKET:

Temporary Erosion Control Blanket will be used on active disturbed soil areas that are particularly difficult to stabilize. These may include: steep slopes (greater than 1:3, V:H); channels where flow exceeds 3.3 feet per second; and areas where vegetation establishment can take periods extending into the rainy season.

TEMPORARY COVER:

Temporary Cover will be used on active disturbed soil areas that are particularly difficult to stabilize, especially stockpiles of soil. Stockpiles shall be located out of floodplains when possible, and at least 50 feet from concentrated flows of stormwater, drainage courses, or inlets, unless written approval is obtained from the Resident Engineer. The Contractor may discontinue addition or removal of material for up to 21 days, and a stockpile will still be considered active. The Contractor shall protect active stockpiles with plastic or geotextile cover, soil stabilization measures, or with linear sediment barrier when precipitation is predicted. Active stockpiles of cold mix asphalt concrete shall be placed on an impervious surface and covered with plastic when precipitation is predicted.

The Contractor shall protect inactive soil stockpiles with a plastic or geotextile cover, or with soil stabilization measures at all times during the rainy season. A linear sediment barrier around the perimeter of the stockpile shall also be used. During the non-rainy season soil stockpiles shall be covered and protected with a linear sediment barrier when precipitation is predicted. The Contractor shall control wind erosion during dry weather as provided in Section 10, "Dust Control," of the Standard Specifications.

Stockpiles of material containing aerially deposited lead will not be placed where affected by surface run-on or run-off. Stockpiles shall be covered with plastic sheeting 1/2 inch minimum thickness or one foot of nonhazardous material, and linear sediment barrier (temporary gravel bag berm). Stockpiles shall not be placed in environmentally sensitive areas. Stockpiled material shall not enter storm drains, inlets, or waters of the State

Stockpiles of portland cement concrete rubble, asphalt concrete (AC), hot mix asphalt (HMA), AC and HMA rubble, aggregate base, or aggregate subbase shall be covered with plastic or geotextile, or protected with a linear sediment barrier at all times during the rainy season, and also when precipitation is predicted during the non-rainy season.

Stockpiles of cold mix asphalt concrete shall be placed on, and covered with, impermeable material at all times during the rainy season, and when precipitation is predicted during the non-rainy season.

Stockpiles of pressure treated wood shall be covered with impermeable material and placed on pallets at all times during the rainy season, and when precipitation is predicted during the non-rainy season.

The Contractor shall repair or replace linear sediment barriers and covers as needed, or as directed by the Engineer, to keep them functioning properly. Sediment shall be removed when it accumulates to 1/3 of the linear sediment barrier height.

SS-9, SS-10, SS-11:

Dikes, drainage swales, outlet protection/velocity dissipation devices, and slope drains may be used to divert run-on to disturbed soil areas. Run-on calculations to size these BMPs are included in Attachement E.

500.3.5 Sediment Control

Sediment controls are structural measures that are intended to complement and enhance the selected soil stabilization (erosion control) measures and reduce sediment discharges from construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water. This project will incorporate minimum temporary sediment control requirements, temporary sediment control measures required by the contract documents, and other measures selected by the contractor. The steps outlined in the instructions for this section for identifying sediment control BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B.

Sediment control BMPs will be installed at all appropriate locations along the site perimeter and at all operational internal inlets to the storm drain system at all times during the rainy season. During the non-rainy season, adequate sediment control materials will be available to control sediment discharges at the downgrade perimeter and operational inlets in the event of a predicted storm.

Temporary sediment control materials, equivalent to 10% of the installed quantites on the site during the rainy and non-rainy seasons will be maintained onsite throughout the duration of the project for implementation in event of predicted rain, rapid response to failures or emergencies, in conformance with other Caltrans requirements, and as described in the SWPPP. This includes implementation requirements for active areas and non-active areas before the onset of rain.

Prior to the opening of a new DSA in the rainy season, additional temporary sediment control materials necessary to protect this DSA will be stored onsite.

The following sediment control BMP implementation table indicates the BMPs that shall be implemented to control sediment on the construction site. Implementation and locations of temporary sediment control BMPs are shown on the WPCDs in Attachment B and described in this section. The BMP working details can also be found in Attachment B of this SWPPP. The following list of BMPs and narrative explain how the selected BMPs will be incorporated into the project.

TEMPORARY SEDIMENT CONTROL BMPs						
CONSTRUCTION BMP ID NO[1]	BMP NAME	MINIMUM REQUIRE-MENT [3]	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
SC-1	Temporary Silt Fence	✓[2]	☒	☒	☐	
SC-2	Temporary Sediment Basin		☐	☐	☒	Not applicable
SC-4	Temporary Check Dam		☒	☒	☐	
SC-5	Temporary Fiber Rolls	✓[2]	☒	☒	☐	
SC-6	Temporary Gravel Bag Berm		☒	☒	☐	
SC-7	Street Sweeping	✓	☒	☒	☐	
SC-8	Temporary Sandbags		☐	☐	☒	
SC-9	Temporary Straw Bale Barrier		☐	☐	☒	Not applicable
SC-10	Temporary Drain Inlet Protection	✓	☒	☒	☐	
ALTERNATIVE SEDIMENT CONTROL BMPs USED[4] ☐ Yes ☒ No						IF USED, STATE REASON
SC-1	Temporary Reinforced Silt Fence					

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] The Contractor shall ensure implementation of one of the two measures listed or a combination thereof to achieve and maintain the contract's rainy and non-rainy season requirements.
[3] Not all minimum requirements may be applicable to every project. Applicability to a specific project shall be determined by the Contractor and approved by the Resident Engineer.
[4] Use of alternative BMPs will require written approval by the Resident Engineer.

TEMPORARY SILT FENCE:

Temporary Silt Fence will be installed and maintained at locations shown on the plans to allow sediment to settle from run-off, prior to flowing beyond the site.

TEMPORARY REINFORCED SILT FENCE:

Temporary Reinforced Silt Fence will be installed and maintained at locations shown on the plans to allow sediment to settle from run-off, prior to flowing beyond the site.

TEMPORARY CHECK DAMS:

Temporary Check Dams will be used in natural and man-made channels or drainage ditches to reduce scour and channel erosion, by reducing flow velocity and allowing sediment to settle.

TEMPORARY FIBER ROLLS:

Temporary Fiber Rolls will be used to minimize erosive effects, by reducing effective slope lengths, of stormwater run-off from active and non-active disturbed soil areas. These will also be used around temporary stockpiles to intercept run-off, reduce velocity, release run-off as sheet flow, and provide removal of sediment.

TEMPRARY GRAVEL BAG BERM:

Temporary Gravel Bag Berms will be installed to form a barrier across a slope to intercept runoff, reduce flow velocity, release as sheet flow, and provide some sediment removal. It will be also used as a barrier for stockpiles of soil or any other construction stockpile material.

STREET SWEEPING:

Street Sweeping will be done by using a mechanical sweeper followed by a vacuum-assisted sweeper, or vacuum-assisted dry (waterless) sweeper or regenerative-air sweeper. Street sweeping will occur at the job site entrance and exit locations during: clearing and grubbing activities; earthwork activities; trenching activities; roadway structural section activities; when vehicles are entering and leaving the job site; after soil disturbing activities; after observing off-site tracking of material.

TEMPORARY DRAINGE INLET PROTECTION:

Temporary Drainage Inlet Protection will be used at all locations shown on CWPCDs.

500.3.6 Tracking Control

The following tracking control BMP implementation table indicates the BMPs that shall be implemented to reduce sediment tracking from the construction site onto private or public roads. The steps outlined in the instructions for this section for identifying tracking control BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B. Implementation and locations of sediment tracking BMPs are shown on the WPCDs in Attachment B and described in this sectionThe BMP working details can also be found in Attachment B of this SWPPP. The following list of BMPs and narrative explain how the selected BMPs will be incorporated into thc project.

TEMPORARY TRACKING CONTROL BMPs						
CONSTRUCTION BMP ID NO[1]	BMP NAME	MINIMUM REQUIRE-MENT	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
SC-7	Street Sweeping		☒	☒	☐	
TC-1	Temporary Construction Entrance		☒	☒	☐	
TC-2	Stabilized Construction Roadway		☐	☒	☐	Temporary Access Plan to be proposed by Contractor
TC-3	Temporary Entrance / Outlet Tire Wash		☒	☒	☐	
ALTERNATIVE TRACKING CONTROL BMPs USED[2] ☐ Yes ☒ No						IF USED, STATE REASON

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] Use of alternative BMPs will require written approval by the Resident Engineer.

TEMPORARY CONSTRUCTION ENTRANCE:

Temporary Construction Entrances will be used at points of entrance and exit to reduce tracking of mud and dirt onto public roads by construction vehicles, as shown on the WPCDs included in Attachment B.

TEMPORARY ACCESS:

The Contractor may propose to develop temporary construction roadway to facilitate movement of large equipment and machinery. A Temporary Access Plan will be developed by the Contractor that includes plans and working drawings that show grading, drainage, surfacing materials, fencing details, restoration work to remove access, and post-construction stabilization. The Contractor will prevent heavy erosion, rutting, or migration of surfacing or supporting soils, from encroaching into environmentally sensitive areas. Once the temporary access is no longer needed, it, and all embankment and structural section materials, will be removed and disposed of outside of the right-of-way. Following removal and disposal of materials, the temporary access areas will be graded and restored to conform with adjacent areas and lightly compacted.

500.3.7 Wind Erosion Control

The steps outlined in the instructions for this section for identifying wind erosion control BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B. Locations and details of wind erosion control BMPs are shown on the WPCDs in Attachment B (as applicable). The following list of BMPs and narrative explain how the selected BMPs shall be incorporated into the project.

TEMPORARY WIND EROSION CONTROL BMPs

CONSTRUCTION BMP ID NO[1]	BMP NAME	MINIMUM REQUIRE-MENT[2]	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
WE-1	Wind Erosion Control	✓	☐	☐	☒	Temporary Soil Stabilization BMPs and Temporary Sediment Control BMPs will be deployed to provide wind erosion control benefits.
TC-1	Temporary Construction Entrance		☒	☒	☐	
TC-2	Stabilized Construction Roadway		☐	☐	☐	Temporary Access Plan
-----	All Soil Stabilization Measures included in Section 500.3.4		☒	☒	☐	
ALTERNATIVE WIND EROSION CONTROL BMPs USED[3] ☐ Yes ☒ No						**IF USED, STATE REASON**

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] Not all minimum requirements may be applicable to every project. Applicability to a specific project shall be determined by the Contractor and approved by the Resident Engineer.
[3] Use of alternative BMPs will require written approval by the Resident Engineer.

500.3.8 Construction Site Management

Construction site management shall consist of controlling potential sources of water pollution before they come in contact with storm water systems or watercourses. The Contractor shall control material pollution and manage waste and non-storm water existing at the construction site by implementing effective handling, storage, use, and disposal practices.

500.3.8.1 Non-Stormwater Management Pollution Control

An inventory of potential non-stormwater discharges is provided in this section. The following BMP consideration checklist indicates the BMPs that have been selected to control non-stormwater pollution on the construction site. The steps outlined in the instructions for this section for identifying non-stormwater pollution control BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B. Locations and details of applicable non-stormwater control BMPs are shown on the WPCDs in Attachment B.

Non-stormwater discharges into storm drainage systems or waterways, which are not authorized under the Caltrans Permit or authorized under a separate NPDES permit shall be prohibited.

CONSTRUCTION SITE MANAGEMENT						
NON-STORMWATER MANAGEMENT POLLUTION CONTROL BMPs						
CONSTRUCTION BMP ID NO [1]	BMP NAME	MINIMUM REQUIRE-MENT [2]	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
NS-1	Water Control and Conservation		☐	☒	☐	
NS-2	Dewatering [3]		☐	☐	☒	Alternative BMP used
NS-3	Paving, Sealing, Sawcutting, and Grinding Operations		☒	☒	☐	
NS-4	Temp Stream Crossing [3]		☐	☐	☒	Not applicable
NS-5	Clear Water Diversion [3]		☐	☐	☒	Not applicable
NS-6	Illegal Connection and Illegal Discharge Detection Reporting	✓	☒	☒	☐	
NS-7	Potable Water / Irrigation		☒	☒	☐	
NS-8	Vehicle and Equipment Cleaning	✓	☒	☒	☐	
NS-9	Vehicle and Equipment Fueling	✓	☒	☒	☐	
NS-10	Vehicle and Equipment Maintenance	✓	☒	☒	☐	
NS-11	Pile Driving Operations		☒	☒	☐	
NS-12	Concrete Curing		☒	☒	☐	
NS-13	Material and Equipment Used Over Water		☐	☐	☐	Not applicable
NS-14	Concrete Finishing		☒	☒	☐	

NS-15	Structure Demolition / Removal Over or Adjacent to Water		☒	☒	☐	
ALTERNATIVE NON-STORMWATER CONTROL BMPs USED[4] ☐ Yes ☐ No						**IF USED, STATE REASON**
CONSTRUCTION BMP ID NO [1]	**BMP NAME**					
NS-2	Dewatering and Non-Storm Water Discharge Control					

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] Not all minimum requirements may be applicable to every project. Applicability to a specific project shall be determined by the Contractor and approved by the Resident Engineer.
[3] The BMPs listed above are incidental and do not include operations included as separate line items in the contract.
[4] Use of alternative BMPs will require writtern approval by the Resident Engineer.

This work includes controlling potential sources of pollution before they come in contact with stormwater systems or watercourses. Material pollution and waste and non-stormwater management will be achieved by implementing effective handling, storage, use, and disposal practices.

The Contractor's employees and subcontractors will be trained in these subjects:
1. Material pollution prevention and control
2. Waste management
3. Non-stormwater management
4. Identifying and handling hazardous substances
5. Potential dangers to humans and the environment from spills and leaks or exposure to toxic or hazardous substances

Training will take place before starting work on this job. New employees will receive the complete training before starting work on this job. Weekly meetings will be conducted to discuss and reinforce spill prevention and control; material delivery, storage, use, and disposal; waste management; and non-stormwater management procedures.

WATER CONTROL AND CONSERVATION

Water used for work activities will be managed to prevent erosion or discharge of pollutants into storm drain systems or watercourses. Approval will be obtained before washing anything on the job site with water that could discharge into a storm drain system or watercourse. Discharges will be reported immediately.

If water is used at the job site, conservation practices will be implemented. Water source to broken lines, sprinklers, or valves will be shut off, and breaks will be repaired within 24 hours. If possible,

reuse water from waterline flushing for landscape irrigation. Paved areas will be swept and vacuumed and water will not be used.

ILLEGAL CONNECTION AND DISCHARGE DETECTION AND REPORTING

The job site and the site perimeter will be inspected before starting work for evidence of illegal connections, discharges, or dumping. After starting work, the job site and perimeter will be inspected on a daily schedule. When illegal connections, discharges, or dumping are discovered, the Engineer will be notified immediately. No further action will be taken unless ordered by the Engineer. Unlabeled or unidentifiable material will be assumed hazardous.

VEHICLE AND EQUIPMENT CLEANING

Vehicle and equipment cleaning or washing at the job site will be limited, except that which is necessary to control vehicle tracking or hazardous waste. The Engineer will be notified before cleaning vehicles and equipment at the job site with soap, solvents, or steam. Waste will be contained and recycled, or disposed of, under "Liquid Waste" or "Hazardous Waste" of the Special Provisions, whichever is applicable. Diesel will not be used to clean vehicles or equipment, and the use of solvents will be minimized.
Vehicle and equipment washing will occur in a structure equipped with disposal facilities. If using a structure is not possible, vehicles and equipment must be cleaned or washed at an outside area:

1. Paved with AC, HMA, or portland cement concrete
2. Surrounded by a containment berm
3. Equipped with a sump to collect and dispose of wash water
4. If within the floodplain, located at least 100 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets unless approved
5. If outside the floodplain, located at least 50 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets unless approved

When washing vehicles or equipment with water, water use will be minimized. Hoses will be equipped with a positive shut-off valve.
Liquid from wash racks will be discharged to a recycle, or other approved, system. Liquids and sediment will be removed as necessary. The WPCM will inspect vehicle and equipment cleaning facilities daily, when vehicle and equipment cleaning occurs daily, and weekly when vehicle and equipment cleaning does not occur daily.

VEHICLE AND EQUIPMENT FUELING AND MAINTENANCE

When practicable, maintenance on vehicles and equipment will be performed off-site. If fueling or maintenance must be done on-site, areas will be designated, which will be on level ground and protected from stormwater run-on. If within the floodplain, these areas will be located at least 100 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets, or if outside the floodplain, these areas will be located at least 50 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets.

Containment berms or dikes will be used around the fueling and maintenance area. Adequate quantities of absorbent spill cleanup material and spill kits will be kept in the fueling and maintenance area and on fueling trucks. After use, spill clean-up material and kits will be disposed of immediately. Drip pans or absorbent pads will be used during fueling or maintenance. Fueling or maintenance activities will not be left unattended. Fueling nozzles will be equipped with an automatic shut-off control.

The WPCM will inspect vehicle and equipment maintenance and fueling areas daily, when vehicle and equipment maintenance and fueling occurs daily, and weekly when vehicle and equipment maintenance and fueling does not occur daily.

The WPCM will inspect vehicles and equipment at the job site for leaks and spills on a daily schedule. Operators will inspect vehicles and equipment each day of use. If leaks cannot be repaired immediately, the vehicle or equipment must be removed from the job site.

MATERIAL AND EQUIPMENT USED OVER WATER:

Drip pans and absorbent pads will be placed under vehicles or equipment used over water. An adequate supply of spill clean-up material will be kept with the vehicle or equipment. If the vehicle or equipment will be idle for more than one hour, drip pans or plastic sheeting will be placed under vehicles or equipment over water.

STRUCTURE REMOVAL OVER OR ADJACENT TO WATER:

Demolished material will not be allowed to enter stormwater systems or watercourses. Approved covers and platforms will be used to collect debris. Debris catching devices will be emptied daily and shall be handled as under "Waste Management" of the Special Provisions. The WPCM will inspect, daily, demolition sites within 50 feet of stormwater systems or watercourses.

PAVING, SEALING, SAWCUTTING AND GRINDING ACTIVITIES:

The following materials will be prevented from entering storm drain systems or water courses:

1. Cementitious material
2. Asphaltic material
3. Aggregate or screenings
4. Grinding or sawcutting residue
5. Pavement debris
6. Shoulder backing
7. Methacrylate

Drainage inlets will be covered and linear sediment barriers will be implemented, to protect downhill watercourses until paving, sealing, sawcutting, or grinding activities are complete and excess

material has been removed. During the rainy season, or when precipitation is predicted, paving, sawcutting, and grinding will be limited to places where run-off can be captured.

A vacuum will be used to remove slurry from sawcutting activities immediately after slurry is produced. Slurry will not be allowed to run onto lanes open to public traffic or off the pavement. Residue from portland cement concrete grinding activities will be collected with a vacuum attachment on the grinding machine. Residue will not be left on pavement or allowed to flow across pavement.

THERMOPLASTIC STRIPING AND PAVEMENT MARKERS:

Thermoplastic striping and preheating equipment shut-off valves will be inspected to ensure proper functioning at all times. Preheating, transfering, or loading thermoplastic will not occur within 50 feet of drainage inlets or watercourses. Preheating container will not be filled above a level that is 6 inches below the top. Truck beds will be cleaned daily of scraps or melted thermoplastic.

Unloading, transfering, or loading bituminous material for pavement markers will not be done within 50 feet of drainage inlets or watercourses. Pressure from melting tanks will be released before removing the lid to fill or service. Melting tanks will not be filled above a level that is 6 inches below the top. Bituminous material shall be collected from the roadway after marker removal.

PILE DRIVING:

Spill kits and clean-up material will be kept near pile driving locations. Pile driving equipment will be parked over drip pans, absorbent pads, or plastic sheeting with absorbent material. When precipitation is predicted, pile driving equipment will be protected by parking on plywood and covering with plastic. When not in use, pile driving equipment will be on level ground, protected from stormwater run-on, and, if within the floodplain, at least 100 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets, unless approved. If outside the floodplain, equipment will be stored at least 50 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets. If practicable, vegetable oil will be used instead of hydraulic fluid.

The WPCM will inspect pile driving area for leaks and spills daily, when pile driving occurs daily, and weekly when pile driving does not occur daily.

CONCRETE CURING:

Chemical curing compound will not be oversprayed. Drift will be minimized by spraying as close to the concrete as possible. Drainage inlets will be protected and drainage inlets will be covered before applying curing compound. Minimize the use and discharge of water by using wet blankets or similar methods to maintain moisture while curing concrete.

CONCRETE FINISHING:

Water and solid waste from high-pressure water blasting will be collected and disposed of properly. Drainage inlets within 50 feet will be coverd before sandblasting. Drift of dust and blast material will be minimized by keeping the nozzle close to the surface of the concrete. Blast residue may contain hazardous material.

Containment structures for concrete finishing activities will be inspected for damage before each day of use and before predicted precipitation. Liquid and solid waste from the containment structure will be removed after each work shift.

DEWATERING AND NON-STORM WATER DISCHARGE CONTROL:

Groundwater and accumulated precipitation dewatered from excavations will be collected, conveyed, treated, and disposed to either a storm drain system upon obtaining coverage under Order No. R2-2006-0075 adopted by the San Francisco Bay RWQCB, or obtaining a Batch Discharge permit from San Francisco Public Utilities Commission (SFPUC) for discharges to the sanitary sewer. Potential sanitary sewer and storm drain discharge locations are shown on the CWPCDs.

500.3.8.2 Waste Management Pollution Control

An inventory of construction activities, materials, and waste is provided in Section 500.3.1. The following BMP consideration checklist indicates the BMPs that have been selected to control construction site wastes and materials. The steps outlined in the instructions for this section for identifying waste management and materials pollution control BMPs to be included in the SWPPP have been followed. The applicable Contract Special Provisions, Contract Plans, Standard Plans, and Standard Specifications are provided or listed in Attachment B. Locations and details of applicable materials handling and waste management BMPs are shown on the WPCDs in Attachment B. In the narrative description, a list of waste disposal facilities and the type of waste to be disposed at each facility is also provided. The following list of BMPs and narrative explain how the selected BMPs will be incorporated into the project.

CONSTRUCTION SITE MANAGEMENT

WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL BMPs

CONSTRUCTION BMP ID NO [1]	BMP NAME	MINIMUM REQUIREMENT [2]	CONTRACT BID ITEM	BMP USED		IF NOT USED, STATE REASON
				YES	NO	
WM-1	Material Delivery and Storage	✓	☐	☒	☐	
WM-2	Material Use	✓	☐	☒	☐	
WM-3	Stockpile Management	✓	☒	☐	☐	
WM-4	Spill Prevention and Control	✓	☐	☒	☐	
WM-5	Solid Waste Management	✓	☒	☒	☐	
WM-6	Hazardous Waste Management [3]		☒	☒	☐	
WM-7	Contaminated Soil Management [3]		☒	☒	☐	
WM-8	Concrete Waste Management		☒	☒	☐	
	Temporary Concrete Washout Facility		☐	☐	☒	
	Temporary Concrete Washout (Portable)		☒	☒	☐	
WM-9	Sanitary/Septic Waste Management	✓	☒	☒	☐	
WM-10	Liquid Waste Management		☒	☒	☐	

ALTERNATIVE WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL BMPs USED[4] ☒ Yes ☐ No			IF USED, STATE REASON
WM-8	Temporary Concrete Washout Facility (Portable)		

Notes:
[1] The BMP designations (SS-1, SC-3, etc.) are solely for maintaining continuity with existing Caltrans documents and are not provided to imply that the Construction Site BMP Reference Manual is a required contract document.
[2] Not all minimum requirements may be applicable to every project. Applicability to a specific project shall be verified by the Contractor or determined by Caltrans.
[3] The BMPs listed above are incidental and do not include operations included as separate line items in the contract.
[4] Use of alternative BMPs will require written approval by the Resident Engineer.

MATERIAL MANAGEMENT:

Material will be delivered, used, and stored for this job in a way that minimizes or eliminates discharge of material into the air, storm drain systems, or watercourses. Employees trained in emergency spill clean-up procedures will be present during unloading of hazardous materials or chemicals. Chemical storage areas such as concrete curing compound will be stored in secondary containment system for refueling system, a cover system with side protection will be included to prevent rain water from coming in contact with the refueling system. The contractor must contact the local certified unified program agency (CUPA) to comply with their requirements, such as the preparation of a hazardous materials management plan.

STOCKPILE MANAGEMENT:

Following practices described in this section for managing stockpiles will be implemented during the rainy season and during the non-rainy season when the National Weather Service predicts precipitation with a probability of at least 30 percent.

Stockpile management procedures will be used to reduce or eliminate potential air and water pollution from stockpiled material including soil, paving material, or pressure treated wood.

Stockpiles located within the floodplain, at least 100 feet from concentrated flows of stormwater, drainage courses, or inlets, unless approved. If located outside the floodplain, at least 50 feet from concentrated flows of stormwater, drainage courses, or inlets.

Active and inactive soil stockpiles will be covered with soil stabilization measures, plastic sheeting, or geosynthetic fabric and surrounded with a linear sediment barrier. Portland cement concrete rubble, AC, HMA, AC and HMA rubble, aggregate base or aggregate sub-base stockpiles will be covered with plastic sheeting, or geosynthetic fabric and surrounded with a linear sediment barrier.

Pressure treated wood stockpiles will be placed on pallets, covered with impermeable material.

Cold mix asphalt concrete stockpiles will be placed on impervious surface, covered with impermeable material and protected from run-on and run-off.

If material is added or removed for up to 21 days, the stockpile will be considered still active during that period.

Linear sediment barriers and covers will be maintained as needed to keep them functioning properly. If sediment accumulates to 1/3 of the linear sediment barrier height, sediment will be removed.

SPILL PREVENTION AND CONTROL:

Implement spill and leak prevention procedures for chemicals and hazardous substances stored on the job site. As soon as it is safe, contain and clean-up spills of petroleum products, sanitary and septic waste substances listed under CFR Title 40, Parts 110, 117, and 302.

SOLID WASTE MANAGEMENT:

Trash and debris will be removed from the job site at least once a week. If practicable, nonhazardous job site waste and excess material will be recycled. If recycling is not practicable, disposal will comply with Section 7-1.13, "Disposal of Material Outside the Highway Right of Way."

Sufficient number of closed-lid dumpsters with adequate volume to contain the solid waste generated by work activities will be furnished. When refuse reaches the fill line, dumpsters will be emptied. Dumpsters will be watertight. Dumpsters will not be washed at the job site. Additional containers and more frequent pick-ups will be necessary during the demolition phase of construction.

HAZARDOUS WASTE MANAGEMENT:

Hazardous waste management practices will be used for the following:

1. Petroleum products
2. Asphalt products
3. Concrete curing compound
4. Pesticides
5. Acids
6. Paints
7. Stains
8. Solvents
9. Wood preservatives
10. Roofing tar
11. Road flares
12. Lime
13. Glues and adhesives
14. Materials classified as hazardous by California Code of Regulations, Title 22, Division 4.5; or listed in CFR Title 40, Parts 110, 117, 261, or 302

Containers with adequate storage volume at convenient locations for hazardous waste collection will be furnished. Hazardous wastes will not be mixed and will not be allowed to accumulate on the ground. Store containers of dry waste that are not watertight on pallets. Store hazardous waste away from storm drains, watercourses, moving vehicles, and equipment.

Cleaning water-based or oil-based paint from brushes or equipment within a contained area will be done in a manner that does not contaminate soil, watercourses, or storm drain systems. Paints, thinners, solvents, residues, and sludges that cannot be recycled or reused will be handled and disposed of as hazardous waste. Dry latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths will be disposed of as solid waste.

Within 90 days of being generated, hazardous waste must be disposed. A licensed hazardous waste transporter will be used to take hazardous waste to a Class I Disposal Site. A copy of uniform hazardous waste manifest forms will be submitted within 24 hours of transporting hazardous waste.

The WPCM will perform daily inspection of storage areas for hazardous materials and wastes, hazardous waste disposal and transporting activities and hazardous material delivery and storage activities.

CONTAMINATED SOIL MANAGEMENT:

Soil within Contract 4 is contaminated, but not hazardous, with aerially deposited lead. The present strategy is to off-haul all excavated material. Some excavated soil may be re-used, but a decision from the Presidio is forthcoming. Bedrock under soil contains serpentine and is considered hazardous. Excavated bedrock will be disposed of at a class I facilty.

TEMPORARY CONCRETE WASHOUT FACILITY (PORTABLE):

Temporary Concrete Washout (Portable) will be used for collection and disposal of: washout from concrete delivery trucks; slurries containing portland cement concrete or hot mix asphalt from sawcutting, coring, grinding, grooving, and hydro-concrete demolition; concrete waste from mortar mixing stations.

CONCRETE WASTE:

Practices to prevent the discharge of portland cement concrete, AC, or HMA waste into storm drain systems or watercourses will be implemented. Portland cement concrete, AC, or HMA will be collected an disposed at waste locations where:

1. Concrete material, including grout, is used

2. Concrete dust and debris result from demolition

3. Sawcutting, coring, grinding, grooving, or hydro-concrete demolition of portland cement concrete, AC, or HMA creates a residue or slurry

4. Concrete truck or other concrete-coated equipment is cleaned at the job site

Sandblast debris/residue generated from grinding, grooving or demolition activities will be contained, in order to prevent the waste from being blown into adjacent system or water bodies.

SANITARY AND SEPTIC WASTE MANAGEMENT:

The WPCM will inspect, at least weekly, sanitary or septic waste storage and monitor disposal procedures. Sanitary facilities that discharge to the sanitary sewer system will be properly connected and free from leaks. Sanitary facilities will be placed at least 50 feet away from storm drains, watercourse, and flow lines. Written approval/permits from local health agency, city, county, and sewer district will be obtained before discharging from a sanitary or septic system directly into a sanitary sewer system, and submit a copy to the Resident Engineer. Local health agency provisions will be complied with while using an on-site disposal system. Temporary sanitary facilities will be serviced on a weekly basis and documented.

LIQUID WASTE MANAGEMENT:

Practices to prevent job site liquid waste from entering storm drain systems or watercourses will be used. Liquid wastes expected on the job site include the following:

1. Drilling slurries or fluids
2. Grease-free or oil-free wastewater or rinse water
3. Dredgings, including liquid waste from drainage system cleaning
4. Liquid waste running off a surface including wash or rinse water
5. Other non-storm water liquids not covered by separate permits

Liquid waste will be held in structurally sound, leak-proof containers such as:

1. Roll-off bins
2. Portable tanks

Liquid waste containers will be of sufficient quantity and volume to prevent overflow, spills and leaks.

Containers will be stored at least 50 feet from moving vehicles and equipment, if within the floodplain, at least 100 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets. If outside the floodplain, they will be stored at least 50 feet from concentrated flows of stormwater, drainage courses, watercourses, or storm drain inlets unless approved

Remove and dispose of deposited solids from sediment traps under "Solid Waste," unless the Engineer authorizes another method.

Liquid waste may require testing to determine hazardous material content before disposal. Drilling fluids and residue will be disposed outside of the right-of-way.

500.4 Water Pollution Control Drawings (WPCDs)

The Water Pollution Control Drawings can be found in Attachment B of the SWPPP.

500.5 Construction BMP Maintenance, Inspection and Repair

Inspections shall be conducted by the Contractor's WPCM or other 24-hour trained staff at the following minimum frequencies:

- Prior to a forecast storm;
- After a rain event that causes runoff from the construction site;
- At 24-hour intervals during extended rain events;
- Daily inspections within the Lake Tahoe Hydrologic Unit;
- Weekly during the rainy season;
- Every 2 weeks during the non-rainy season; and
- At any other time(s) or intervals of time specified in the project Special Provisions.

Completed inspection checklists shall be submitted to the Resident Engineer within 24 hours of inspection. Copies of the completed checklists will be kept with the SWPPP. A tracking or follow-up procedure shall follow any inspection that identifies deficiencies in BMPs. A program for Maintenance, Inspection and Repair of BMPs shall be provided in Attachment G of this SWPPP.

500.6 Post-Construction Stormwater Management

500.6.1 Post-Construction Control Practices

The following are the post-construction BMPs that are to be used at this construction site after all construction is complete:

- Hydraulic Mulch (Polymer Stabilized Fiber Matrix)
- Erosion Control (Netting)
- Fiber Rolls
- Erosion Control (Compost Blanket)

500.6.2 Operation/Maintenance after Project Completion

The post-construction BMPs that are described above will be funded and maintained as follows:

Short Term Funding: Caltrans District 4 Maintenance

Long Term Funding: Caltrans District 4 Maintenance

The responsible party for the long-term maintenance of post-construction BMPs is Caltrans District 4 Maintenance.

500.7 Training

Section 300.5 shows the name of the contractor's WPCM. This person has received the following training:

- To be listed by the Contractor

The training log showing formal and informal training of various personnel is shown in Attachment I. A copy of all training certificate(s) (e.g., Caltrans 24 Hour Training Class and Construction General Permit Training) for the WPCM and the SWPPP Preparer are included in Attachment I. Training records shall be updated, documented and reported in the SWPPP quarterly. Documentation of new training shall be submitted to the Resident Engineer within 24-hours of training.

-ONTRACTOR TO INSERT HERE ANY ADDTIONAL TEXT REGARDING TRAINING OF PERSONNEL.

This SWPPP was prepared by CONTRACTOR TO INSERT COMPANY, NAME AND PROFESSIONAL REGISTRATION OR OTHER QUALIFICATIONS (INCLUDING

INFORMATION REGARDING OTHER TRAINING COURSES, SUCH AS CALTRANS SWPPP PREPARATION TRAINING) OF PERSON THAT PREPARED THE SWPPP.

500.8 List of Subcontractors

All contractors and subcontractors shall be notified of the requirement for stormwater management measures during the project. A list of contractors shall be maintained and included in the SWPPP. If subcontractors change during the project, the list shall be updated accordingly. The completed subcontractor notification letter and log is included in the SWPPP as Attachment J.

Section 600
Monitoring Program and Reports

600.1 Site Inspections

Site inspections shall be conducted by the Contractor's WPCM or other Caltrans approved 24-hour trained staff at the following minimum frequencies:

- Prior to a forecast storm;
- After a rain event that causes runoff from the construction site;
- At 24-hour intervals during extended rain events;
- Daily inspections within the Lake Tahoe Hydrologic Unit;
- Weekly during the rainy season;
- Every 2 weeks during the non-rainy season; and
- At any other time(s) or intervals of time specified in the Contract Special Provisions.

The results of all inspections and assessments shall be documented, a copy shall be provided to the Resident Engineer within 24 hours of the inspection, and copies of the completed inspection checklists shall be maintained with the SWPPP. Site inspections conducted for monitoring purposes shall be performed using the inspection checklist shown in Attachment H.

The name(s) and contact number(s) of the assigned inspection personnel are listed below and their training qualifications are provided in Attachment I:

Assigned inspector: NAME OF INSPECTOR Contact phone: TELEPHONE NUMBER
Alternate inspector: NAME OF INSPECTOR Contact phone: TELEPHONE NUMBER

600.2 Discharge Reporting

If a discharge occurs or if the project receives a written notice or order from any regulatory agency, the contractor will immediately notify the Resident Engineer, and will file a written report to the Resident Engineer within 7 days (3 days for Districts 7 and 11) of the discharge event, notice, or order. Corrective measures will be implemented immediately following the discharge, notice or order. All discharges will be documented on a Discharge Reporting Log.

Discharges requiring reporting include:

- Stormwater from a DSA discharged to a waterway without treatment by an effective combinatin of temporary erosion and sediment control BMPs;
- Non-stormwater, except conditionally exempted discharges, discharged to a waterway or a storm drain system, without treatment by an approved control measure (BMP);

- Stormwater discharged to a waterway or a storm drain system where the control measures (BMPs) have been overwhelmed or not properly maintained or installed;
- Discharge of hazardous substances above the reportable quantities in 40 CFR 110.3, 117.3 or 302.4;
- Stormwater runoff containing hazardous substances from spills discharged to a waterway or storm drain system;
- Where water quality sample results from a CWA Section 303(d) stream listed for sediment, siltation or turbidity indicate elevated levels of sediment or turbidity in downstream samples;
- Where water quality sample results indicate elevated levels of non-visible pollutants;
- Discharges that may endanger health or the environment; and
- Other discharge reporting as directed by the Resident Engineer.

The report to the Resident Engineer will contain the following items:

- The date, time, location, nature of operation, and type of unauthorized discharge, including the cause or nature of the notice or order;
- The control measures (BMPs) deployed before the discharge event, or prior to receiving notice or order;
- The date of deployment and type of control measures (BMPs) deployed after the discharge event, or after receiving the notice or order, including additional measures installed or planned to reduce or prevent re-occurrence; and
- An implementation and maintenance schedule for any affected BMPs.

600.3 Record Keeping and Reports

Records shall be retained for a minimum of three years for the following items:

- Site inspections;
- Compliance certifications;
- Discharge reports;
- Approved SWPPP document and amendments;
- Sampling and analysis results; and
- Copies of all applicable permits.

600.4 Sampling and Analysis Plan for Sediment

Does this project have the potential to discharge directly to a water body listed as impaired due to Sedimentation/Siltation and/or Turbidity pursuant to Clean Water Act, Section 303(d)?

☐ Yes ☒ No

Does this project have the potential to discharge collected stormwater by dewatering?

☐ Yes ☒ No

This project does not have the potential to discharge directly to a water body listed as impaired due to Sedimentation/Siltation and/or Turbidity pursuant to Clean Water Act, Section 303(d).

This project does not have the potential to discharge collected stormwater by dewatering.

600.5 Sampling and Analysis Plan for Non-Visible Pollutants

This Sampling and Analysis Plan (SAP) for Non-Visible Pollutants describes the sampling and analysis strategy and schedule for monitoring non-visible pollutants in stormwater discharges from the project site and offsite activities directly related to the project in accordance with the requirements of Section B of the General Permit, and applicable requirements of the Caltrans *Construction Site Storm Water Quality Sampling Guidance Manual,* December 2003.

600.5.1 Scope of Monitoring Activities

The following construction materials, wastes or activities, as identified in Section 500.3.1, are potential sources of non-visible pollutants to stormwater discharges from the project. Storage, use, and operational locations are shown on the WPCDs in Attachment B.

- Vehicle fluids, including oil, grease, petroleum, and coolant;
- Asphaltic emulsions associated with asphalt-concrete paving operations;
- Cement materials associated with PCC paving operations, drainage structures, median barriers, and bridge construction;
- Base and subbase material;
- Joint and curing compounds;
- Concrete curing compounds (e.g. methacrylate and epoxy resin products);
- Paints;
- Solvents, thinners, acids;
- Sandblasting materials;

- Mortar Mix;
- Raw landscaping materials and wastes (topsoil, plant materials, herbicides, fertilizers, pesticides, mulch);
- BMP materials (sandbags, liquid copolymer);
- Treated lumber (materials and wastes);
- PCC rubble;
- Masonry block rubble; and
- General litter

The following existing site features, as identified in Section 500.3.3, are potential sources of non-visible pollutants to stormwater discharges from the project. Locations of existing site features contaminated with non-visible pollutants are shown on the WPCDs in Attachment B.

- ?????

The following soil amendments have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil and will be used on the project site. Locations of soil amendment application are shown on the WPCDs in Attachment B.

- Not applicable

The project has the potential to receive stormwater run-on with the potential to contribute non-visible pollutants to stormwater discharges from the project. Locations of such run-on to the Caltrans right-of-way are shown on the WPCDs in Attachment B.

- Not applicable

Sampling for non-visible pollutants will be conducted when (1) a breach, leakage, malfunction, or spill is observed; and (2) the leak or spill has not been cleaned up prior to the rain event; and (3) there is the potential for discharge of non-visible pollutants to surface waters or drainage system.

600.5.2 Monitoring Strategy

Sampling Schedule

Samples for the applicable non-visible pollutant(s) and a sufficiently large uncontaminated background sample shall be collected during the first two hours of discharge from rain events that result in a sufficient discharge for sample collection. Samples shall be collected during daylight hours (sunrise to sunset) and shall be collected regardless of the time of year, status of the construction site, or day of the week.

In conformance with the U.S. Environmental Protection Agency definition, a minimum of 72 hours of dry weather will be used to distinguish between separate rain events.

Collection of discharge samples for non-visible pollutant monitoring will be triggered when any of the following conditions are observed during the required inspections conducted before or during rain events:

- Materials or wastes containing potential non-visible pollutants are not stored under watertight conditions. Watertight conditions are defined as (1) storage in a watertight container, (2) storage under a watertight roof or within a building, or (3) protected by temporary cover and containment that prevents stormwater contact and runoff from the storage area.

- Materials or wastes containing potential non-visible pollutants are stored under watertight conditions, but (1) a breach, malfunction, leakage, or spill is observed, (2) the leak or spill is not cleaned up prior to the rain event, and (3) there is the potential for discharge of non-visible pollutants to surface waters or a storm sewer system.

- An operational activity, including but not limited to those in Section 600.5.1, with the potential to contribute non-visible pollutants (1) was occurring during or within 24 hours prior to the rain event, (2) applicable BMPs were observed to be breached, malfunctioning, or improperly implemented, and (3) there is the potential for discharge of non-visible pollutants to surface waters or a storm sewer system.

- Soil amendments that have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil have been applied, and there is the potential for discharge of non-visible pollutants to surface waters or a storm sewer system.

- Stormwater runoff from an area contaminated by historical usage of the site has been observed to combine with stormwater runoff from the site, and there is the potential for discharge of non-visible pollutants to surface waters or a storm sewer system.

Sampling Locations

Sampling locations are based on proximity to planned non-visible pollutant storage, occurrence or use; accessibility for sampling, personnel safety; and other factors in accordance with the applicable requirements in the Caltrans *Construction Site Storm Water Quality Sampling Guidance Manual,* December 2003. Planned sampling locations are shown on the WPCDs and include the following:

- Eight sampling location(s) on the project site and the contractor's yard have been identified for the collection of samples or runoff from planned material and waste storage areas and from areas where that non-visible pollutant producing operations are planned.

- Sample location number(s) S1-S8 is located throughout the project site, as shown on the CWPCDs included in Attachment B.

- Two sampling locations have been identified for the collection of samples of runoff that drain areas where soil amendments that have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil will be applied.

- If applicable, Sample location number(s) S1-S8 is located at drainage inlets shown on the CWPCDs, included in Attachment B.

- [Enter Number] sampling locations have been identified for the collection of samples of runoff that drain areas contaminated by historical usage of the site.

- If applicable, Sample location number(s) [Enter Number] is located [Enter Location].

- No sampling locations have been identified for the collection of samples of run-on to the Caltrans right–of-way with the potential to combine with discharges being sampled for non-visible pollutants. These samples are intended to identify sources of potential non-visible pollutants that originate off the project site.

- If applicable, Sample location number(s) [Enter Number] is located [Enter Location].

- Two sampling location(s) has been identified for the collection of an uncontaminated sample of runoff as a background sample for comparison with the samples being analyzed for non-visible pollutants. This location(s) was selected such that the sample will not have come in contact with (1) operational or storage areas associated with the materials, wastes, and activities identified in Section 500.3.1; (2) potential non-visible pollutants due to historical use of the site as identified in Section 500.3.3; (3) areas in which soil amendments that have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil have been applied; or (4) disturbed soils areas.

- Sample location number(s) S9-S10 is located as shown on the CWPCDs, included in Attachment B.

If an operational activity or stormwater inspection conducted 24 hours prior to or during a rain event identifies the presence of a material storage, waste storage, or operations area with spills or the potential for the discharge of non-visible pollutants to surface waters or a storm sewer system that was an unplanned location and has not been identified on the WPCDs, sampling locations will be selected using the same rationale as that used to identify planned locations.

600.5.3 Monitoring Preparation

Samples will be collected by:

Contractor	☐ Yes	☐ No
Consultant	☐ Yes	☐ No
Laboratory	☐ Yes	☐ No

Samples on the project site will be collected by the following contractor sampling personnel:

Name/Telephone Number:

Name/Telephone Number:

Alternate(s)/Telephone Number:

Alternate(s)/Telephone Number:

Prior to the rainy season, all sampling personnel and alternates will review Section 600 through 600.5.10 of this SWPPP. Qualifications of designated contractor personnel describing environmental sampling training and experience are provided in Attachment I.

An adequate stock of monitoring supplies and equipment for monitoring non-visible pollutants will be available on the project site prior to a sampling event. Monitoring supplies and equipment will be stored in a cool temperature environment that will not come into contact with rain or direct sunlight. Sampling personnel with be available to collect samples in accordance with the sampling schedule. Supplies maintained at the project site will include, but are not limited to, surgical gloves, sample collection equipment, coolers, appropriate number and volume of sample bottles, identification labels, re-sealable storage bags, paper towels, personal rain gear, ice, Sampling Activity Log forms, and COC forms.

The contractor will obtain and maintain the field testing instruments, as identified in Section 600.5.6, for analyzing samples in the field by contractor sampling personnel.

Safety practices for sample collection will be in accordance with the [ENTER TITLE AND PUBLICATION DATE OF CONTRACTOR'S HEALTH AND SAFETY PLAN FOR THE PROJECT OR PROVIDE SPECIFIC REQUIREMENTS HEREIN].

Samples on the project site will be collected by the following [specify laboratory or environmental consultant]:

Company Name:

Address:

Telephone Number:

Point of Contact:

Qualifications of designated sampling personnel describing environmental sampling training and experience are provided in Attachment I.

WPCM will contact [specify name of laboratory or environmental consultant] 24 hours prior to a predicted rain event and if one of the triggering conditions is identified during an inspection before,

during, or after a storm event to ensure that adequate sample collection personnel, supplies and field test equipment for monitoring non-visible pollutants are available and will be mobilized to collect samples on the project site in accordance with the sampling schedule.

[Specify name of laboratory or environmental consultant] will obtain and maintain the field testing instruments, as identified in Section 600.5.6, for analyzing samples in the field by their sampling personnel.

600.5.4 Analytical Constituents

Identification of Non-Visible Pollutants

The following table lists the specific sources and types of potential non-visible pollutants on the project site and the applicable water quality indicator constituent(s) for that pollutant.

Table 600-3
Potential Non-Visible Pollutants and Water Quality Indicator Constituents

Pollutant Source	Pollutant	Water Quality Indicator Constituent
Cleaning Products	Acids, Bleaches, Detergents, TSP, Solvents,	pH, Residua l Chlorine, Phosphate, VOC, SVOC
Portland Cement Concrete & Masonry Products	Masonry Products, Sealant, Fly Ash, Municipal Solid Waste, Curing Compounds	pH, Alkalinity, Methyl Methacrylate, Metals, VOC, SVOC
Landscaping and Other Products	Fertilizers, Inorganic and Organic, Herbicides, Top Soil	TDS, Aluminum, Sulfate, Nitrate, Phosphate, pH, Organic Nitrogen and COD
Painting Products	Paint, Paint Strippers, Sealants, Solvents, Thinners, etc.	VOC, SVOC, COD
Contaminated Soil	Aerially Deposited Lead, Petroleum, etc.	Lead, Contaminant specific
Adhesives	Adhesives	COD, Phenols, SVOC
Dust Palliative Products	Salts	Chloride, TDS, Cations (Sodium, Magnesium, Calcium)
Vehicle	Antifreeze, Batteries, Fuels, Lubricants	Lead, pH, Sulfuric Acid
Soil Amendment/Stabilization Products	Polymer/Copolymer	Organic Nitrogen, BOD, COD, DOC, Nitrate, Sulfate, Nickel
Treated Wood Products	ACZA, CCA, ACA Copper Naphthenate, Creosote	Aresenic, Total Chromium, Copper amd Zinc

600.5.5 Sample Collection and Handling

Sample Collection Procedures

Samples of discharge shall be collected at the designated sampling locations shown on the WPCDs for observed breaches, malfunctions, leakages, spills, operational areas, soil amendment application areas, and historical site usage areas that triggered the sampling event.

Grab samples shall be collected and preserved in accordance with the methods identified in Table 600-3, "Sample Collection, Preservation and Analysis for Monitoring Non-Visible Pollutants" table provided in Section 600.5.6. Only personnel trained in proper water quality sampling shall collect samples.

Samples shall be collected by placing a separate laboratory-provided sample container directly into a stream of water downgradient and within close proximity to the potential non-visible pollutant discharge location. This separate laboratory-provided sample container shall be used to collect water, which shall be transferred to sample bottles for laboratory analysis. The upgradient and uncontaminated background samples shall be collected first prior to collecting the downgradient to minimize cross-contamination. The sampling personnel shall collect the water upgradient of where they are standing. Once the separate laboratory-provided sample container is filled, the water sample shall be poured directly into sample bottles provided by the laboratory for the analyte(s) being monitored.

To maintain sample integrity and prevent cross-contamination, sampling collection personnel shall:

- Wear a clean pair of surgical gloves prior to the collection and handling of each sample at each location;
- Not contaminate the inside of the sample bottle by not allowing it to come into contact with any material other than the water sample;
- Discard sample bottles or sample lids that have been dropped onto the ground prior to sample collection;
- Not leave the cooler lid open for an extended period of time once samples are placed inside;
- Not sample near a running vehicle where exhaust fumes may impact the sample;
- Not touch the exposed end of a sampling tube, if applicable;
- Avoid allowing rainwater to drip from rain gear or other surfaces into sample bottles;
- Not eat, smoke, or drink during sample collection;
- Not sneeze or cough in the direction of an open sample bottle;

- Minimize the exposure of the samples to direct sunlight, as sunlight may cause biochemical transformation of the sample to take place;
- Decontaminate sampling equipment prior to sample collection using a TSP-soapy water wash, distilled water rinse, and final rinse with distilled water; and
- Dispose of decontamination water/soaps appropriately (i.e., not discharge to the storm drain system or receiving water).

Sample Handling Procedures

All or some of samples will be analyzed by (select one or both):

Laboratory ☐ Yes ☐ No

Contractor (Field Measurement) ☐ Yes ☐ No

Immediately following collection, sample bottles for laboratory analytical testing shall be capped, labeled, documented on a COC form provided by the analytical laboratory, sealed in a re-sealable storage bag, placed in an ice-chilled cooler, at ±4 degrees Celsius as practicable, and delivered within 24 hours to the following California Environmental Laboratory Accreditation Program (ELAP) – certified laboratory:

Laboratory Name:
Address:

Telephone Number:
Point of Contact:

Immediately following collection, samples for field analysis shall be tested in accordance with the field instrument manufacturer's instructions and results recorded on the Sampling Activity Log.

Sample Documentation Procedures

All original data documented on sample bottle identification labels, COC forms, Sampling Activity Logs, and Inspection Checklists shall be recorded using waterproof ink. These shall be considered accountable documents. If an error is made on an accountable document, the individual shall make corrections by lining through the error and entering the correct information. The erroneous information shall not be obliterated. All corrections shall be initialed and dated. Copies of the COC form and Sampling Activity Log are provided in Attachment R.

Duplicate samples shall be identified consistent with the numbering system for other samples to prevent the laboratory from identifying duplicate samples. Duplicate samples shall be identified in the Sampling Activity Logs.

Sampling and field analysis activities shall be documented using the following:

- Sample Bottle Identification Labels: Sampling personnel shall attach an identification label to each sample bottle. At a minimum, the following information shall be recorded on the label, as appropriate:

  - Project name
  - Project number
  - Unique sample identification code as shown below:

    SSSSSYYMMDDHHmmTT

    Where:

    SSSSS = sampling point number (e.g., CCUP1, CCDN2)
    YY = last two digits of the year (e.g. 06)
    MM = month (01-12)
    DD = day (01-31)
    HH = hour sample collected (00-23)
    mm = minute sample collected (00-59)
    TT = Type or QA/QC Identifier (if applicable)
    G = grab
    FS = field duplicate

    For example, the sample number for a grab sample collected at Station CCUP1 collected at 4:15PM on December 8, 2006 would be:

    CCUP10612081615G

  - Collection date/time (No time applied to QA/QC samples)
  - Analysis constituent
  - Initials of person who collected the sample

- Sampling Activity Logs: A log of sampling events shall identify:

  - Sampling date;
  - Separate times for collected samples and QA/QC samples recorded to the nearest minute;
  - Unique sample identification number and location;
  - Analysis constituent;
  - Names of sampling personnel;
  - Weather conditions (including precipitation amount);
  - Field analysis results; and
  - Other pertinent data.

- COC Forms: All samples to be analyzed by a laboratory will be accompanied by a COC form provided by the laboratory. Only the sample collectors will sign the COC form over to the lab. COC procedures will be strictly adhered to for QA/QC purposes.

- Stormwater Quality Construction Inspection Checklists: When applicable, the contractor's Stormwater inspector will document on the checklist that samples for non-visible pollutants were taken during a rain event.

600.5.6 Sample Analysis

Samples shall be analyzed for the applicable constituents using the analytical methods identified in Table 600-4, "Sample Collection, Preservation and Analysis for Monitoring Non-Visible Pollutants" table in this section.

TABLE 600-4
Sample Collection, Preservation and Analysis for Monitoring Non-Visible Pollutants

Constituent	Analytical Method	Minimum Sample Volume	Sample Bottle	Sample Preservation	Reporting Limit	Maximum Holding Time
Notes:						

Will samples be analyzed in the field?:

☐ Yes ☒ No

600.5.7 Quality Assurance/Quality Control

For an initial verification of laboratory or field analysis, duplicate samples shall be collected at a rate of 10 percent or 1 duplicate per sampling event. The duplicate sample shall be collected, handled, and analyzed using the same protocols as primary samples. A duplicate sample shall be collected at each location immediately after the primary sample has been collected. Duplicates shall be collected where contamination is likely, not on the background sample. Duplicate samples shall not influence any evaluations or conclusions; however, they shall be used as a check on laboratory quality assurance.

600.5.8 Data Management and Reporting

A copy of all water quality analytical results and QA/QC data shall be submitted to the Resident Engineer within 5 days of sampling (for field analyses) and within 30 days (for laboratory analyses). All submitted information shall include a signed copy of the sampling data reporting certification form. Electronic results shall be submitted on diskette in Microsoft Excel (.xls) format, and shall include, at a minimum, the following information from the lab: Sample ID Number, Contract Number, Constituent, Reported Value, Lab Name, Method Reference, Method Number, Method Detection Limit, and Reported Detection Limit. Attachment T contains the Sampling Data Reporting Form, which must accompany the submittal of sampling data.

Lab reports and COCs shall be reviewed for consistency between lab methods, sample identifications, dates, and times for both primary samples and QA/QC samples. All data, including COC forms, Sampling Activity Logs, and Sampling Data Reporting Forms shall be kept with the SWPPP document. Electronic results shall be emailed to [NAME] of [COMPANY] at [email address] after final sample results are received after each sampling event. Electronic copies shall be forwarded by email to [Resident Engineer Name] at [email address] for inclusion into a statewide database.

600.5.9 Data Evaluation

An evaluation of the water quality sample analytical results, including figures with sample locations, shall be submitted to the Resident Engineer with the water quality analytical results and the QA/QC data. Should the runoff/downgradient sample show an increased level of the tested analyte relative to the background sample, the BMPs, site conditions, and surrounding influences shall be assessed to determine the probable cause for the increase.

As determined by the site and data evaluation, appropriate BMPs shall be repaired or modified to mitigate discharges of non-visual pollutant concentrations. Any revisions to the BMPs shall be recorded as an amendment to the SWPPP.

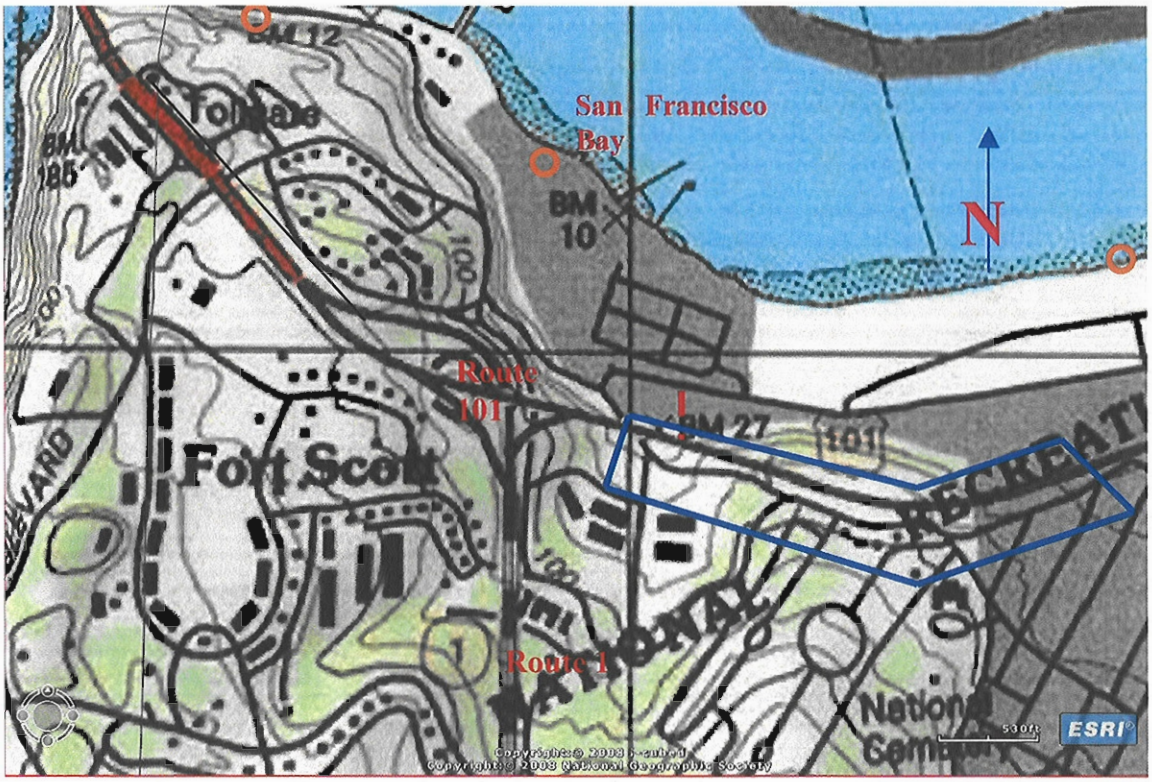
600.5.10 Change of Conditions

Whenever SWPPP monitoring, pursuant to Section B of the General Permit, indicates a change in site conditions that might affect the appropriateness of sampling locations or introduce additional non-visible pollutants of concern, testing protocols shall be revised accordingly. All such revisions shall be recorded as amendments to the SWPPP.

ATTACHMENT A

CONCEPTUAL
STORMWATER POLLUTION PREVENTION PLAN

VICINITY MAP
FOR
THE CONSTRUCTION FROM 0.7 MILE TO 0.3 MILE SOUTH OF ROUTE 101/1 SEPARATION IN THE CITY AND COUNTY OF SAN FRANCISCO
04-163744



LEGEND

PROJECT AREA

DISCHARGE POINTS

CONCEPTUAL WATER POLLUTION CONTROL DRAWINGS (CWPCDs)

FOR CONSTRUCTION ON STATE HIGHWAY IN THE CITY AND COUNTY OF SAN FRANCISCO ON ROUTE 101

FROM 0.7 MILE TO 0.3 MILE SOUTH OF ROUTE 101/1 SEPARATION

LEGEND:

- VESA — CONFINEMENT SYSTEM FOR HORSE PIT
- CONCENTRATED SURFACE FLOW
- CSM — CONSTRUCTION SITE MANAGEMENT (CSM)
- DEWATERING & NON-STORM WATER DISCHARGE CONTROL
- PIPE/UNDERGROUND FLOW DIRECTION
- RUN-ON FLOW AREA (A1-A3) & DIRECTION
- S# — SAMPLING LOCATION
- SSD — SANITARY SEWER DISCHARGE LOCATION (NON-STORM WATER)
- STAGING/CONSTRUCTION AREA
- CSM — STAGING AREA FOR CONTRACTOR'S USE
- STORM WATER DISCHARGE LOCATION
- SDD — STORM DRAIN DISCHARGE LOCATION (NON_STORM WATER)
- TEMPORARY CHECK DAM
- TCE — TEMPORARY CONSTRUCTION EASEMENT (TCE)
- TEMPORARY CONSTRUCTION ENTRANCE/EXIT
- C. WASH — TEMPORARY CONCRETE WASHOUT (PORTABLE)
- TEMPORARY DRAINAGE INLET PROTECTION
- TEMPORARY EROSION CONTROL BLANKET (TECB)
- TFESA — TEMPORARY FENCE (ESA)
- TEMPORARY FIBER ROLL (TFR)
- TEMPORARY GRAVEL BERM BAG (TGBB)
- TEMPORARY RAILING (TYPE K)
- TRSF — TEMPORARY REINFORCED SILT FENCE (TRSF)
- TSF — TEMPORARY SILT FENCE (TSF)
- T. WASH — TEMPORARY TIRE WASH
- TEMPORARY TYPE III BARRICADE

GENERAL WATER POLLUTION CONTROL NOTES

1. CWPCDs depict construction activities and best management practices (BMPs) by each stage that are expected to occur in the rainy season(s) for the duration of the Contract.

2. The Conceptual Water Pollution Control Drawings (CWPCDs)are intended to provide additional direction and convey specific BMP expectations to the contractor. The (CWPCDs) are prepared assuming standard construction practices and may not reflect the contractor's actual methods of construction, access requirements or project phasing.

3. The Conceptual Storm Water Pollution Prevention Plan (CSWPPP) will be adhered to for all construction activities planned for the first 60 days after contract approval, or until the Contractor's SWPPP is approved by the Engineer.

4. The CSWPPP will be used as a guide and reference tool to develop and submit the contract SWPPP that includes all elements of the CSWPPP and any additional elements required to complete the SWPPP in conformance with the Special Provisions, the Permits, any other local requirements. The Contractor's SWPPP shall supersede the Conceptual SWPPP upon Engineer's approval.

5. Field conditions may necessitate modifications to the CWPCDs in the contract SWPPP prepared by the Contractor.

6. Disturbed Soil Areas (DSA) are limited to 5 acres during the rainy season from October 15 to April 15.

7. The Contractor will use all temporary water pollution control practices included in the Contract to develop and submit the Contract SWPPP.

8. The Contractor will use best management practices (BMPs) described under in special provisions section "Construction Site Management" to control potential sources of water pollution before they come in contact with storm water systems or watercourses. Control material pollution and manage waste and non-storm water at the job site by implementing effective handling, storage, use, and disposal practices.

9. The Contractor will include the following contract items of work for permanent water pollution control as shown on the Erosion Control Plans: Hydraulic Mulch (Polymer Stabilized Fiber Matrix); Move-In/Move-Out (Erosion Control); Erosion Control (Netting); Fiber Rolls; Erosion Control (Compost Blanket). Permanent water Pollution Control measures shall be applied to non-active DSAs deemed complete. These permanent water pollution control practices may be constructed and utilized during the construction period. The Contractor shall maintain and protect the permanent water pollution control practices throughout the duration of the project and shall restore these controls to the lines, grades and condition shown on the plans prior to acceptance of the contract.

10. Construction Site Management BMPs will be implemented year-round to control mobile operations common to this contract, which may include Asphalt recycling, concrete mixing, crushing and storage of materials.

11. The Contractor shall monitor the National Weather Service weather forecast on a daily basis during the contract. The Contractor may use an alternative weather forecasting service if approved by the Engineer. Active DSAs where soil disturbance has occurred and will continue to occur during the ensuing 21 days shall be protected using appropriate water pollution control practices within 15 days, or before predicted precipitation, whichever occurs first.

12. Temporary soil stabilization and sediment control practices will be implemented during the rainy season between October 15 and April 15. The Contractor shall implement soil stabilization and sediment control practices a minimum of 6 days before the start of the rainy season using Temporary Hydraulic Mulch, Temporary Silt Fences, Temporary Fiber Rolls and Temporary Drainage Inlet Protection. The Contractor shall maintain soil stabilization and sediment control materials on site to protect disturbed soil areas.

Sampling and Analysis

13. A Sampling and Analysis Plan (SAP) to monitor the effectiveness of the water pollution control practices has been prepared. This project has the potential to discharge non-visible pollutants in storm water from the construction site. Non-visible pollutant sampling locations (downhill from each non-visible pollutant source and background/uncontaminated control sample) are shown on the CWPCDs.

STORM WATER POLLUTION CONTROL CONSTRUCTION NOTES:

1. Construction schedule included in the Conceptual SWPPP considers the amount and duration of soil exposed to erosion by wind, rainfall and vehicle tracking and minimizes DSA during any rain y season. Contractor will be prepared with sufficient quantities of temporary water pollution control practices year-round to deploy soil stabilization and sediment control practices in response to seasonal and unseasonal rainfall.

2. Temporary Fence Type ESA (TFESA) will be installed prior to clearing and grubbing or soil disturbing activities in order to preserve existing vegetation through out the project site. TFESA locations have been delineated after consideration of impacts from grade changes to existing vegetation and the root zone.

3. Temporary Hydraulic Mulch (Bonded Fiber Matrix - BFM) will be applied to active and non-active DSAs that require temporary protection until permanent vegetation is established, or disturbed areas that must be redistributed following an extended period of inactivity. Prior to application, embankments and fill areas will be roughened by rolling with a crimping or punching type roller or by track walking. BFM will require 24 hours to dry to become effective.

4. Temporary Erosion Control Blanket will be used on active DSAs when areas are particularly difficult to stabilize. These DSAs will include: steep slopes (greater than 1:3, V:H); channels where flow exceeds 3.3 ft per sec; and areas where vegetation establishment can take periods extending into the rainy season.

5. Temporary Cover will be used on active DSAs when areas are particularly difficult to stabilize, especially stockpiles of soil, cold mix asphalt concrete, portland cement concrete (PCC) rubble, asphalt concrete, hot mix asphalt (HMA), AC, HMA rubble, aggregate base or subbase shall be placed on an impervious surface and covered with plastic. when precipitation is predicted. Inactive soil stockpiles will be protected with a plastic or geotextile cover, or with soil stabilization measures at all times during the rainy season. During the non-rainy season all soil stockpiles shall be covered and protected with a linear sediment barrier when precipitation is predicted.

6. Temporary Silt Fence will be installed and maintained at locations shown on the plans to allow sediment to settle and from runoff before it leaves the site.

7. Temporary Reinforced Silt Fence will be installed and maintained at locations shown on the plans to allow sediment to settle and from runoff before it leaves the site.

8. Temporary Check Dams will be used in natural and man made channels or drainage ditches to reduce scour and channel erosion b reducing flow velocity and allowing sediment to settle.

9. Temporary Fiber Rolls will be used to minimize erosive effects of storm water runoff from active and non-active DSAs to break up the slope lengths, and will be used around temporary stockpiles to intercept runoff, reduce velocity, release runoff as sheet flow and provide removal of sediment.

10. Temporary Gravel Bag Berms will be installed to form a barrier across a slope to intercept runoff, reduce its flow velocity, release runoff as sheet flow and provide some sediment removal.

11. Street Sweeping will be done by using a Mechanical sweeper followed by a vacuum-assisted sweeper, or Vacuum-assisted dry (waterless) sweeper or Regenerative-air sweeper. Street sweeping will occur at the job site entrance and exit locations during: clearing and grubbing activities; earthwork activities; trenching activities; roadway structural section activities; when vehicles are entering and leaving the job site; after soil disturbing activities; after observing offsite tracking of material.

12. Temporary Drainage Inlet Protection will be used at all locations shown on CWPCDs.

13. Temporary Construction Entrances will be used at points of entrance and exit to reduce tracking of mud and dirt onto public roads by construction vehicles.

14. Construction Site Management will be implemented year-round control material pollution and manage waste and non-storm water existing at the construction site by implementing effective handling, storage, use, and disposal practices.

15. Groundwater and accumulated precipitation dewatered from excavations will be collected, conveyed, treated, and disposed to either a storm drain system upon obtaining coverage under Order No. R2-2006-0075 adopted by the San Francisco Bay Regional Water Quality Control Board (RWQCB), or obtaining a Batch Discharge permit from San Francisco Public Utilities Commission (SFPUC) for discharges to the sanitary sewer. Designated sanitary sewer discharge (SSD) and storm drain discharge (SDD) locations are shown on the CWPCDs.

16. Temporary Concrete Washout (Portable) will be used for collection and disposal of: Washout from concrete delivery trucks; Slurries containing portland cement concrete or hot mix asphalt from sawcutting, coring, grinding, grooving, and hydro-concrete demolition; Concrete waste from mortar mixing stations.

ATTACHMENT B: CWPCD-1

PROJECT MANAGER

SENIOR LANDSCAPE ARCHITECT

LAST REVISION 00-00-00 | DATE PLOTTED => 18-OCT-2009 | TIME PLOTTED => 10:28

BORDER LAST REVISED 8/1/2008 | CALTRANS WEB SITE IS: HTTP//WWW.DOT.CA.GOV/ | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => s128010 | DGN FILE => CWPCD_Title Sheet_1.dgn | CU 00000 | EA 000000

FOR ACCURATE RIGHT OF WAY AND ACCESS DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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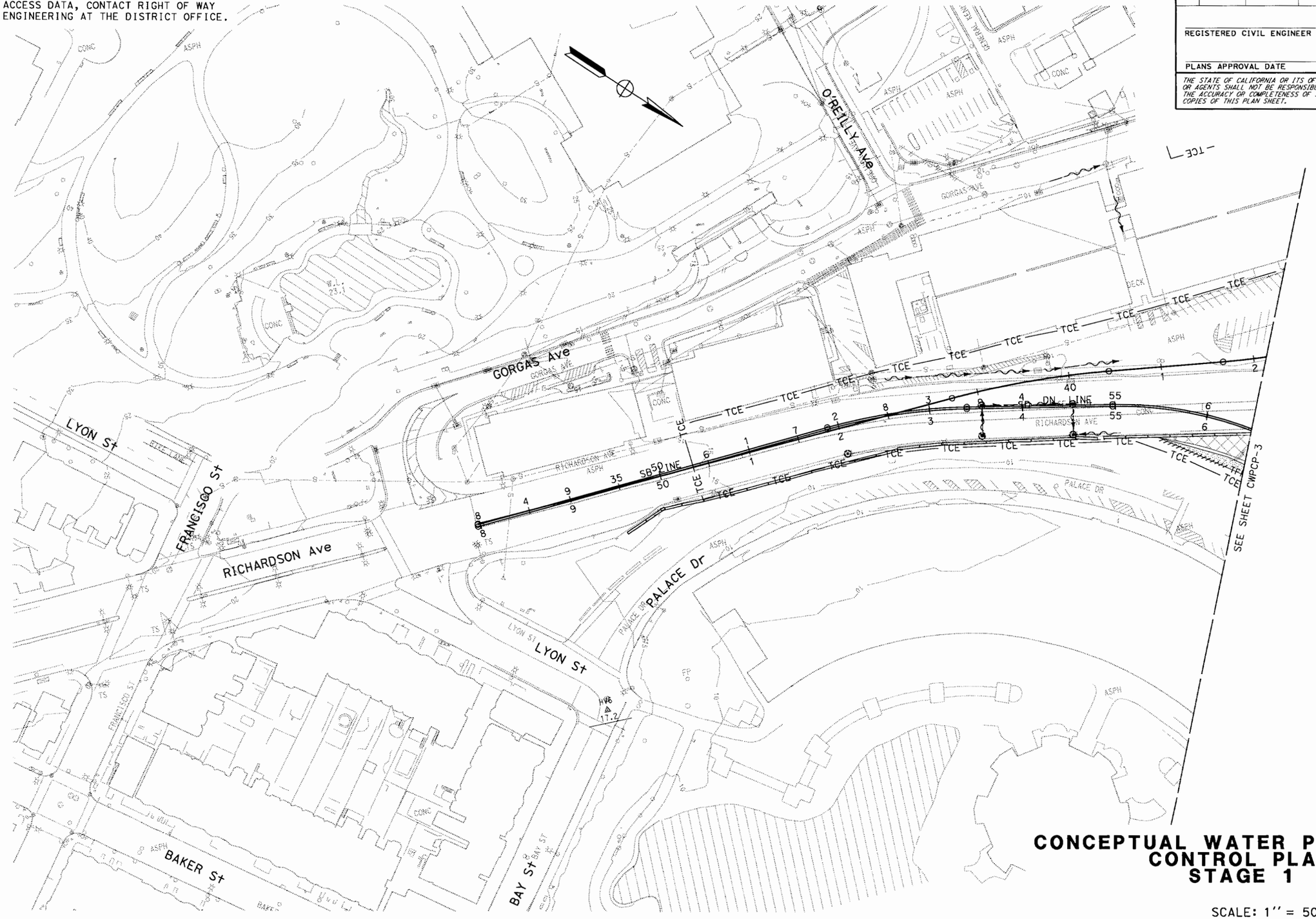

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 1

SCALE: 1'' = 50'

CWPCP-2

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

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LAST REVISION: DATE PLOTTED => 14-OCT-2009; 09-25-09 TIME PLOTTED => 11:01

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s128010
DGN FILE => CWPCP_2_th.BR 09-25-09.dgn

CU 04335

EA 163741

FOR ACCURATE RIGHT OF WAY AND ACCESS DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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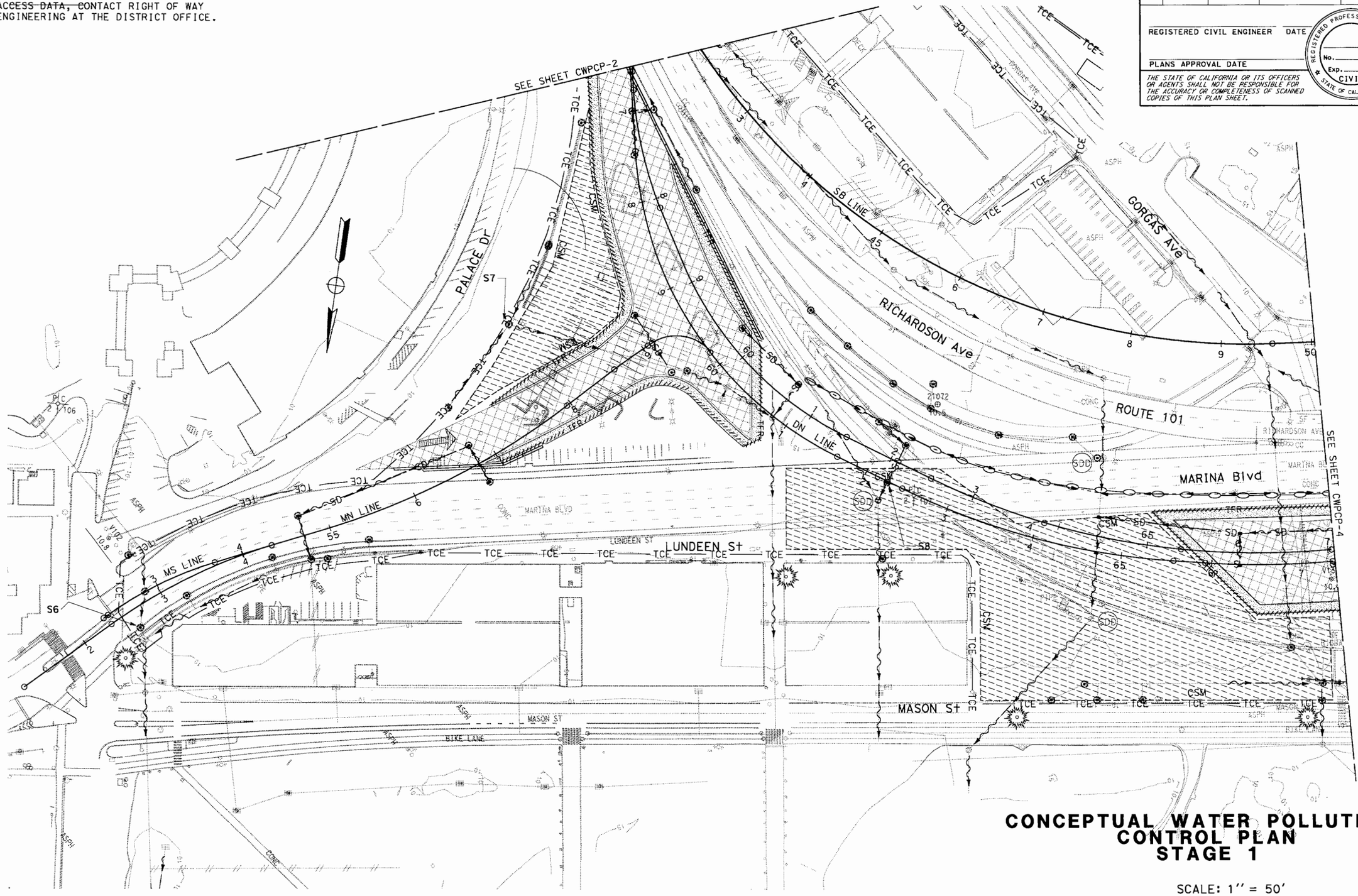

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 1

SCALE: 1'' = 50'

CWPCP-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION | FUNCTIONAL SUPERVISOR | CALCULATED-DESIGNED BY | CHECKED BY | REVISED BY | DATE REVISED

LAST REVISION 09-25-09 | DATE PLOTTED => 15-OCT-2009 | TIME PLOTTED => 16:38

BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => s128010 | DGN FILE => CWPCP_3_th.BR 09-25-09.dgn | CU 04242 | EA 163741

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 1

SCALE: 1'' = 50'

CWPCP-4

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FUNCTIONAL SUPERVISOR

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LAST REVISION: DATE PLOTTED => 15-OCT-2009 | 09-25-09 | TIME PLOTTED => 15:28

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s128010
DGN FILE => CWPCP_4_th.BR 09-25-09.dgn

CU 04335

EA 163741

FOR ACCURATE RIGHT OF WAY AND ACCESS DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — No. — Exp. — CIVIL — STATE OF CALIFORNIA

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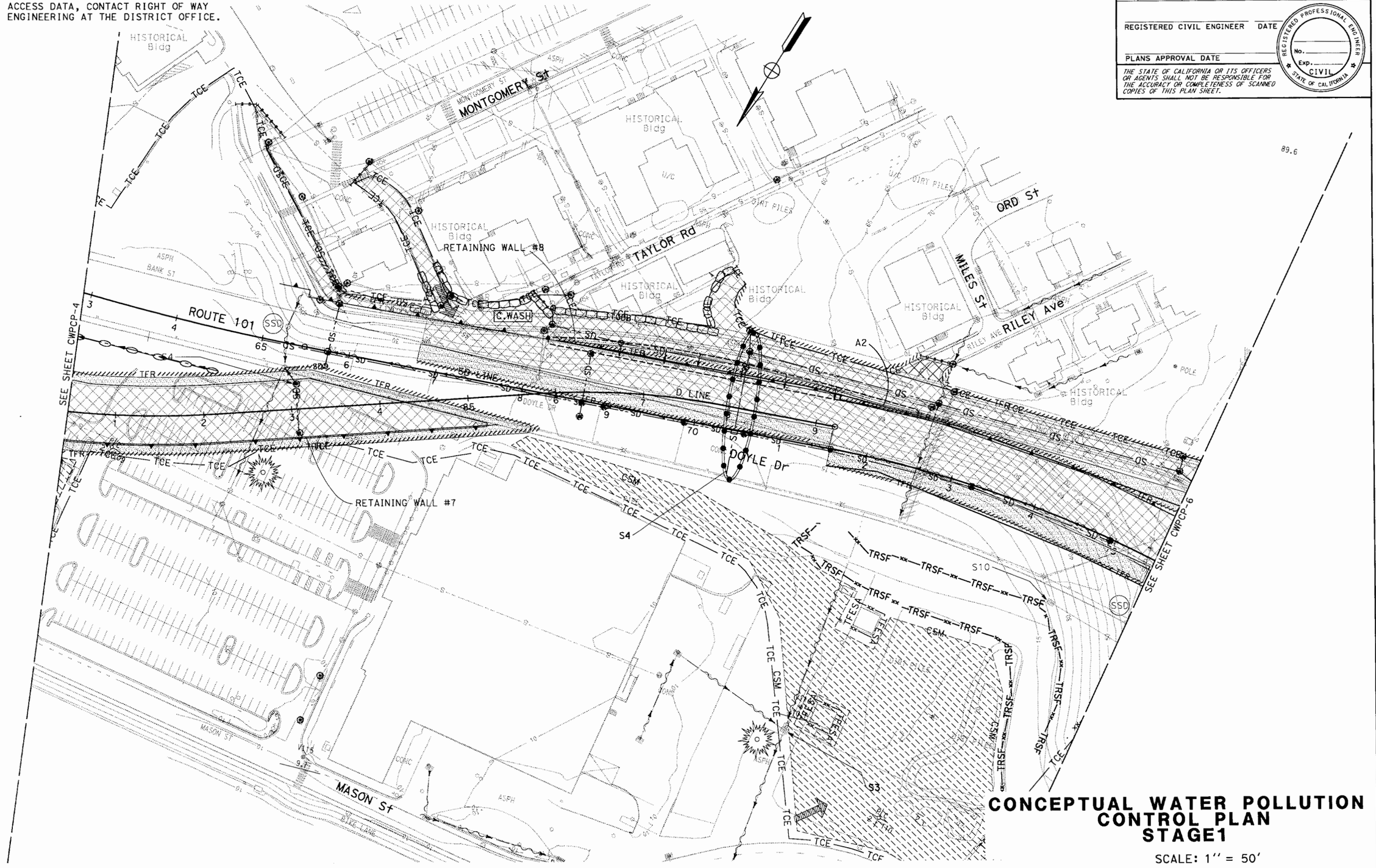

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE1

SCALE: 1'' = 50'

CWPCP-5

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

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DATE REVISED

LAST REVISION 09-25-09

DATE PLOTTED => 15-OCT-2009
TIME PLOTTED => 16:39

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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CU 04335

EA 163741

FOR ACCURATE RIGHT OF WAY AND
ACCESS DATA, CONTACT RIGHT OF WAY
ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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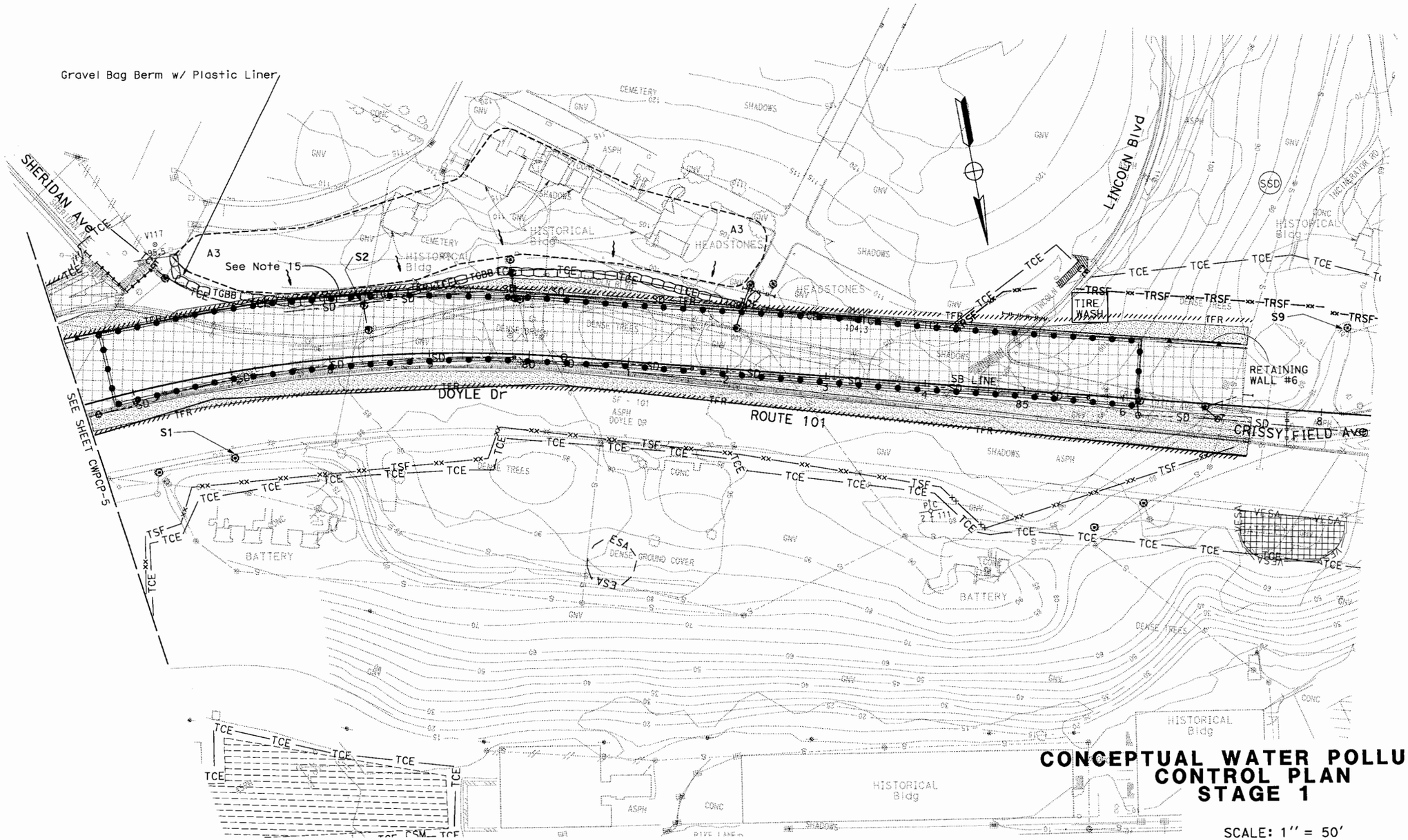

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 1

SCALE: 1'' = 50'

CWPCP-6

LAST REVISION: DATE PLOTTED => 18-OCT-2009; 09-25-09 TIME PLOTTED => 10:40

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USERNAME => s128010
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CU 04335

EA 163741

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

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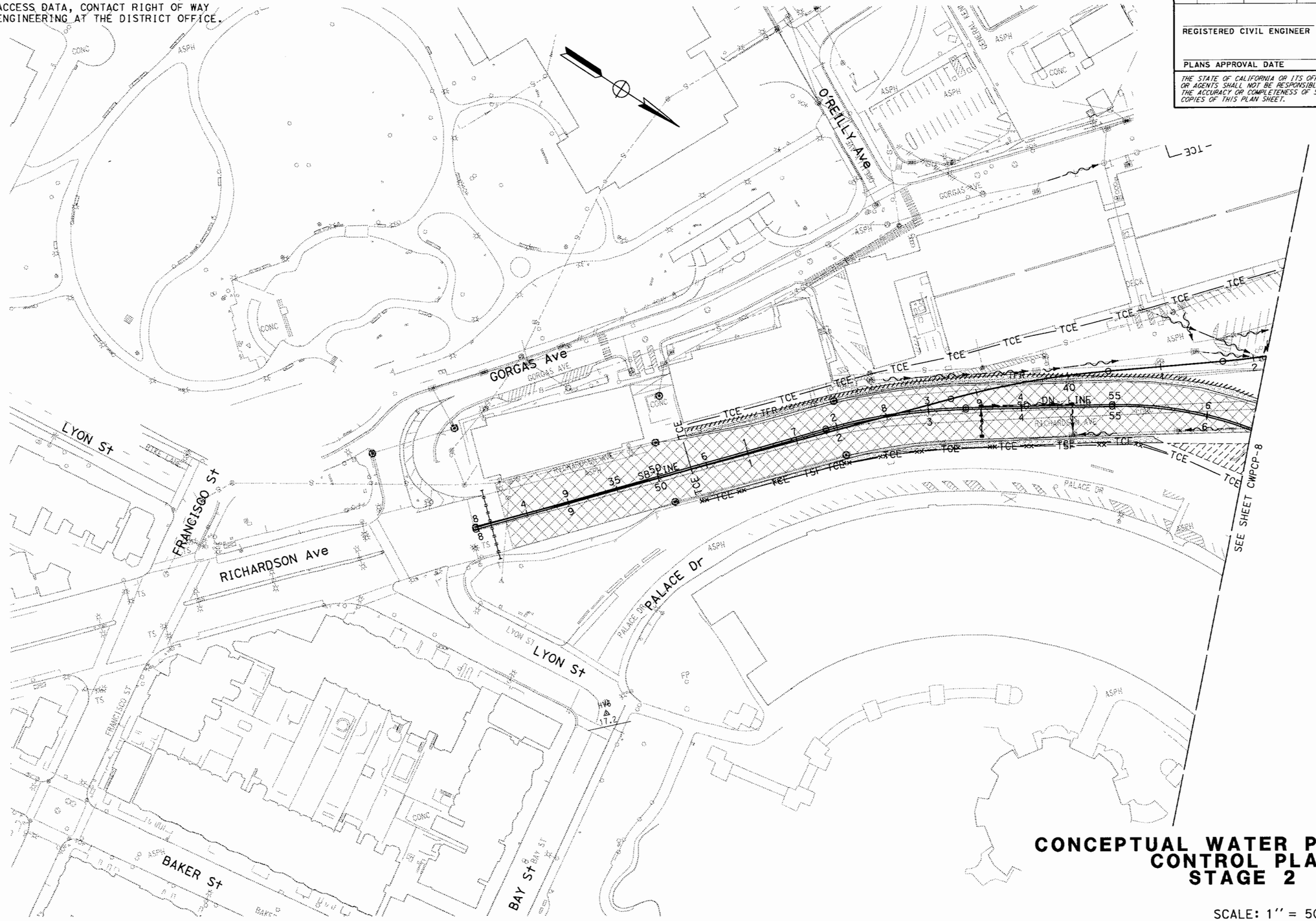

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 2

SCALE: 1'' = 50'

CWPCP-7

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LAST REVISION 09-25-09

DATE PLOTTED => 15-OCT-2009
TIME PLOTTED => 15:48

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USERNAME => s128010
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CU 04335

EA 163741

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

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PLANS APPROVAL DATE

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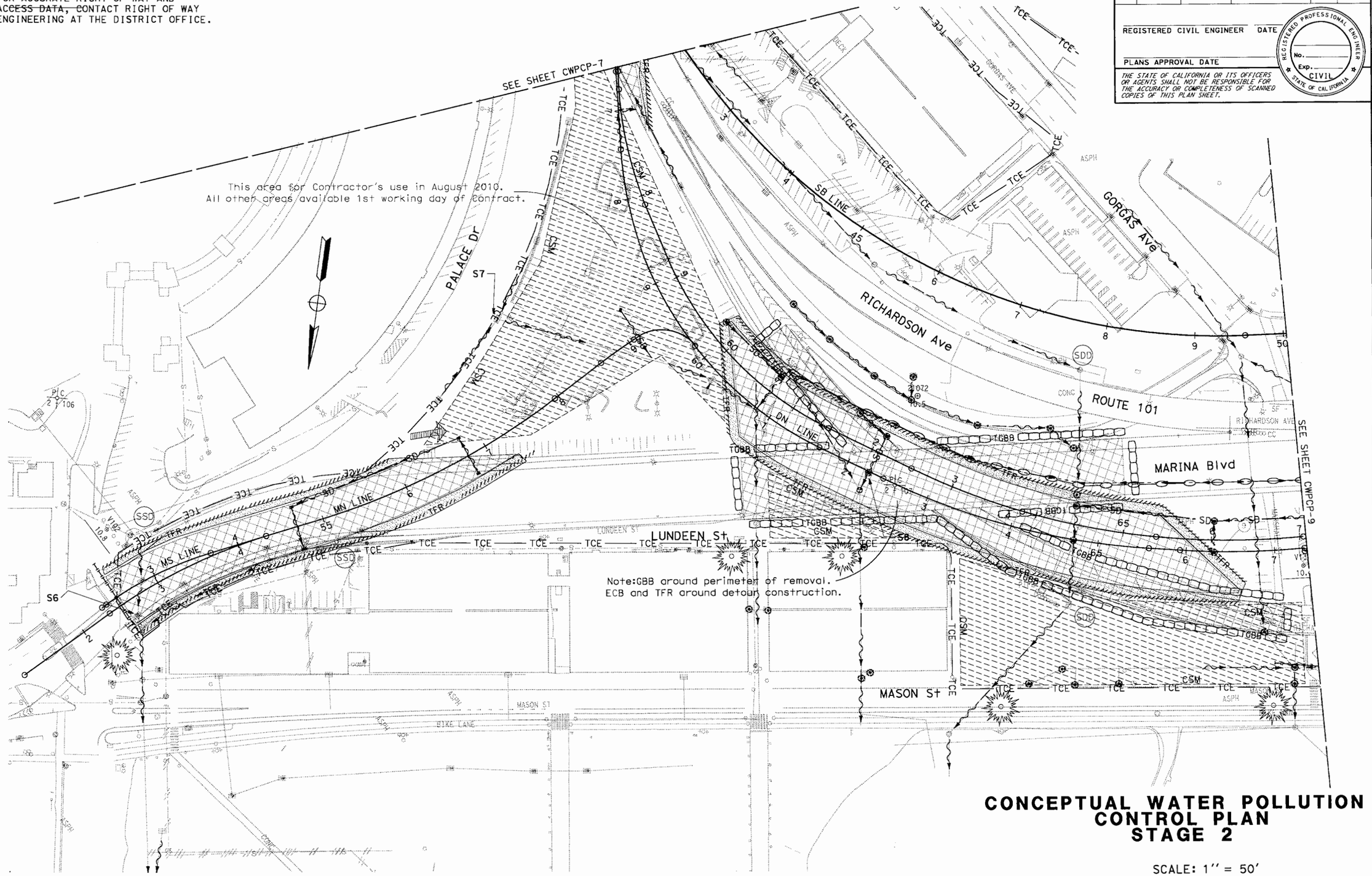

Note:GBB around perimeter of removal.
ECB and TFR around detour construction.

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 2

SCALE: 1'' = 50'

CWPCP-8

LAST REVISION 09-25-09 | DATE PLOTTED => 15-OCT-2009 | TIME PLOTTED => 15:51

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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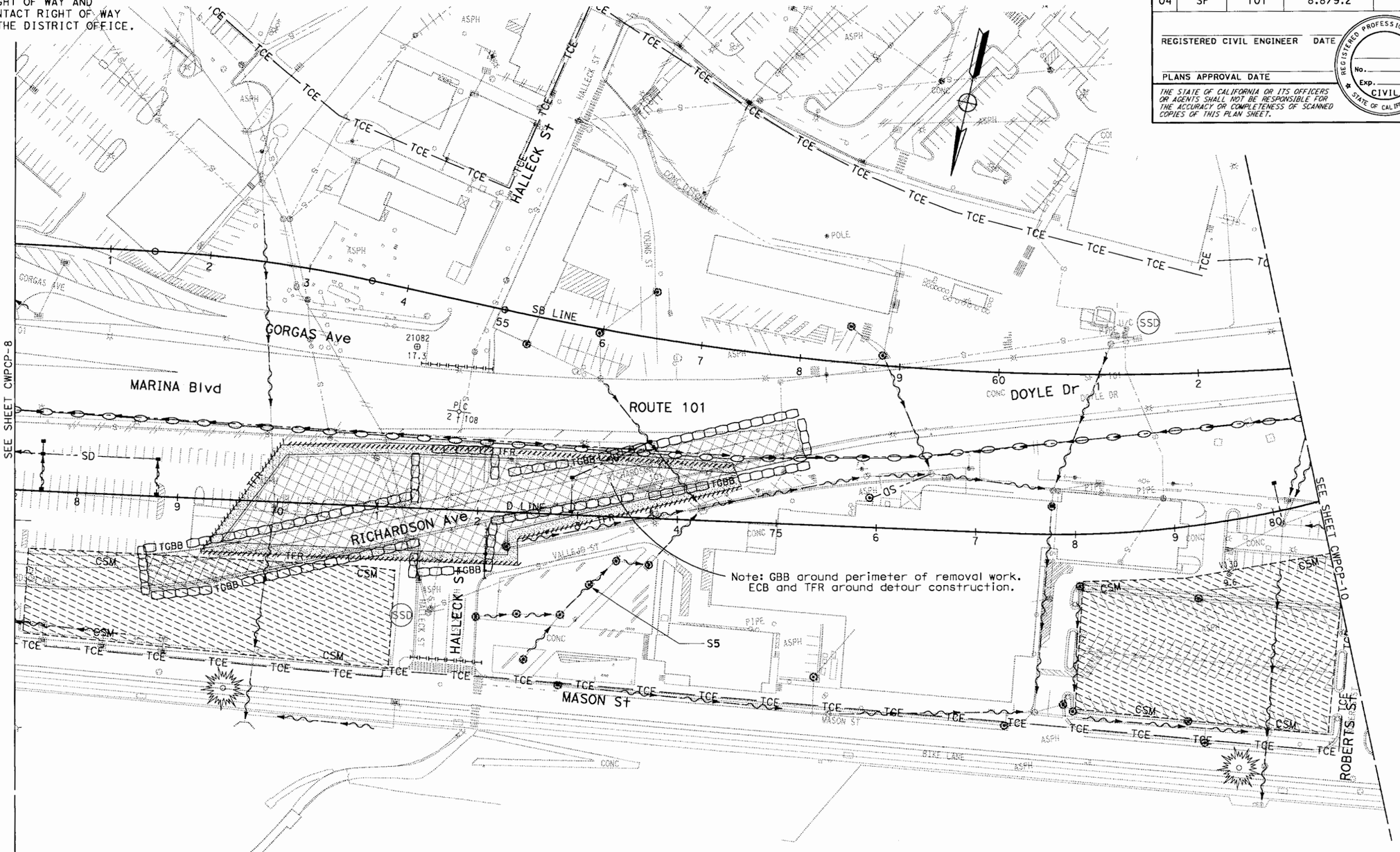

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 2

SCALE: 1'' = 50'

CWPCP-9

REVISED BY | DATE REVISED

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LAST REVISION 09-25-09 | DATE PLOTTED => 15-OCT-2009 | TIME PLOTTED => 15:55

BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => s128010 | DGN FILE => CWPCP_9_th.BR 09-25-09.dgn | CU 04335 | EA 163741

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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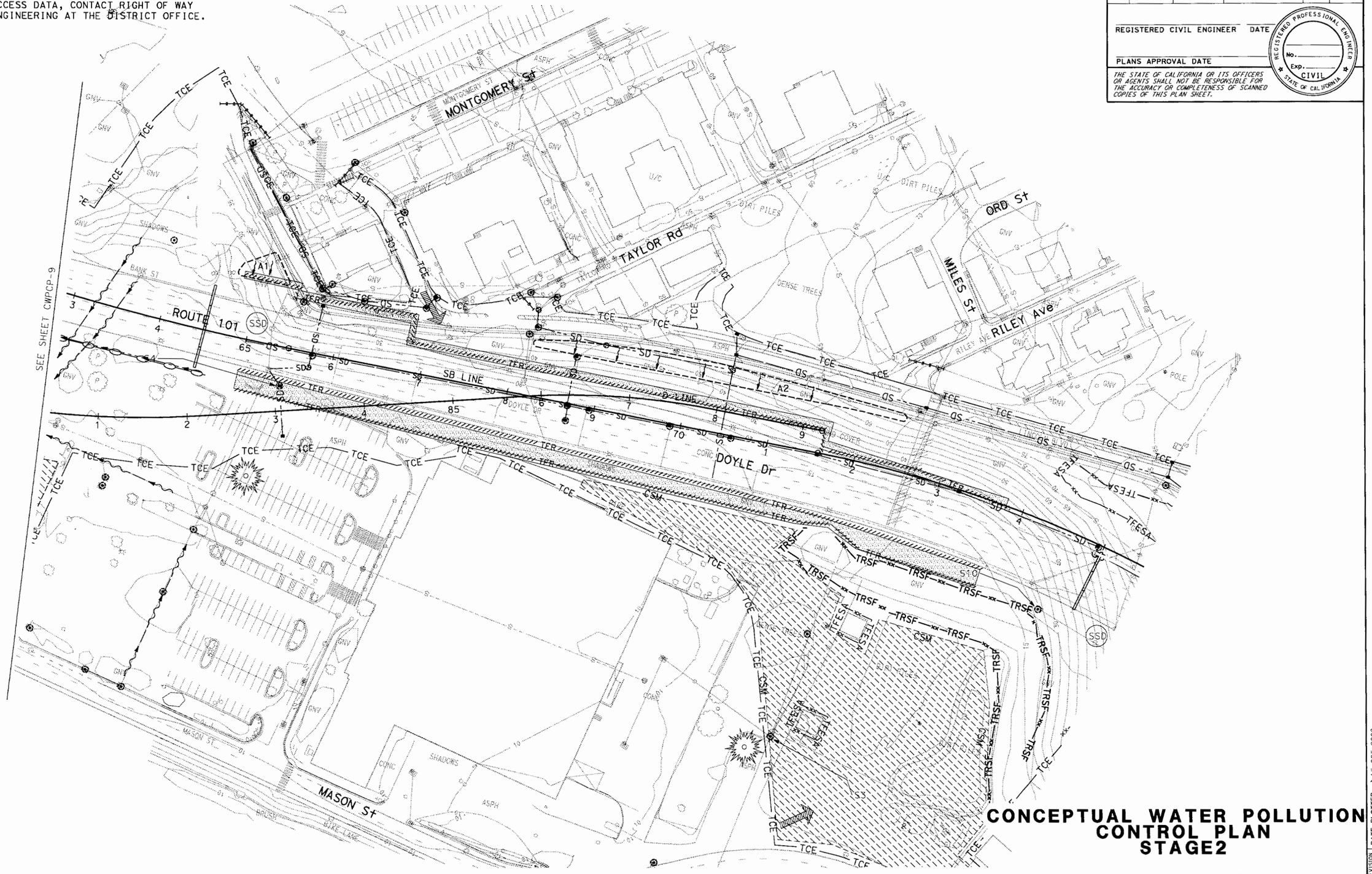

CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE2

SCALE: 1'' = 50'

CWPCP-10

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LAST REVISION: DATE PLOTTED => 15-OCT-2009; TIME PLOTTED => 16:04; 09-26-09

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DGN FILE => CWPCP_10_thmerge.dgn

CU 04335

EA 163741

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

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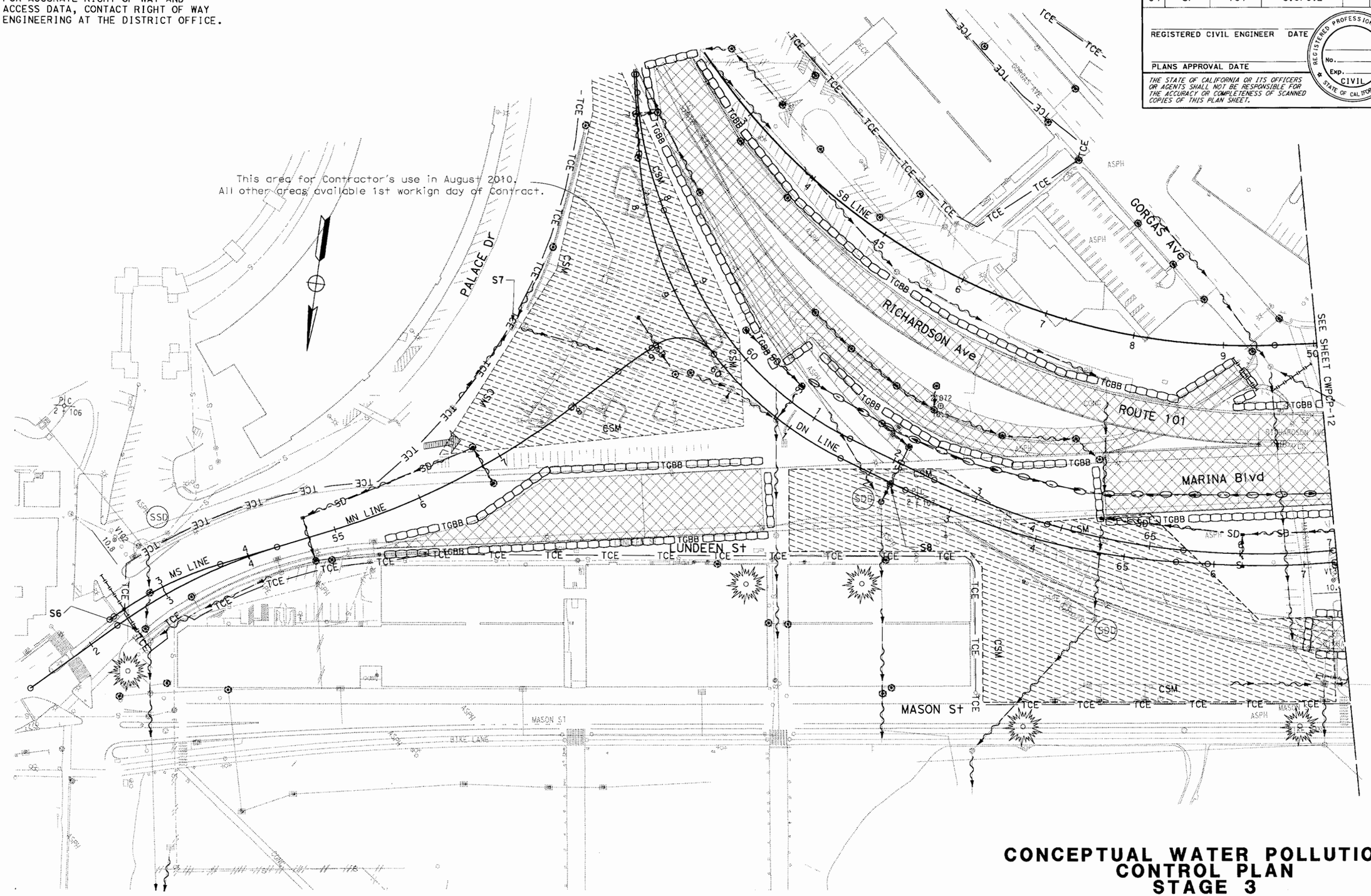
This area for Contractor's use in August 2010.
All other areas available 1st workign day of Contract.



CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 3

CWPCP-11

LAST REVISION	DATE PLOTTED => 15-OCT-2009
09-25-09	TIME PLOTTED => 16:11

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s128010
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CU 04242

EA 163741

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

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PLANS APPROVAL DATE _____

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE 3

SCALE: 1'' = 50'

CWPCP-12

LAST REVISION	DATE PLOTTED => 15-OCT-2009
09-25-09	TIME PLOTTED => 16:14

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BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => s128010 | DGN FILE => CWPCP_14-12_th.BR 09-25-09.dgn | CU 04335 | EA 163741

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

REGISTERED PROFESSIONAL ENGINEER — No. — Exp. — CIVIL — STATE OF CALIFORNIA

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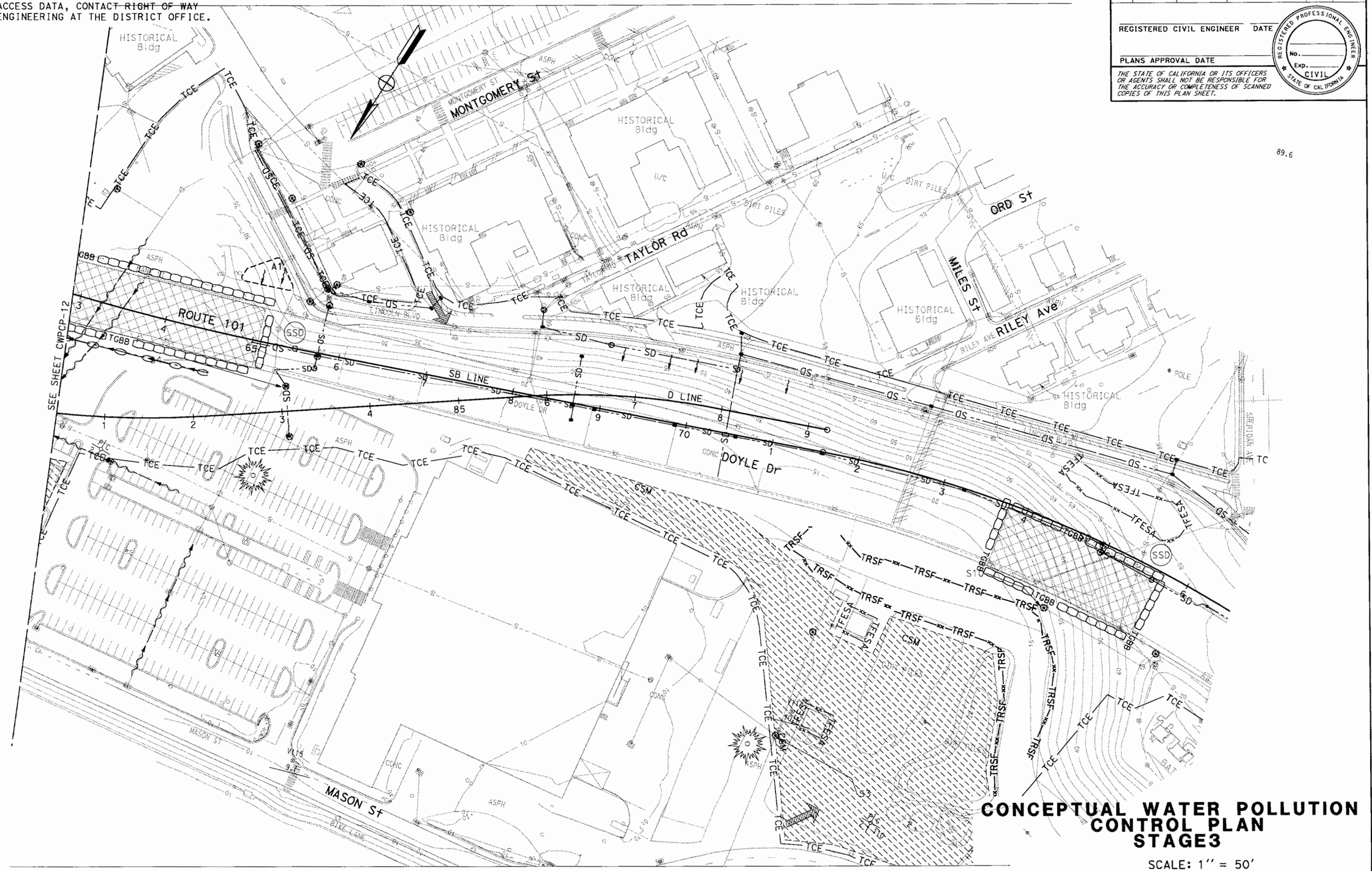
89.6



CONCEPTUAL WATER POLLUTION CONTROL PLAN STAGE3

SCALE: 1'' = 50'

CWPCP-13

LAST REVISION	DATE PLOTTED => 15-OCT-2009
09-25-09	TIME PLOTTED => 16:17

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => s128010
DGN FILE => CWPCP_15-13_th.BR 09-25-09.cgn

CU 04335

EA 163741

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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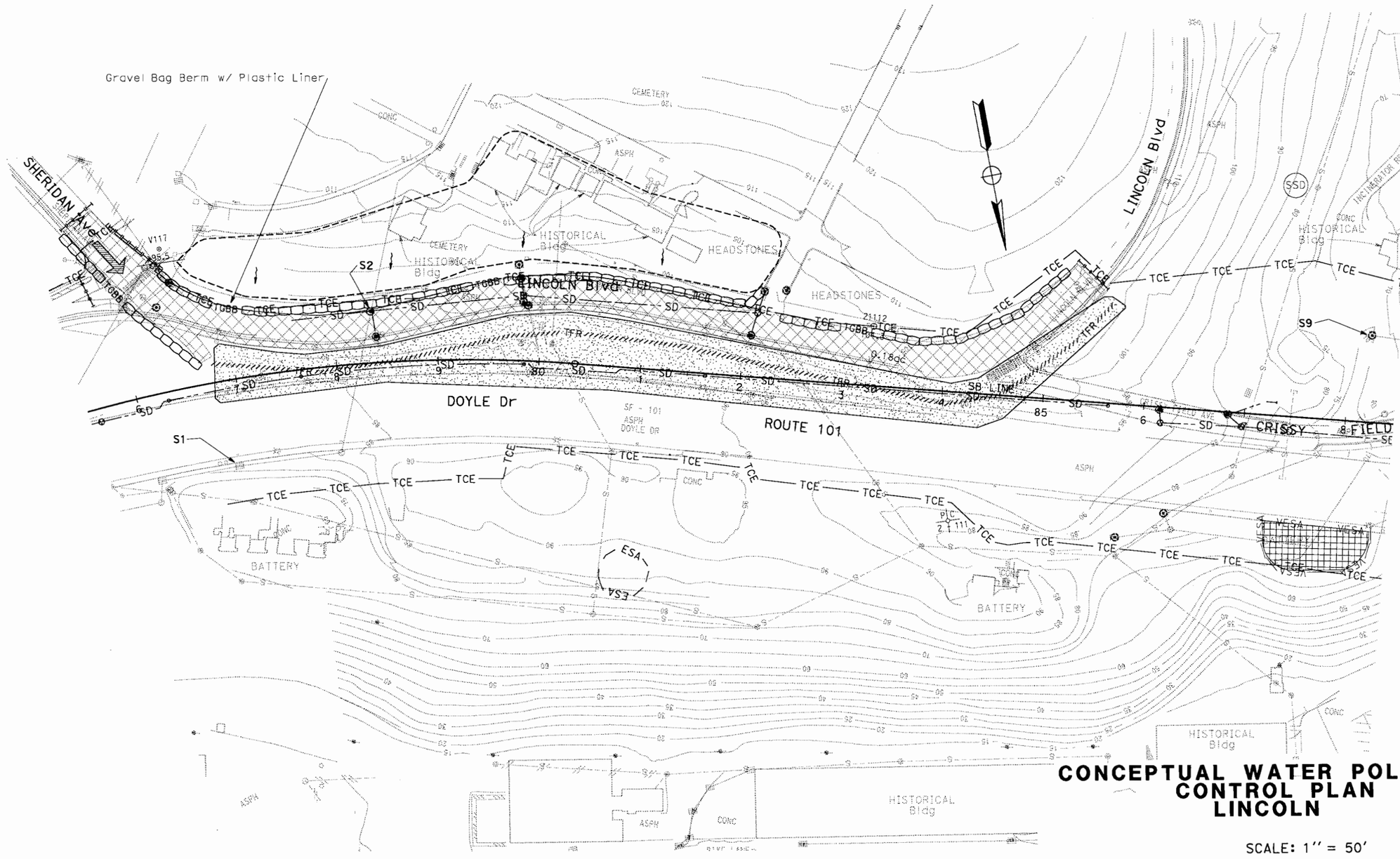

CONCEPTUAL WATER POLLUTION CONTROL PLAN LINCOLN

SCALE: 1'' = 50'

CWPCP-14

LAST REVISION: 09-25-09 DATE PLOTTED => 15-OCT-2009 TIME PLOTTED => 16:23

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

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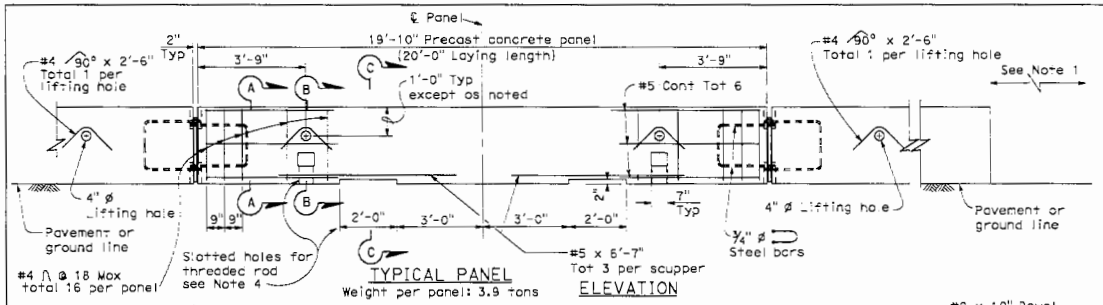
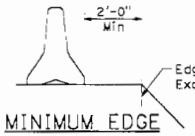
CU 04335

EA 163741



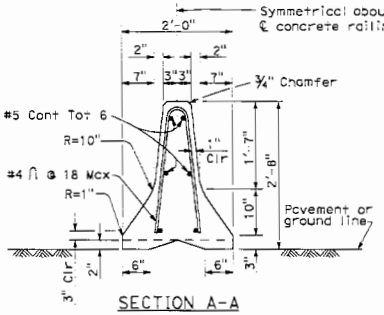
TYPICAL PANEL ELEVATION

Weight per panel: 3.9 tons

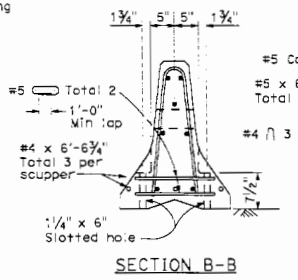


MINIMUM EDGE DISTANCE

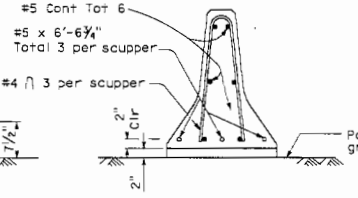
See Note 4



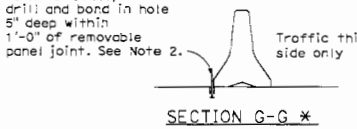
SECTION A-A



SECTION B-B



SECTION C-C

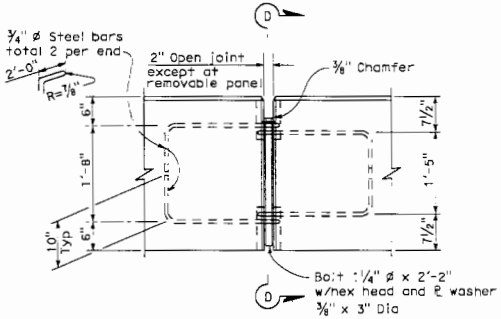


SECTION G-G *

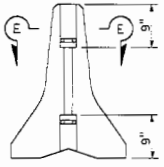
* Section G-G is for concrete pavement. Alternative detail, 1" ø pins 2'-0" long driven in AC or firm soil permitted, minimum 1'-6" deep.

NOTES:

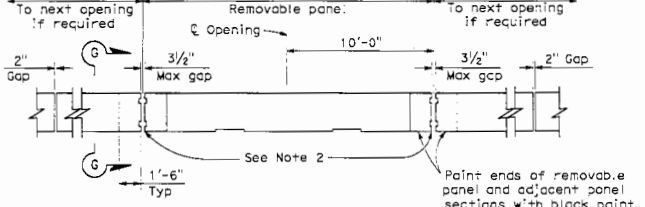
1. For end treatment, layout and crash cushions, where needed, see Project Plans or Special Provisions.
2. All 3½" gaps at removable panels are to be backed at the base with #8 x 10" dowel or 1" ø pin each side of joint. See Section G-G.
3. Where Temporary Railing (Type K) is placed on curves and radii that are too severe to connect panels with bolted joints, the railing is to be backed continuously with earth fill. See Section F-F.
4. Where the offset distance from the exposed edge of deck to the closest edge of the temporary railing is less than 2'-0", attach each panel to deck slab with 1" diameter threaded rods (total four per panel) inserted through the slotted holes of the panel and bond in drilled holes 6" deep in the deck slabs. See "Bridge Memo to Designers" Manual.



ELEVATION

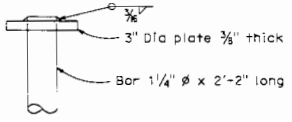


VIEW D-D

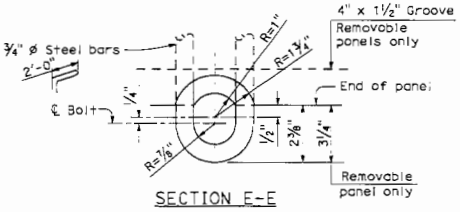


ELEVATION

TYPICAL OPENING DETAIL

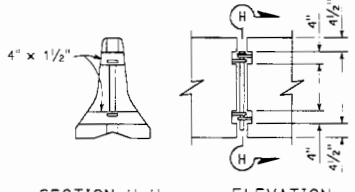


ALTERNATIVE HEAD DETAIL



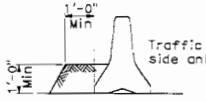
SECTION E-E

BOLT CONNECTION DETAIL



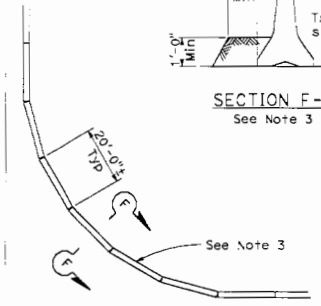
SECTION H-H ELEVATION

REMOVABLE PANEL GROOVE DETAILS



SECTION F-F

See Note 3



CURVED LAYOUT

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Randell D. Hiatt
REGISTERED CIVIL ENGINEER

May 1, 2006
PLANS APPROVAL DATE

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Randell D. Hiatt
No. C50200
Exp. 6-30-07
CIVIL
REGISTERED PROFESSIONAL ENGINEER
STATE OF CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY RAILING (TYPE K)

NO SCALE

T3

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Robert B Schlett
LICENSED LANDSCAPE ARCHITECT

May 1, 2006
PLANS APPROVAL DATE

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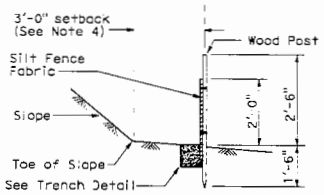
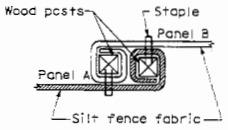
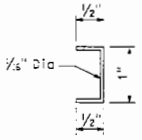


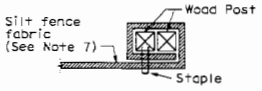
SECTION A-A
TEMPORARY SILT FENCE



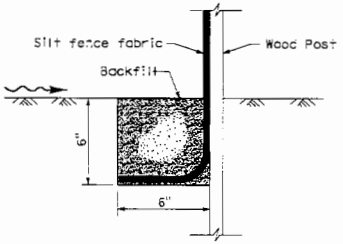
PLAN
POST AT JOINTS



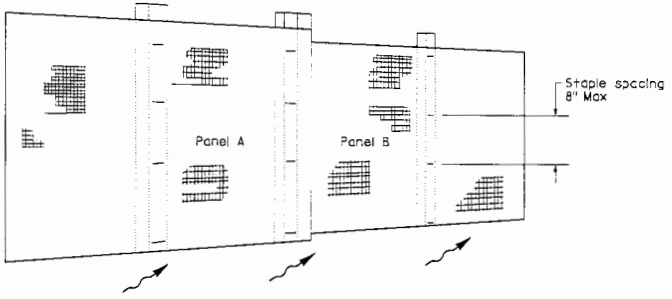
STAPLE DETAIL
(See Note 8)



PLAN
END POST DETAIL



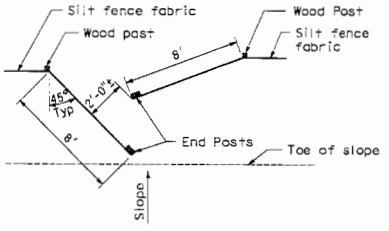
SECTION
TRENCH DETAIL



PERSPECTIVE
SILT FENCE PANELS AT JOINTS

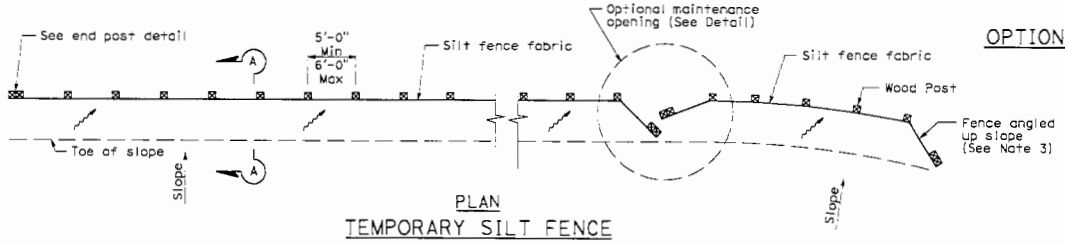
NOTES:

1. Install Temporary Silt Fence by first digging trench, driving posts, placing and securing fabric. Then backfill and tamp.
2. Reach length not to exceed 500 feet.
3. The down stream end of the Temporary Silt Fence shall have the last 8' angled up slope.
4. Setback dimensions may vary to fit field conditions.
5. Posts to overlap and fence fabric to fold around each post one full turn. Secure fabric with 4 staples for each post.
6. Posts shall be driven tightly together to prevent potential flow-through of sediment at the joint. The tops of the posts shall be secured to each other with wire.
7. For each end post, fence fabric shall be folded around two posts one full turn and secured with 4 staples.
8. Minimum of 4 staples shall be installed per post. Dimensions shown are typical.
9. Maintenance openings shall be constructed in a manner to ensure that sediment is retained by the temporary silt fence.
10. Joint sections shall not be placed at sump locations.



PLAN
OPTIONAL MAINTENANCE OPENING DETAIL

LEGEND
- Tamped backfill
- Slope direction
- Direction of flow



PLAN
TEMPORARY SILT FENCE

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY SILT FENCE)

NO SCALE

T51

10-27-05

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

May 1, 2006
PLANS APPROVAL DATE

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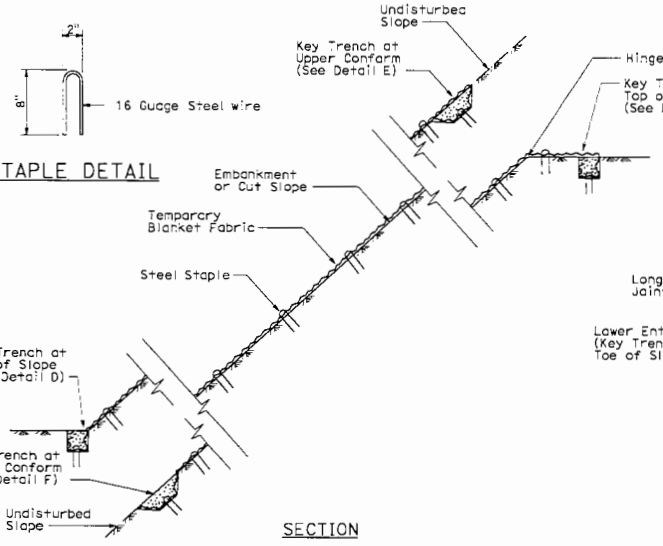
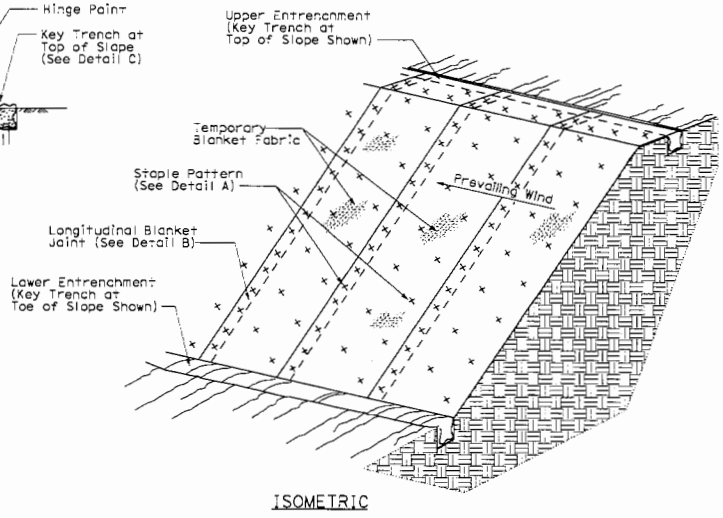


STAPLE DETAIL

SECTION

TEMPORARY EROSION CONTROL BLANKET
ON SLOPE WITH VARIOUS KEY ENTRENCHMENTS

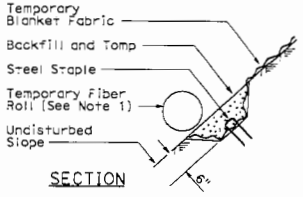


ISOMETRIC

TEMPORARY EROSION CONTROL BLANKET
ON SLOPE

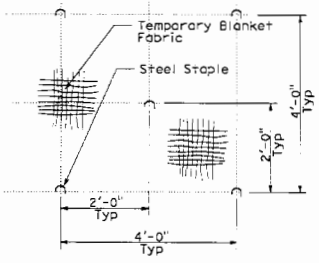
NOTE:

1. Temporary fiber roll shown for reference purposes only.

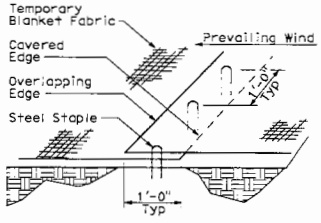


SECTION

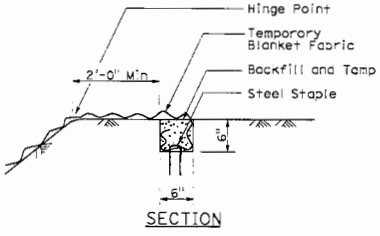
DETAIL F
KEY TRENCH AT
LOWER CONFORM



DETAIL A
STAPLE PATTERN

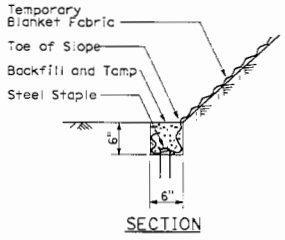


DETAIL B
LONGITUDINAL BLANKET JOINT



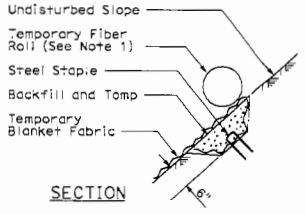
SECTION

DETAIL C
KEY TRENCH AT
TOP OF SLOPE



SECTION

DETAIL D
KEY TRENCH AT
TOE OF SLOPE



SECTION

DETAIL E
KEY TRENCH AT
UPPER CONFORM

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY EROSION CONTROL BLANKET)

NO SCALE

T54

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

April 3, 2009
PLANS APPROVAL DATE

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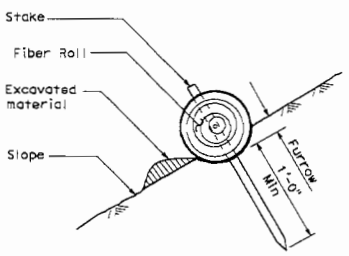
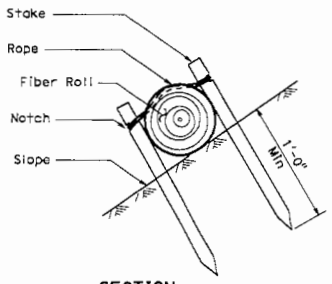
To accompany plans dated _____

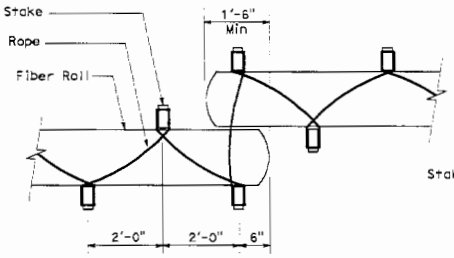


SECTION

TEMPORARY FIBER ROLL (TYPE 1)

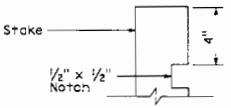


SECTION



PLAN

TEMPORARY FIBER ROLL (TYPE 2)

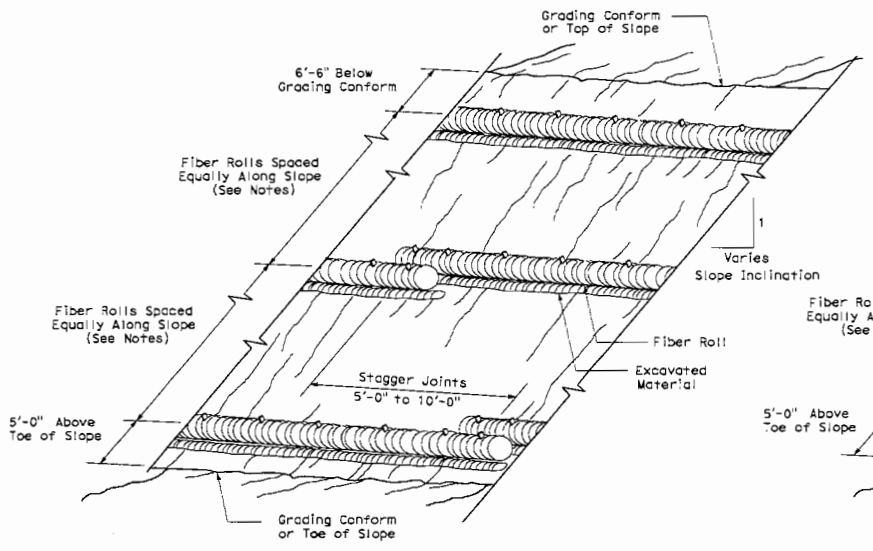


ELEVATION

STAKE NOTCH DETAIL

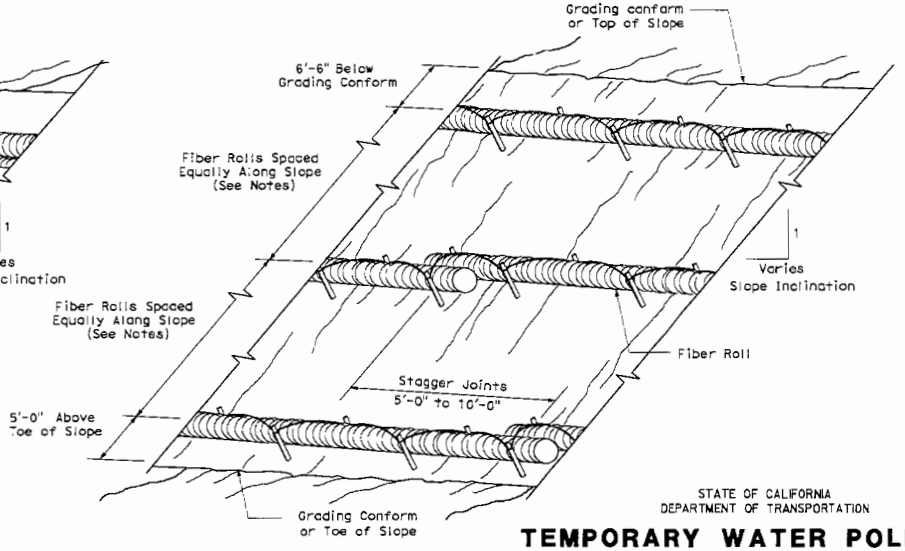
NOTES:

1. Temporary fiber roll spacing varies depending upon slope inclination.
2. Installations shown in the perspectives are for slope inclination of 10:1 and steeper.



PERSPECTIVE

TEMPORARY FIBER ROLL (TYPE 1)



PERSPECTIVE

TEMPORARY FIBER ROLL (TYPE 2)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY FIBER ROLL)

NO SCALE

RSP T56 DATED APRIL 3, 2009 SUPERSEDES STANDARD PLAN T56 DATED MAY 1, 2006 - PAGE 232 OF THE STANDARD PLANS BOOK DATED MAY 2006.

REVISED STANDARD PLAN RSP T56

2-23-09

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

May 1, 2006
PLANS APPROVAL DATE

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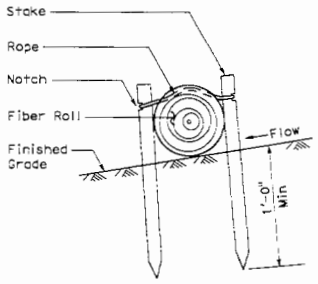
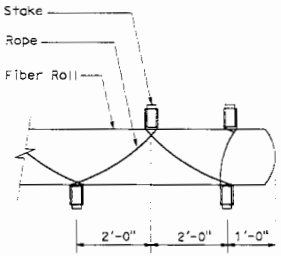
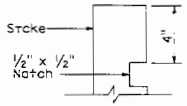




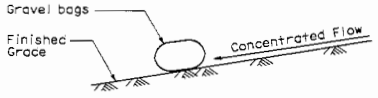
SECTION PLAN

STAKING AND LASHING DETAIL



ELEVATION

STAKE NOTCH DETAIL

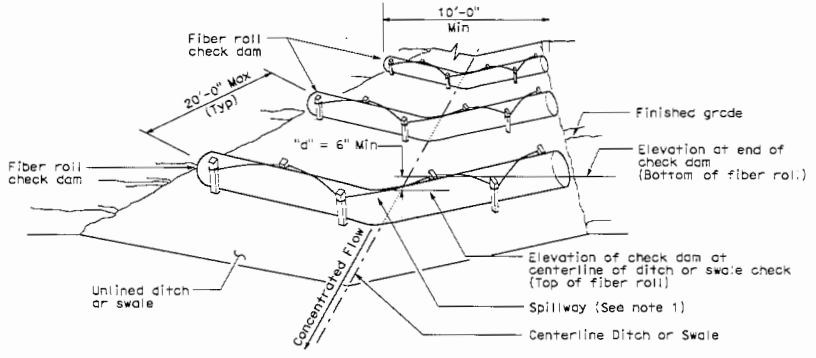


SECTION

TEMPORARY CHECK DAM (TYPE 2)

NOTE:

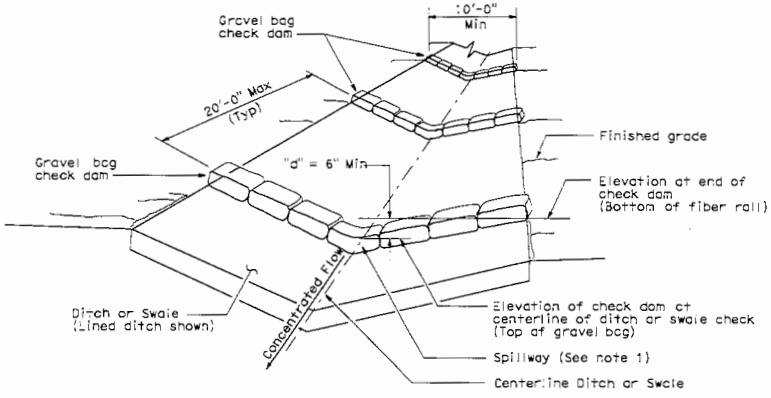
1. Spillway depth "d" shall be maintained to prevent flanking of concentrated flow around the ends of each check dam.



PERSPECTIVE

TEMPORARY CHECK DAM (TYPE 1)

(Total of 3 check dams shown)



PERSPECTIVE

TEMPORARY CHECK DAM (TYPE 2)

(Total of 3 check dams shown)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY CHECK DAM)

NO SCALE

T57

10-20-05

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

May 1, 2006
PLANS APPROVAL DATE

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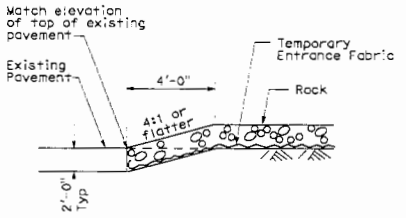
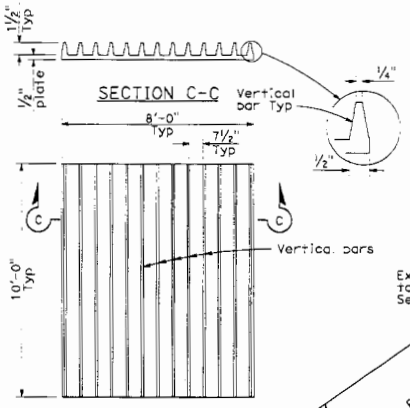
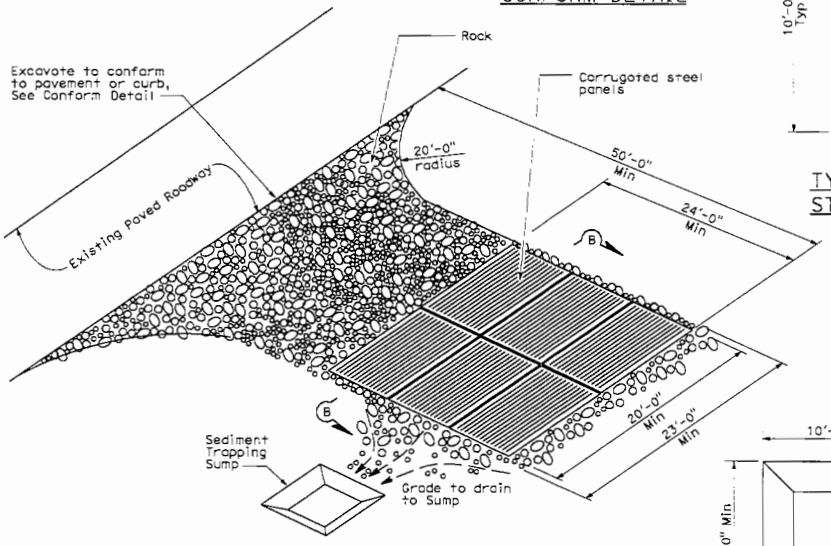


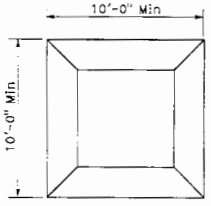
SECTION
CONFORM DETAIL



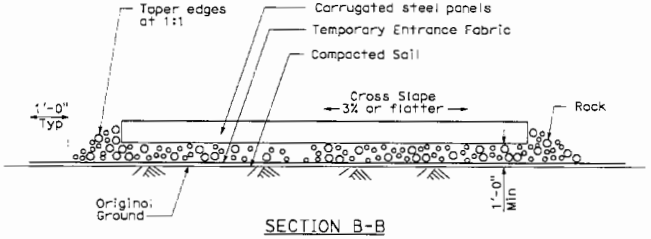
PLAN
TYPICAL CORRUGATED
STEEL PANEL DETAIL



PERSPECTIVE
TEMPORARY CONSTRUCTION ENTRANCE (TYPE 2)

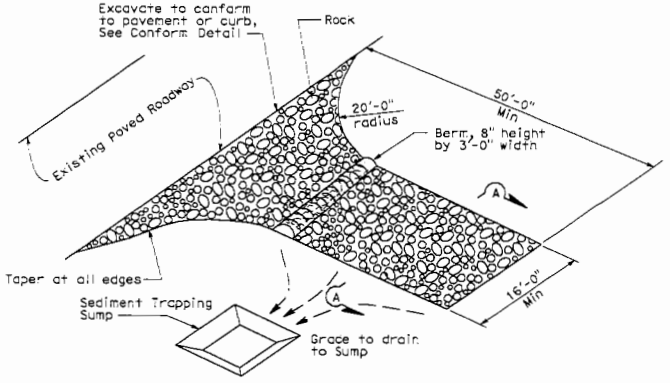


PLAN

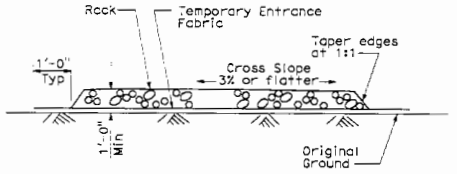


SECTION B-B

ELEVATION
SEDIMENT TRAPPING SUMP



PERSPECTIVE
TEMPORARY CONSTRUCTION ENTRANCE (TYPE 1)



SECTION A-A

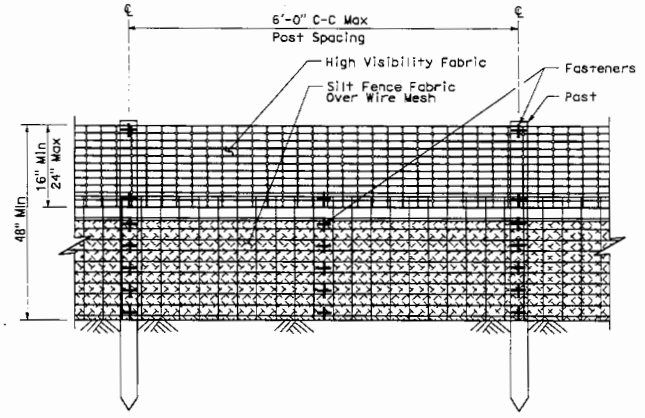
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY CONSTRUCTION ENTRANCE)

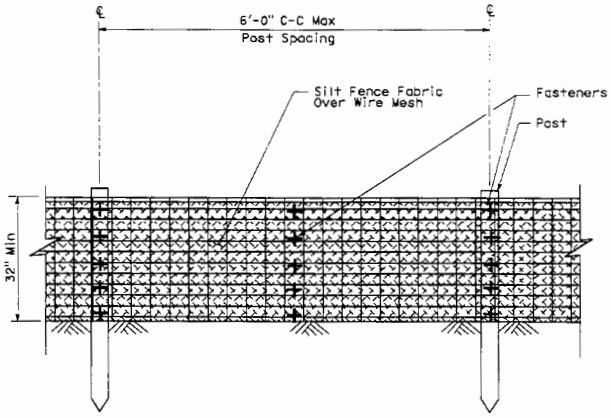
NO SCALE

T58

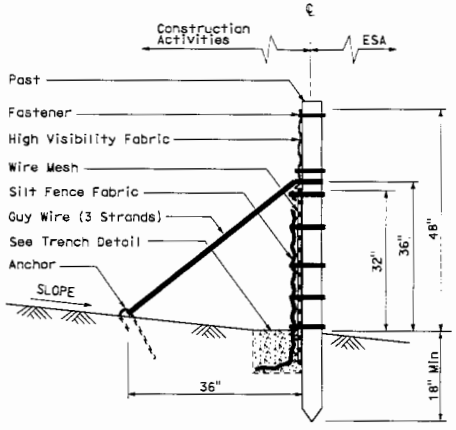
10-29-05



ELEVATION

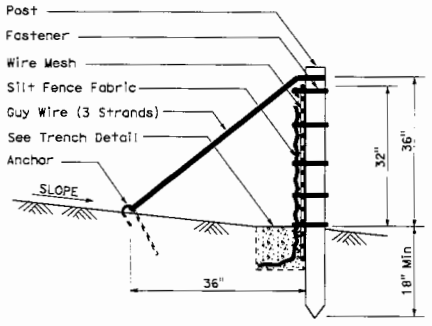


ELEVATION



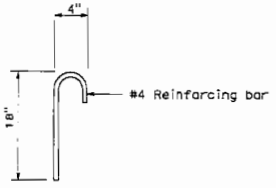
SECTION

TEMPORARY REINFORCED SILT FENCE (TYPE 1)

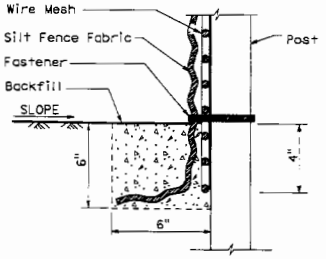


SECTION

TEMPORARY REINFORCED SILT FENCE (TYPE 2)



ANCHOR



SECTION

TRENCH DETAIL

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Robert B. Schmitt
LICENSED LANDSCAPE ARCHITECT

April 3, 2009
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

LICENSED LANDSCAPE ARCHITECT — Robert B. Schmitt — 11-30-10 — 2-28-09 — STATE OF CALIFORNIA

To accompany plans dated _____

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY REINFORCED SILT FENCE)

NO SCALE

NSP T60 DATED APRIL 3, 2009 SUPPLEMENTS
THE STANDARD PLANS BOOK DATED MAY 2006.

NEW STANDARD PLAN NSP T60

1-1-09

2006 NEW STANDARD PLAN NSP T60

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

August 15, 2008
PLANS Approval DATE

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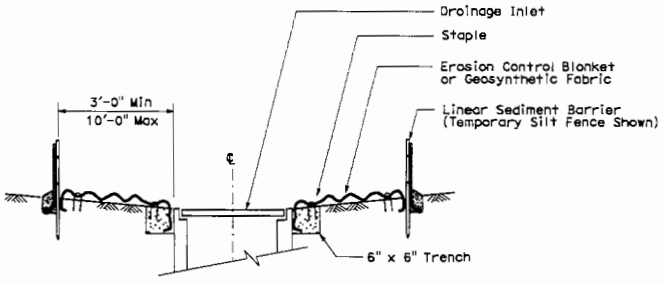
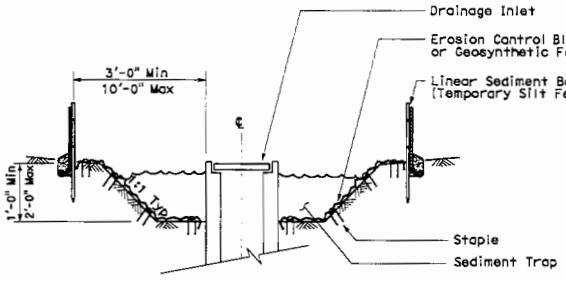
To accompany plans dated _____



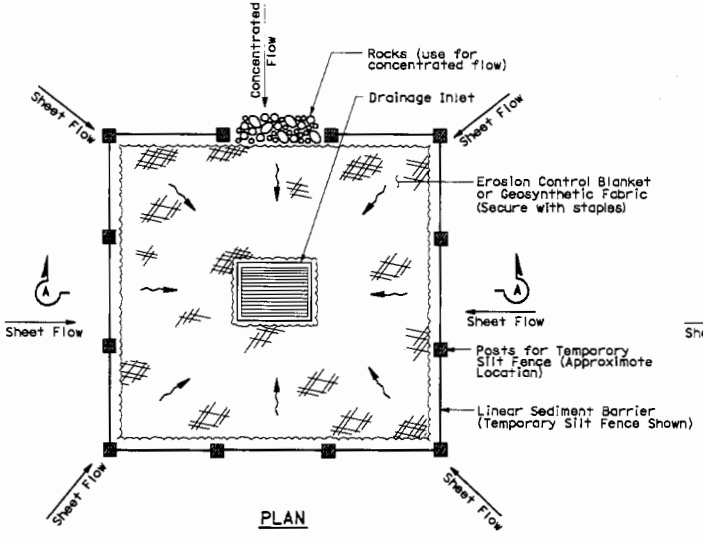
SECTION A-A



SECTION B-B

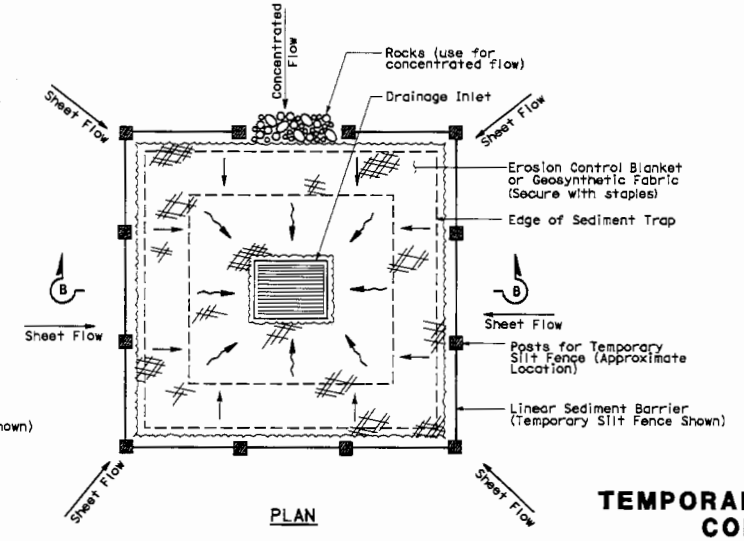
NOTES:

1. See Standard Plan T51 for Temporary Silt Fence.
2. Dimensions may vary to fit field conditions.



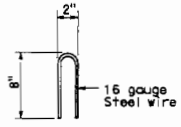
PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 1)



PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 2) (EXCAVATED SEDIMENT TRAP)



STAPLE DETAIL

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

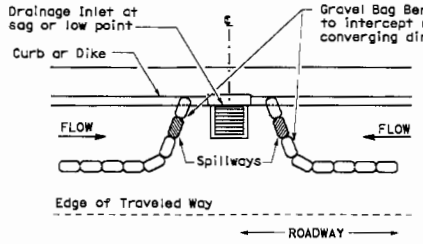
TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY DRAINAGE INLET PROTECTION)

NO SCALE

Nsp t61 dated ouguet 15, 2008 supplements the standard plans book dated may 2006.

NEW STANDARD PLAN NSP T61

7-11-08



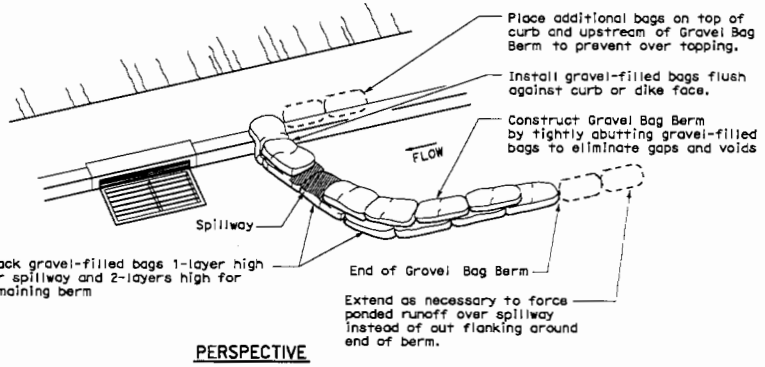
PLAN

CONFIGURATION FOR SAG POINT INLET (GRAVEL BAG BERM)

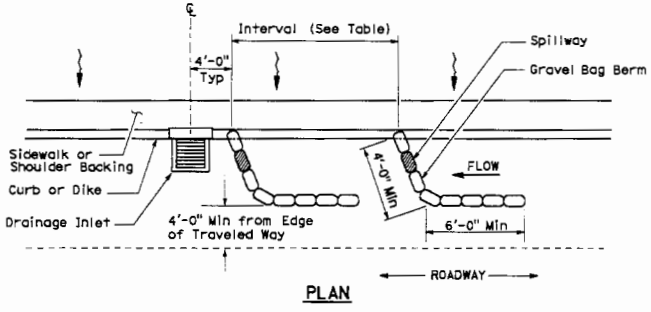
GRAVEL BAG BERM (TYPE 3A) SPACING TABLE

SLOPE OF ROADWAY (PERCENT)	1 to 3.9	4 to 5.9	6 to 7.9	8 to 10	10+
INTERVAL BETWEEN BERM	100'	75'	50'	25'	12'

For slope of less than 1%, install barriers only if erosion/sediment is prevalent

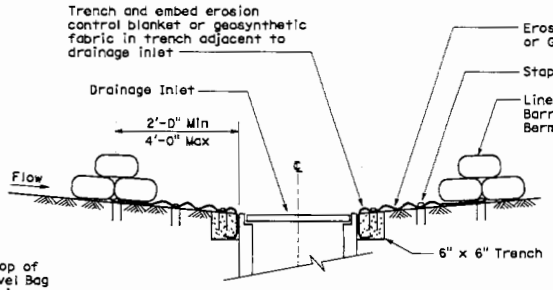


PERSPECTIVE

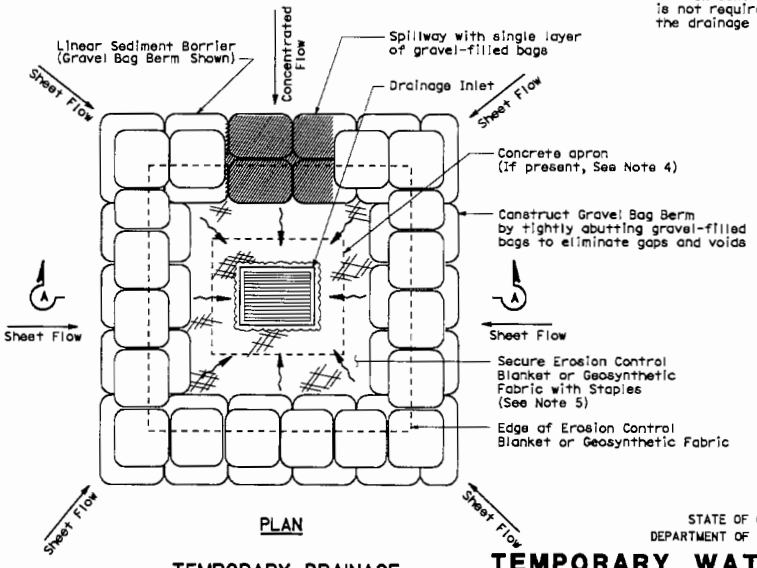


PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 3A) (GRAVEL BAG BERM)

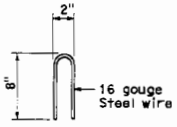


SECTION A-A



PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 3B)



STAPLE DETAIL

NOTES:

1. Place safety cones adjacent to drainage inlet protection.
2. Dimensions may vary to fit field conditions.
3. Install a minimum of 3 gravel bag berms upstream of each drainage inlet to be protected.
4. Position erosion control blanket or geosynthetic fabric at edge of concrete apron and secure in trench.
5. Erosion control blanket or geosynthetic fabric is not required if the area adjacent to the drainage inlet is vegetated or paved.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

August 15, 2008
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

To accompany plans dated _____

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY DRAINAGE INLET PROTECTION)

NO SCALE

NSP T62 DATED AUGUST 15, 2008 SUPPLEMENTS THE STANDARD PLANS BOOK DATED MAY 2006.

NEW STANDARD PLAN NSP T62

7-11-08

2006 NEW STANDARD PLAN NSP T62

FLEXIBLE SEDIMENT BARRIER SPACING TABLE

SLOPE OF ROADWAY (PERCENT)	0 to 0.9	1 to 1.9	2 to 2.9	3 to 4	5+
INTERVAL BETWEEN BARRIERS	50'	35'	30'	25'	20'
ANGLE FROM FACE OF CURB	70°	70°	70°	45°	45°
SUGGESTED BARRIER LENGTH	6'	6'	6'	6'	6'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

August 15, 2008
PLANS APPROVAL DATE

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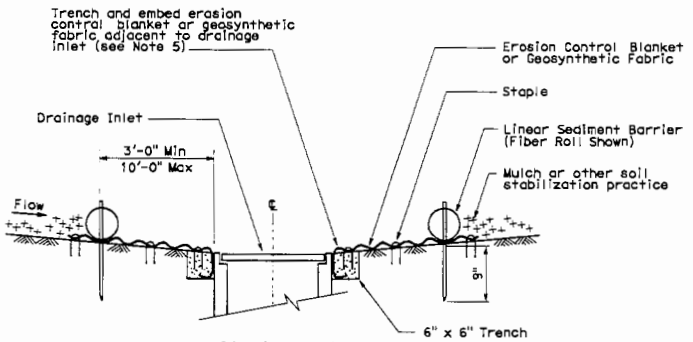
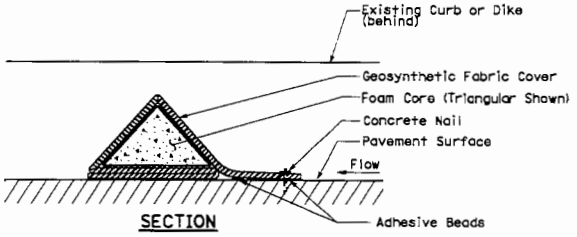
To accompany plans dated _____

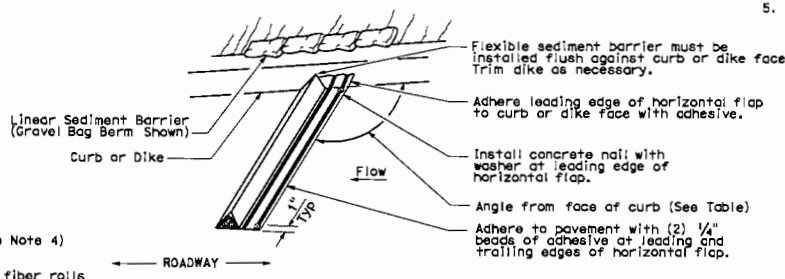


SECTION A-A



SECTION

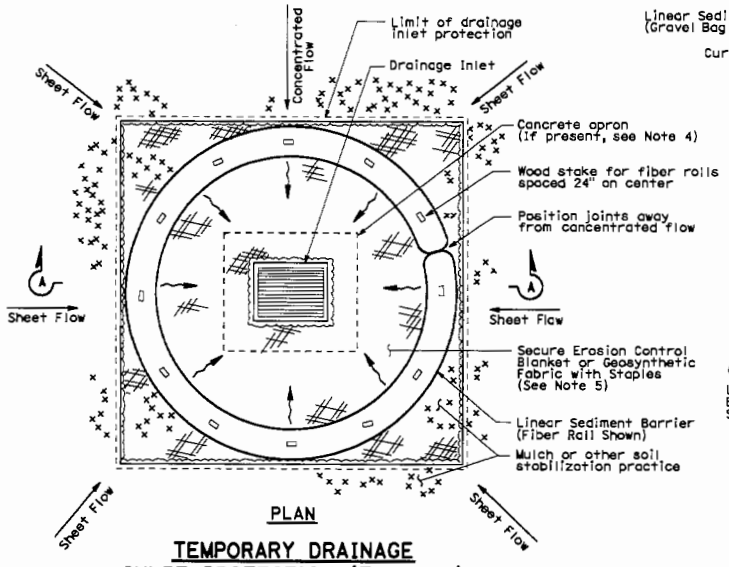
FLEXIBLE SEDIMENT BARRIER DETAIL (FOAM BARRIER SHOWN)



PERSPECTIVE

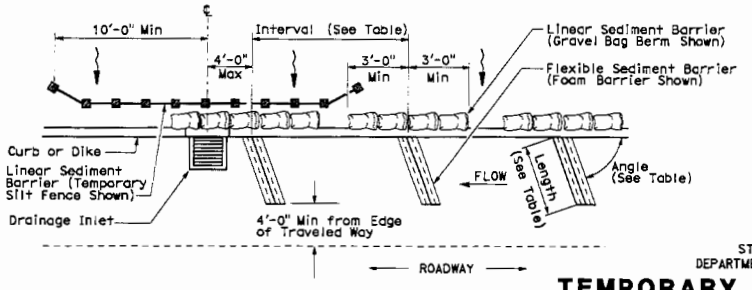
NOTES:

1. See Standard Plan T51 for Temporary Silt Fence.
2. Dimensions may vary to fit field conditions.
3. Install a minimum of 3 flexible sediment barriers upstream of each drainage inlet to be protected.
4. Position erosion control blanket or geosynthetic fabric at edge of concrete apron and secure in trench.
5. Erosion control blanket or geosynthetic fabric is not required if the area adjacent to the drainage inlet is vegetated.



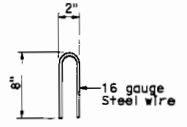
PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 4A)



PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 4B) FLEXIBLE SEDIMENT BARRIER



STAPLE DETAIL

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY DRAINAGE INLET PROTECTION)

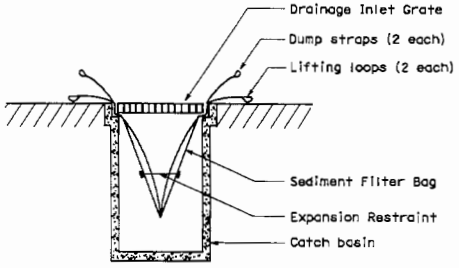
NO SCALE

NSP T63 DATED AUGUST 15, 2008 SUPPLEMENTS THE STANDARD PLANS BOOK DATED MAY 2006.

NEW STANDARD PLAN NSP T63

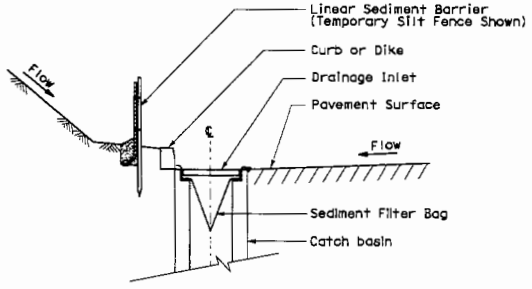
7-11-08

2006 NEW STANDARD PLAN NSP T63

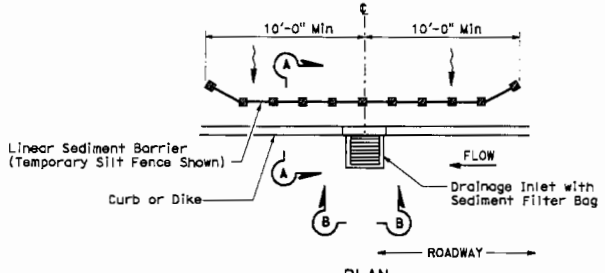


SECTION B-B

SEDIMENT FILTER BAG DETAIL

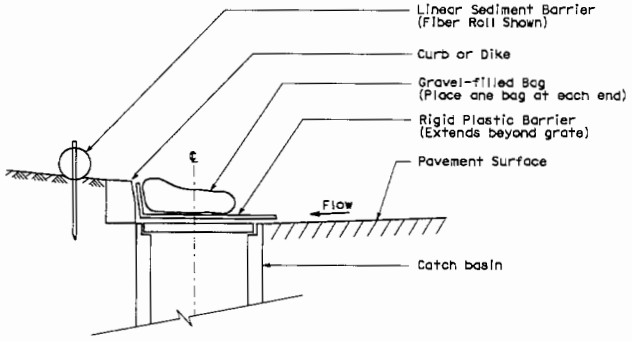


SECTION A-A



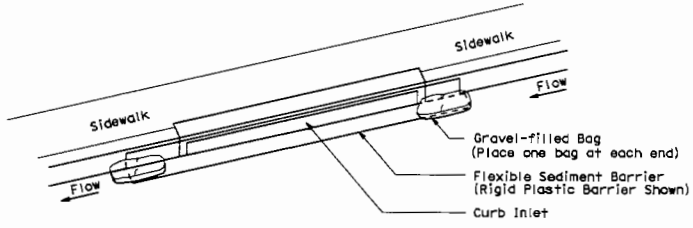
PLAN

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 5) (SEDIMENT FILTER BAG)



SECTION

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 6A) (CATCH BASIN WITH GRATE)



PERSPECTIVE

TEMPORARY DRAINAGE INLET PROTECTION (TYPE 6B) (CURB INLET WITHOUT GRATE)

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

August 15, 2008
PLANS APPROVAL DATE

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To accompany plans dated _____

NOTES:

1. See Standard Plan T51 for Temporary Silt Fence.
2. Dimensions may vary to fit field conditions.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY DRAINAGE INLET PROTECTION)

NO SCALE

NSP T64 DATED AUGUST 15, 2008 SUPPLEMENTS THE STANDARD PLANS BOOK DATED MAY 2006.

NEW STANDARD PLAN NSP T64

7-11-08

2006 NEW STANDARD PLAN NSP T64

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

LICENSED LANDSCAPE ARCHITECT

April 3, 2009
PLANS APPROVAL DATE

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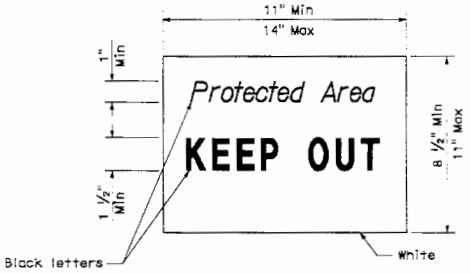
LICENSED LANDSCAPE ARCHITECT — 11-30-10 — STATE OF CALIFORNIA

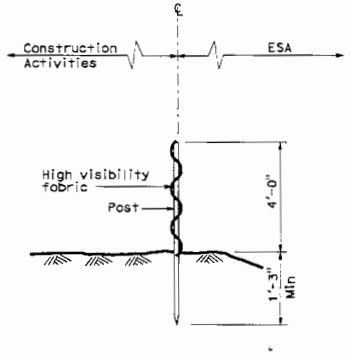
To accompany plans dated _____



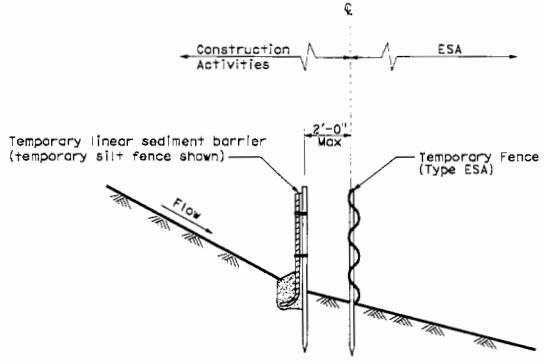
SIGN DETAIL

NOTE:

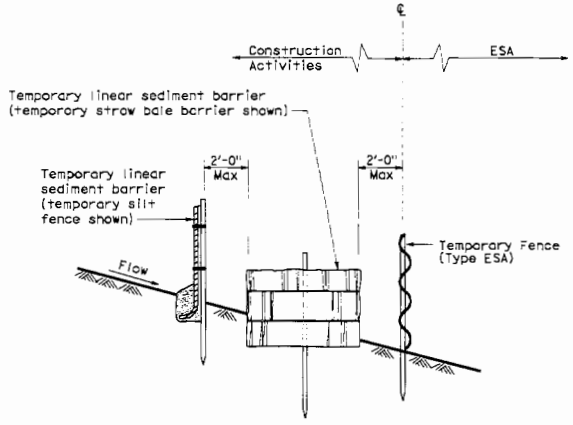
1. Temporary silt fence and temporary straw bale barrier shown for reference purposes only.



SECTION
TEMPORARY FENCE (TYPE ESA)



SECTION
PLACEMENT DETAIL
FOR TEMPORARY LINEAR SEDIMENT BARRIER
USED WITH TEMPORARY
FENCE (TYPE ESA)
(See Note 1)



SECTION
PLACEMENT DETAIL
FOR TEMPORARY SILT FENCE
AND TEMPORARY STRAW BALE BARRIER
USED WITH TEMPORARY FENCE (TYPE ESA)
(See Note 1)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS [TEMPORARY FENCE (TYPE ESA)]

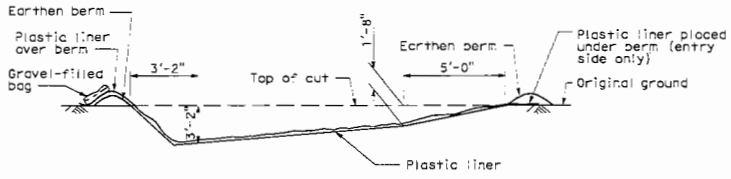
NO SCALE

NSP T65 DATED APRIL 3, 2009 SUPPLEMENTS
THE STANDARD PLANS BOOK DATED MAY 2006.

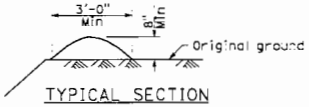
NEW STANDARD PLAN NSP T65

2006 NEW STANDARD PLAN NSP T65

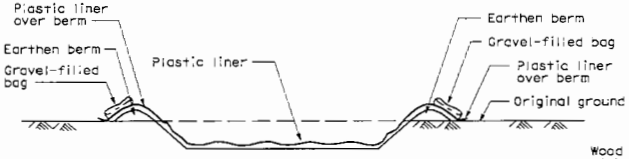
1-7-09



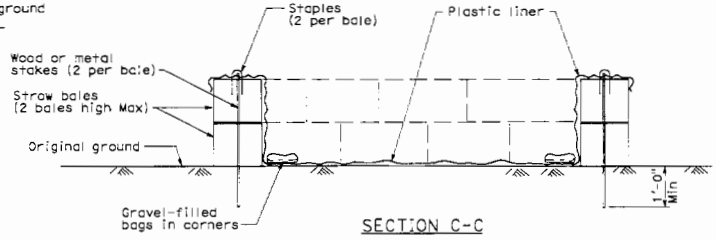
SECTION B-B



TYPICAL SECTION
EARTHEN BERM



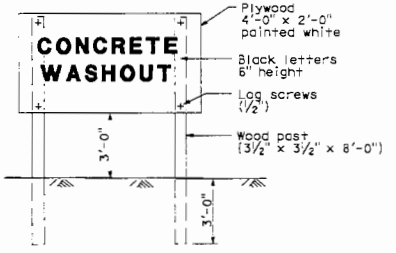
SECTION A-A



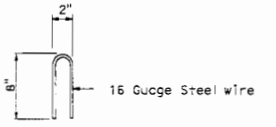
SECTION C-C

NOTES:

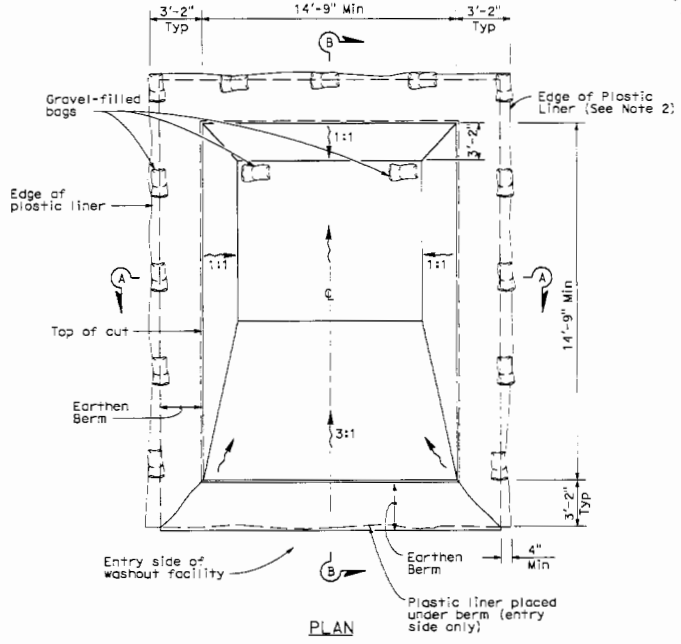
1. The concrete washout sign shall be installed within 32'-10" of the temporary concrete washout facility.
2. Plastic liner shall be anchored with gravel-filled bags for below grade concrete washout facility.



CONCRETE WASHOUT SIGN DETAIL

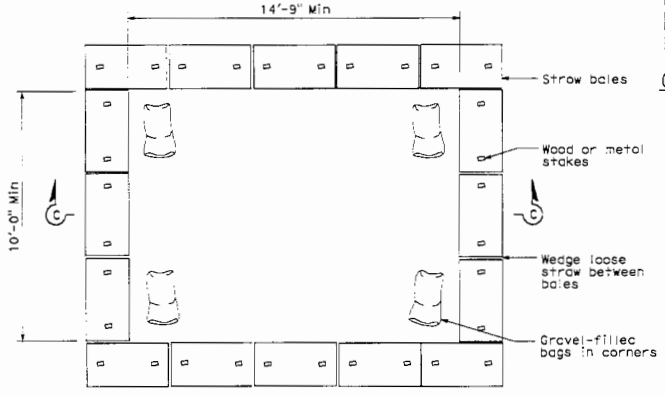


STAPLE DETAIL



PLAN

TEMPORARY CONCRETE WASHOUT FACILITY
(Below Grade)



PLAN

TEMPORARY CONCRETE WASHOUT FACILITY
(On Grade)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY CONCRETE WASHOUT FACILITY)

NO SCALE

T59

2006 STANDARD PLAN T59

235

10-20-06

SECTION 4. BEGINNING OF WORK, TIME OF COMPLETION, AND LIQUIDATED DAMAGES

The 1st working day is the 5th day after contract approval.

The first paragraph and second paragraph, item number 2, of Section 8-1.03 "Beginning of Work" will not apply. Submit a written notice 24 hours before beginning work.

Do not start work at the job site, except for measuring controlling field dimensions and locating utilities, until the Engineer approves your submittal for:

1. Time-scaled logic diagram (Critical Path Method).
2. Storm Water Pollution Prevention Plan (SWPPP). A Conceptual SWPPP has been prepared for this Contract as described in "Supplemental Project Information," of these special provisions. The Contractor shall adhere to the Conceptual SWPPP for all construction activities planned for the first 60 days after contract approval, or until the Contractor's SWPPP as required in "Water Pollution Control," of these special provisions is approved by the Engineer. The Contractor shall sign the "Initial SWPPP Certification," included within the Conceptual SWPPP and submit it to the Engineer. The Contractor's SWPPP shall supersede the Conceptual SWPPP upon Engineer's approval.
3. Traffic Management Plan (TMP).
4. Temporary Access Plans (TAP).

In addition to the above submittals, do not start work at the job site, except for measuring controlling field dimensions and locating utilities, until you submit:

1. Notice of Materials To Be Used.
2. Contingency plan for reopening closures to public traffic.
3. Written statement from the vendor that the order for electrical material has been received and accepted by the vendor. The statement must show the dates that the materials will be shipped.
4. Written statement from the vendor that the order for structural steel has been received and accepted by the vendor. The statement must show the dates that the materials will be shipped.

You may start work at the job site before the 5th day after contract approval if:

1. You obtain required approval for each submittal before the 5th day
2. The Engineer authorizes it in writing

The Department grants a time extension if a delay is beyond your control and prevents you from starting work at the job site on the 1st working day.

Complete the work within 550 working days.

The time limit specified for the completion of the work contemplated herein is considered insufficient to permit completion of the work by the Contractor working a normal number of hours per day or week on a single shift basis. Should the Contractor fail to maintain the progress of the work in conformance with the "Progress Schedule" required in these special provisions, additional shifts will be required to the extent necessary to ensure that the progress conforms to the abovementioned schedule and that the work will be completed within the time limit specified.

The working day is defined as follows:

The working day: Time measure unit for work progress. A working day is any day except:

1. Special event days as listed in the table in this special provision.
2. A day when you cannot perform work on the controlling activity for at least 50 percent of the day with at least 50 percent of the normal labor and equipment due to any of the following:

    2.1. The Engineer's direction to suspend the controlling activities for reasons unrelated to your performance

    2.2. An unanticipated event not caused by either party such as:

        2.2.1. Act of God (Pub Cont Code § 7105)
        2.2.2 Act of a public enemy
        2.2.3. Epidemic
        2.2.4. Fire
        2.2.5. Flood
        2.2.6. Governor-declared state of emergency
        2.2.7. Landslide
        2.2.8. Quarantine restriction

    2.3. An issue involving a third-party, including:

        2.3.1. Industry or area-wide labor strike
        2.3.2. Material shortage
        2.3.3. Freight embargo
        2.3.4. Jurisdictional requirement of a law enforcement agency
        2.3.5. Workforce labor dispute of a utility or non-highway facility owner resulting in a utility or non-highway facility reconstruction not described and not solely for the Contractor's convenience

No work will performed in the Presidio on the same days where the following special events are being held in the Presidio:

Special Event Days

Presidio Event	Date of Event
Special Olympic Polar Bear Run	4th Thursday in February
Emerald Nuts Across the Bay 12k	2nd Sunday in March
US Half Marathon – Spring Half	2ndSaturday in April
Girl Scout Golden Gate Bridging Ceremony	2nd Saturday in May
Annual Memorial Day Observance	Memorial Day
Anchorman Escape from Alcatraz Triathlon	1st or 2nd Sunday in June
Golden Gate Triathlon	3rd or 4th Sunday in June
Avon 2 Day Walk	2nd Saturday and Sunday in July
San Francisco Marathon	Last Sunday in July
Aloha Festival Event	1st Saturday and Sunday in August
Film in the Fog	Last Saturday in September
Susan G. Komen 3-Day Breast Cancer Walk	1st Friday, Saturday and Sunday in October
Juvenile Diabetes Walk	1st Saturday in October
KNBR Bridge to Bridge Run	1st Sunday in October
Hold for Genentech	3rd Friday in October
Fleet Week/Blue Angels Performances	2nd or 3rd Saturday and Sunday in October
Seismic Challenge	3rd Saturday and Sunday in October
Nike Marathon	3rd Sunday in October
HDSA Walkathon	4th Saturday in October
Temp-Hold Mermaid	2nd Saturday in November
Rival 10 Run	2nd Saturday and Sunday in November
US Half Marathon	2nd or 3rd Sunday of November

Phase 1 work is defined as the work necessary to complete the full width of all structures and roadways in their final configuration on State Route 101, as shown on the plans, ready to be opened for public use without any work that requires lane closures.

Phase 2 work is defined as the remaining work to complete the contract.

For each and every calendar day's delay in completion of the Phase 1 work after the expiration of 485 working days, a disincentive deduction of $50,000 per calendar day will be deducted from any monies due the Contractor under the contract .

For each and every calendar day, the Phase 1 work, is completed before the expiration of 485 working days, the Contractor will receive an incentive payment of $50,000 per calendar day.

The total of all incentive payments paid to the Contractor shall not exceed $3,000,000.

The total of all disincentive payments deducted shall not exceed $3,000,000.

Liquidated damages shall accrue separately and independently of disincentive deductions.

Full compensation for any additional costs occasioned by compliance with the provisions in this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefor.

5-1.__ SUPPLEMENTAL PROJECT INFORMATION

The Department makes the following supplemental project information available:

Supplemental Project Information

Means	Description
Included in the Information Handout	Transportation Management Plan Guidelines Manual Non-Stormwater Information Package Site Investigation Report for Dolye Drive Overcrossing VMS Handouts
Available for inspection at the District Office	
Available for inspection at the Transportation Laboratory	
Available as specified in the Standard Specifications	Bridge as-built drawings

5-1. RELATIONS WITH CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

This project lies within the boundaries of the San Francisco Bay Regional Water Quality Control Board (RWQCB).

The State Water Resources Control Board (SWRCB) has issued to the Department a permit that governs storm water and non-storm water discharges from the Department's properties, facilities, and activities. The Department's permit is entitled "Order No. 99 - 06 - DWQ, NPDES No. CAS000003, National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)." Copies of the Department's permit are available for review from the SWRCB, Storm Water Permit Unit, 1001 "I" Street, P.O. Box 1977, Sacramento, California 95812-1977, Telephone: (916) 341-5254, and may also be obtained at:

http://www.waterboards.ca.gov/water_issues/programs/stormwater/

The Department's permit references and incorporates by reference the current statewide general permit issued by the SWRCB entitled "Order No. 99-08-DWQ, National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000002, Waste Discharge Requirements (WDRs) for Discharges of Storm Water Runoff Associated with Construction Activity" that regulates discharges of storm water and non-storm water from construction activities disturbing one acre or more of soil in a common plan of development. Sampling and analysis requirements as specified in SWRCB Resolution No. 2001-46 are added to the statewide general permit. Copies of the statewide permit and modifications thereto are available for review from the SWRCB, Storm Water Permit Unit, 1001 "I" Street, P.O. Box 1977, Sacramento, California 95812-1977, Telephone: (916) 341-5254 and may also be obtained at:

http://www.waterboards.ca.gov/water_issues/programs/stormwater/

The NPDES permits that regulate this project, as referenced above, are collectively referred to in this section as the "permits."

This project shall conform to the permits and modifications thereto. The Contractor shall maintain copies of the permits at the project site and shall make them available during construction.

The Contractor shall know and comply with provisions of Federal, State, and local regulations and requirements that govern the Contractor's operations and storm water and non-storm water discharges from the project site and areas of disturbance outside the project limits during construction. Attention is directed to Sections 7-1.01, "Laws to be Observed," 7-1.11, "Preservation of Property," 7-1.12, "Indemnification and Insurance," and 9-1.055, "Penalty Withholds," of the Standard Specifications.

The Contractor shall notify the Engineer immediately upon request from the regulatory agencies to enter, inspect, sample, monitor, or otherwise access the project site or the Contractor's records pertaining to water pollution control work. The Contractor and the Department shall provide copies of correspondence, notices of violation, enforcement actions, or proposed fines by regulatory agencies to the requesting regulatory agency.

10-1.___ WATER POLLUTION CONTROL

GENERAL

Water pollution control work shall conform to the provisions in Section 7-1.01G, "Water Pollution," of the Standard Specifications, section of these special provisions entitled "Relations With California Regional Water Quality Control Board," and these special provisions.

A Conceptual Storm Water Pollution Prevention Plan (CSWPPP) has been prepared for this contract and is available as described in "Project Information" of these special provisions.

The Contractor may obtain other National Pollutant Discharge Elimination System (NPDES) permits that apply to activities and mobile operations within or outside of the project limits including hot mix asphalt batch plants, material borrow areas, concrete plants, staging areas, storage yards, or access roads.

The Contractor shall perform water pollution control work in conformance with the requirements in the "Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual" and its addenda in effect on the day the Notice to Contractors is dated. This manual is referred to as the "Preparation Manual." Copies of the Preparation Manual may be obtained from:

State of California
Department of Transportation
Publication Distribution Unit
1900 Royal Oaks Drive
Sacramento, California 95815
Telephone: (916) 445-3520

The Preparation Manual and other references for performing water pollution control work are available from the Department's Construction Storm Water and Water Pollution Control web site at:

http://www.dot.ca.gov/hq/construc/stormwater/stormwater1.htm

Before the start of job site activities, the Contractor shall provide training for project managers, supervisory personnel, and employees involved with water pollution control work. The training shall include:

A. Rules and regulations
B. Implementation and maintenance for:

    1. Temporary Soil Stabilization
    2. Temporary Sediment Control
    3. Tracking Control
    4. Wind Erosion Control

The Contractor shall designate in writing a Water Pollution Control Manager (WPCM). The Contractor shall submit a statement of qualifications describing the training, work history, and expertise of the proposed WPCM. The qualifications shall include either:

A. A minimum of 24 hours of Department approved storm water management training described at Department's Construction Storm Water and Water Pollution Control web site.
B. Certification as a Certified Professional in Erosion and Sediment Control (CPESC).

The WPCM shall be:

A. Responsible for water pollution control work.
B. The primary contact for water pollution control work.
C. Have authority to mobilize crews to make immediate repairs to water pollution control practices.

The Contractor may designate one manager to prepare the SWPPP and a different manager to implement the plan. The WPCP preparer shall meet the training requirements for the WPCM.

STORM WATER POLLUTION PREVENTION PLAN

The Contractor shall submit a Storm Water Pollution Prevention Plan (SWPPP) to the Engineer for approval. The SWPPP shall conform to the requirements in the Preparation Manual, the NPDES permit, and these special provisions. The SWPPP shall be submitted in place of the water pollution control program required by the provisions in Section 7-1.01G, "Water Pollution," of the Standard Specifications.

The SWPPP shall include water pollution control practices:

A. For storm water and non-storm water from areas outside of the job site related to construction activities for this contract such as:

    1. Staging areas.
    2. Storage yards.
    3. Access roads.

B. Appropriate for each season as described in "Implementation Requirements" of these special provisions.
C. For activities or mobile operations related to all NPDES permits.

The SWPPP shall include a schedule that:

A. Describes when work activities that could cause water pollution will be performed.
B. Identifies soil stabilization and sediment control practices for disturbed soil area.
C. Includes dates when these practices will be 25, 50, and 100 percent complete.
D. Shows 100 percent completion of these practices before the rainy season.

The SWPPP shall include the following temporary water pollution control practices and their associated contract items of work as shown on the plans or specified in these special provisions:

A. Temporary Soil Stabilization

    1. Temporary Hydraulic Mulch (Bonded Fiber Matrix)
    2. Temporary Cover
    3. Move-In/Move-Out (Temporary Erosion Control)

4. Temporary Erosion Control Blanket

B. Temporary Sediment Control
   1. Temporary Drainage Inlet Protection
   2. Temporary Silt Fence
   3. Temporary Gravel Bag Berm
   4. Temporary Fiber Roll
   5. Temporary Check Dam

C. Tracking Control
   1. Street Sweeping
   2. Temporary Construction Entrance
   3. Temporary Tire Wash System
   4. Temporary Confinement System

D. Wind Erosion Control

   1. Temporary Cover

E. Non-Storm Water Management

   1. Construction Site Management

F. Waste Management and Materials Pollution Control

   1. Construction Site Management
   2. Temporary Concrete Washout (Portable)
   3. Temporary Storm Water Run-On Bypass and Excavation Dewatering

The SWPPP shall include the following contract items of work for permanent water pollution control as shown on the plans or as specified in these special provisions:

A. Erosion Control (Hydroseed)
B. Fiber Rolls
C. Erosion Control (Netting)
D. Erosion Control (Compost Blanket)
E. Move-In/Move-Out (Erosion Control)

Within 5 days after contract approval, follow this process for SWPPP approval:

1. Submit 3 copies of the SWPPP and allow 15 days for the Engineer's review. If revisions are required, the Engineer provides comments and specifies the date that the review stopped

2. Change and resubmit the SWPPP within 5 days of receipt of the Engineer's comments. The Engineer's review resumes when the complete SWPPP is resubmitted. Allow 5 days for the Engineer's second review

3. When the Engineer approves the SWPPP, submit 4 copies of the approved SWPPP. After approval, the Engineer submits one copy of the approved SWPPP to the San Francisco Bay RWQCB for their review and comment
4. If the San Francisco Bay RWQCB provides comments to the SWPPP, amend the SWPPP within 5 days

If the Engineer fails to complete the review within the time allowed and if, in the opinion of the Engineer, completion of the work is delayed or interfered with because of the Engineer's or the RWQCB's review, the Department pays you for resulting losses, and grants an extension of time.

The SWPPP shall include a copy of the US Army Corps of Engineers Permit, Clean Water Act Section 401 Water Quality Certification from the San Francisco Bay RWQCB.

The Contractor shall not perform work that may cause water pollution until the SWPPP has been approved by the Engineer. The Engineer's review and approval shall not waive any contract requirements and shall not relieve the Contractor from complying with Federal, State and local laws, regulations, and requirements.

The Contractor shall amend the SWPPP annually and shall resubmit it to the Engineer 25 days before the defined rainy season.

If there is a change in construction schedule or activities, the Contractor shall prepare an amendment to the SWPPP to identify additional or revised water pollution control practices. The Contractor shall submit the amendment to the Engineer for review within a time agreed to by the Engineer not to exceed the number of days specified for the initial submittal of the SWPPP. The Engineer will review the amendment within the same time allotted for the review of the initial submittal of the SWPPP.

If directed by the Engineer or requested in writing by the Contractor and approved by the Engineer, changes to the water pollution control work specified in these special provisions will be allowed. Changes may include addition of new water pollution control practices. The Contractor shall incorporate these changes in the SWPPP. Additional water pollution control work will be paid for as extra work in accordance with Section 4-1.03D, "Extra Work," of the Standard Specifications.

The Contractor shall keep a copy of the approved SWPPP at the job site. The SWPPP shall be made available when requested by a representative of the Regional Water Quality Control Board, State Water Resources Control Board, United States Environmental Protection Agency, or the local storm water management agency. Requests from the public shall be directed to the Engineer.

SAMPLING AND ANALYSIS

The Contractor shall include a Sampling and Analysis Plan (SAP) in the SWPPP to monitor the effectiveness of the water pollution control practices. The Contractor shall prepare the SAP in conformance with the Preparation Manual.

The Contractor shall designate trained personnel to collect water quality samples. The personnel and training shall be documented in the SAP. Training shall consist of the following elements:

A. SAP review,
B. Health and safety review, and
C. Sampling simulations.

In the SAP the Contractor shall describe the following water quality sampling procedures:

A. Sampling preparation,
B. Collection,
C. Quality assurance and quality control,
D. Sample labeling,
E. Collection documentation,
F. Sample shipping,
G. Chain of custody,
H. Sample numbering, and
I. Precautions from the construction site health and safety plan.

The Contractor shall document sample collection during precipitation.

Samples to be analyzed in the field shall be taken by the Contractor's designated sampling personnel using collection and analysis methods, and equipment calibration specified by the manufacturer of the sampling equipment. Samples to be analyzed by a laboratory, shall be sampled, preserved, and analyzed by a State-certified laboratory in conformance with the requirements in 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants." The Contractor shall identify the State-certified laboratory, sample containers, preservation requirements, holding times, and analysis method in the SAP. A list of State-certified laboratories that are approved by the Department is available at:

http://www.dhs.ca.gov/ps/ls/ELAP/html/lablist.htm

Non-Visible Pollutants

This project has the potential to discharge non-visible pollutants in storm water from the construction site. The Contractor shall include in the SAP a description of the sampling and analysis strategy to be implemented on the project for monitoring non-visible pollutants.

In the SAP the Contractor shall identify potential non-visible pollutants that will be present on the construction site associated with the following:

A. Construction materials and wastes;
B. Existing contamination due to historical site usage; or
C. Application of soil amendments, including soil stabilization products, with the potential to alter pH or contribute toxic pollutants to storm water.

The Contractor shall show the locations planned for storage and use of the potential non-visible pollutants on the SWPPP Water Pollution Control Drawings.

The Contractor shall include in the SAP the following list of conditions that require sampling when observed during a storm water inspection:

A. Materials or wastes containing potential non-visible pollutants are not stored under watertight conditions.

B. Materials or wastes containing potential non-visible pollutants are stored under watertight conditions, but:

1. A breach, leakage, malfunction, or spill is observed;
2. The leak or spill has not been cleaned up before precipitation; and
3. There is the potential for discharge of non-visible pollutants to surface waters or drainage system.

C. Construction activities; such as application of fertilizer, pesticide, herbicide, methyl methacrylate concrete sealant, or non-pigmented curing compound; have occurred during precipitation or within 24 hours preceding precipitation, and have the potential to discharge pollutants to surface waters or drainage system.
D. Soil amendments, including soil stabilization products, with the potential to alter pH levels or contribute toxic pollutants to storm water runoff have been applied, and have the potential to discharge pollutants to surface waters or drainage system (unless independent test data are available that demonstrate acceptable concentrations of non-visible pollutants in the soil amendment).
E. Storm water runoff from an area contaminated by historical usage of the site has the potential to discharge pollutants to surface waters or drainage system.

The Contractor shall describe in the SAP the schedule for collecting a sample downhill from each non-visible pollutant source and an uncontaminated control sample, during the first 2 hours of discharge from precipitation during daylight hours that result in enough discharge for sample collection. If discharge flows to the non-visible pollutant source, a sample shall be collected immediately downhill from where the discharge enters the Department's right of way. If precipitation occurs again after at least 72 hours of dry weather the Contractor shall take new samples.

In the SAP the Contractor shall identify sampling locations for collecting downstream and control samples, and the reason for their selection. The control sampling location shall be selected so the sample does not come into contact with materials, wastes or areas associated with potential non-visible pollutants or disturbed soil areas. The Contractor shall show non-visible pollutant sampling locations on the SWPPP Water Pollution Control Drawings.

The Contractor shall identify in the SAP the analytical method to be used for downhill and control samples for potential non-visible pollutants on the project.

Analytical Results and Evaluation

The Contractor shall submit a hard copy and electronic copy of water quality analytical results, and quality assurance and quality control data to the Engineer within 5 days of sampling for field analyses, and within 30 days for laboratory analyses. The Contractor shall also provide an evaluation of whether the downhill samples show levels of the tested parameter higher than in the control sample. If downhill or downstream samples show increased levels, the Contractor will assess the water pollution control measures, site conditions, and surrounding influences to determine the probable cause for the increase. As determined by the assessment, the Contractor will repair or modify water pollution control measures to address increases and amend the SWPPP as necessary. Electronic results (in one of the following file formats: .xls, .txt, .csv, .dbs, or .mdb) shall have the following information:

A. Sample identification number.
B. Contract number.

C. Constituent.
D. Reported value.
E. Analytical method.
F. Method detection limit.
G. Reported limit.

The Contractor shall maintain the water quality sampling documentation and analytical results with the SWPPP on the project site.

If construction activities or knowledge of site conditions change such that discharges or sampling locations change, the Contractor shall amend the SAP in conformance with this section, "Water Pollution Control."

IMPLEMENTATION REQUIREMENTS

The Contractor's responsibility for SWPPP implementation shall continue throughout any temporary suspension of work ordered in conformance with the provisions in Section 8-1.05, "Temporary Suspension of Work," of the Standard Specifications.

If the Contractor or the Engineer identifies a deficiency in the implementation of the approved SWPPP, the deficiency shall be corrected immediately, unless an agreed date for correction is approved in writing by the Engineer. The deficiency shall be corrected before the onset of precipitation. If the Contractor fails to correct the deficiency by the agreed date or before the onset of precipitation, the Department may correct the deficiency and deduct the cost of correcting deficiencies from payments.

If the Contractor fails to conform to the provisions of this section, "Water Pollution Control," the Engineer may order the suspension of work until the project complies with the requirements of this section.

Year-Round

The Contractor shall monitor the National Weather Service weather forecast on a daily basis during the contract. The Contractor may use an alternative weather forecasting service if approved by the Engineer. Appropriate water pollution control practices shall be in place before precipitation.

The Contractor may discontinue earthwork operations for a disturbed area for up to 21 days and the disturbed soil area will still be considered active. When earthwork operations in the disturbed area have been completed, the Contractor shall implement appropriate water pollution control practices within 15 days, or before predicted precipitation, whichever occurs first.

Rainy Season

The Contractor shall provide soil stabilization and sediment control practices during the rainy season between October 15 and April 15.

The Contractor shall implement soil stabilization and sediment control practices a minimum of 10 days before the start of the rainy season.

During the defined rainy season, the active disturbed soil area of the project site shall be not more than _5_ acres. The Engineer may approve expansions of the active disturbed soil area limit if requested in writing. The Contractor shall maintain soil stabilization and sediment control materials on site to protect disturbed soil areas.

Rain Event Action Plan

The contractor shall prepare a written Rain Event Action Plan (REAP) as part of the SWPPP. The REAP must describe work to be done to protect exposed areas of the jobsite before predicted storms.

The REAP must include:

1. Title sheet
2. Table of contents
3. Description of the storm event requiring the mobilization of crews and protection of exposed areas:

    3.1. Precipitation predicted by the National Weather Service to occur within 72 hours and have one of the following:

        3.1.1. Probability of at least 40 percent
        3.1.2. Quantity of at least 0.25 inches

4. Pre-storm activities including:

    4.1. Responsibilities of the WPC manager
    4.2. Responsibilities of the crew and crew size
    4.3. Stabilization for active and inactive disturbed soil areas
    4.4. Stockpile management

5. Activities to be done during storm events including:

    5.1. Responsibilities of the WPC manager
    5.2. Responsibilities of the crew and crew size
    5.3. Stabilization for active and inactive disturbed soil areas
    5.4. Stockpile management
    5.5. BMP maintenance

6. Diagram showing drainage patterns including:

    6.1. Surface flow and subsurface drainage systems
    6.2. Run-on flows to the jobsite
    6.3. Flows to drainage inlets and other drainage facilities
    6.4. Modifications to existing surface and subsurface drainage systems
    6.5. Impacts of current work and construction phase

7. Coordination with subcontractors
8. Description of flood contingency measures

The REAP must be revised whenever the SWPPP is amended:

1. At the start of the rainy season
2. When there is a change in the construction schedule or activities

The WPC manager must implement the REAP including mobilizing crews to complete activities before precipitation occurs.

INSPECTION AND MAINTENANCE

The WPCM shall inspect the water pollution control practices identified in the SWPPP as follows:

A. Before a forecasted storm,
B. After precipitation that causes site runoff,
C. At 24-hour intervals during extended precipitation,
D. On a predetermined schedule, a minimum of once every 2 weeks outside of the defined rainy season, and
E. On a predetermined schedule, a minimum of once a week during the defined rainy season.

The WPCM shall oversee the maintenance of the water pollution control practices.

The WPCM shall use the Storm Water Quality Construction Site Inspection Checklist provided in the Preparation Manual or an alternative inspection checklist provided by the Engineer. A copy of the completed site inspection checklist shall be submitted to the Engineer within 24 hours of finishing the inspection.

REPORTING REQUIREMENTS

If the Contractor identifies discharges into surface waters or drainage systems causing or potentially causing pollution, or if the project receives a written notice or order from a regulatory agency, the Contractor shall immediately inform the Engineer. The Contractor shall submit a written report to the Engineer within 7 days of the discharge, notice or order. The report shall include the following information:

A. The date, time, location, and nature of the operation, type of discharge and quantity, and the cause of the notice or order.
B. The water pollution control practices used before the discharge, or before receiving the notice or order.
C. The date of placement and type of additional or altered water pollution control practices placed after the discharge, or after receiving the notice or order.
D. A maintenance schedule for affected water pollution control practices.

Annual Certifications

By June 15 of each year, the Contractor shall complete and submit to the Engineer an Annual Certification of Compliance, as contained in the Preparation Manual.

PAYMENT

During each estimate period the Contractor fails to conform to the provisions in this section, "Water Pollution Control," or fails to implement the water pollution control practices shown on the plans or specified elsewhere in these special provisions as items of work, the Department will withhold 25 percent of the progress payment.

Withholds for failure to perform water pollution control work will be in addition to all other withholds provided for in the contract. The Department will return performance-failure withholds in the progress payment following the correction of noncompliance.

The contract lump sum price paid for prepare storm water pollution prevention plan shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in preparing, obtaining approval of, and amending the SWPPP and inspecting water pollution control practices as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Payments for prepare storm water pollution prevention plan will be made as follows:

A. After the SWPPP has been approved by the Engineer, 50 percent of the contract item price for prepare storm water pollution prevention plan will be included in the monthly progress estimate.
B. Forty percent of the contract item price for prepare storm water pollution prevention plan will be paid over the life of the contract.
C. After acceptance of the contract in conformance with the provisions in Section 7-1.17, "Acceptance of Contract," of the Standard Specifications, payment for the remaining 10 percent of the contract item price for prepare storm water pollution prevention plan will be made in conformance with the provisions in Section 9-1.07A, "Payment Prior to Proposed Final Estimate."

Storm water sampling and analysis will be paid for as extra work as provided in Section 4-1.03D, "Extra Work," of the Standard Specifications. No payment will be made for the preparation, collection, analysis, and reporting of storm water samples where appropriate water pollution control practices are not implemented before precipitation or if a failure of a water pollution control practice is not corrected before precipitation.

Implementation of water pollution control practices in areas outside the highway right of way not specifically provided for in the SWPPP or in these special provisions will not be paid for.

Water pollution control practices for which there are separate contract items of work will be measured and paid for as those contract items of work.

10-1.__ TEMPORARY STORM WATER RUN-ON BYPASS AND EXCAVATION DEWATERINGSummary

This work includes temporary diversion of storm water run-on around work areas; and excavation dewatering as described in this section.

This work includes designing, implementing, monitoring, maintaining, and later removing the temporary storm water run-on bypass system and the temporary non-storm water treatment system (TNSWTS) in conformance with "Water Pollution Control" and "Construction Site Management" of these special provisions and this special provision. Maintenance includes disposal of sediments and other material removed from the collection, conveyance and treatment systems.

TEMPORARY STORM WATER RUN-ON BYPASS

The Contractor shall furnish all tools, equipment, materials, and supplies, and shall perform all labor as required to divert storm water in order to prevent run-on entering work areas including, but not limited to, tunnel excavations, structure excavations for footings, walls, excavations for storm drain systems, sanitary sewer systems, structure demolition, utilities and appurtenances to complete the work. Storm water run-on being bypassed shall not be allowed to mix with non-storm water.

Storm water Run-on Bypass Plan (SRBP)

The Contractor shall submit to the Engineer, as provided in "Working Drawings," of these special provisions, a Storm water Run-on Bypass Plan (SRBP) within the Dewatering and Discharge Plan (DDP), described elsewhere in this section. The SRBP shall include:

1. Identification and description of all major sources of storm water run-on discharges that are expected to enter work areas.
2. Water pollution control drawings that show temporary bypass measures for bypassing storm water run-on from above, and around the work areas at the project site. The drawings shall show how natural run-on shall be diverted and prevented from entering into work areas and show the storm drain discharge location and receiving water.
3. Description of the best management practices (BMPs) with information on the sizing and installation of the conveyance system including pipes, pumps, and their inspection and maintenance procedures to ensure that no storm water runon discharges enter the work areas.

Temporary Bypass Measures

The Contractor shall select and deploy temporary bypass measures or BMPs that shall consist of a system of structures and measures that intercept storm water run-on discharges upstream of work areas, transport it around the work area, and discharge it downstream with minimal water quality degradation from either construction activities or the construction of the BMPs. The temporary bypass measures shall be designed to divert and convey storm water run-on in a manner that does not cause erosion and scour, and shall not result in discharge of sediment at the discharge location to the storm drain system.

The Contractor's selection of temporary BMPs shall conform to the Department's "Construction Site Best Management Practices (BMPs) Manual," including addenda to the Manual issued up to and including the date of advertisement of this contract. Copies of this Manual may be obtained from the Department of Transportation, Material Operations Branch,

Publication Distribution Unit, 1900 Royal Oaks Drive, Sacramento, California 95815, Telephone: (916) 445 3520, and may also be obtained from the Department's Internet website at:

http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf.

Temporary BMPs including but not limited to any or all of following components shall be employed in conformance with this Manual:

1. Earth Dikes/Drainage Swales &Lined Ditches (SS-9)
2. Outlet Protection/Velocity Dissipation Devices (SS-10)
3. Slope Drains (SS-11)
4. Check Dam (SC-4)

Any substance used to assemble or maintain diversion structures, or to minimize seepage underneath diversion structures, such as grout, shall be non-toxic, non-hazardous.

The size and type of temporary culverts or pipes to be installed shall be capable of conveying the 10 year, 24 hour storm event. Pipe joints for temporary culverts or pipes shall be watertight in conformance with the provisions in Section 61-1.02, "Performance Requirements for Culvert and Drainage Pipe Joints," of the Standard Specifications. The Contractor shall be responsible for incorporating any required fittings or appurtenances to ensure that the temporary bypass measures can be placed without inducing stresses that could damage the pipes used to convey the bypass flow.

The material, size and type of supports for temporary culverts shall be at the option of the Contractor; however, supports shall be constructed in a manner that will provide adequate supports for the culvert.

The Contractor shall be responsible for preventing, at Contractor's expense, any leakage in the temporary storm water run-on bypass measures. Any portion of the temporary storm water run-on bypass measures that is damaged from any cause during the progress of the work shall be repaired or replaced by the Contractor at the Contractor's expense. If during the progress of work for a particular section it becomes necessary to reposition, relocate portions or reconstruct the temporary drainage bypass measures, the work shall be done at the Contractor's expense.

When no longer required for the work as determined by the Engineer, temporary run-on bypass measures shall be removed. Removed facilities shall become the property of the Contractor and shall be disposed of outside the highway right of way in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Inspection and Maintenance

The Contractor shall conduct a daily inspection of storm water run-on bypass equipment, when in use, and ensure that all components are functional and routinely maintained. If any component of the equipment is damaged so that the performance of the equipment is diminished below allowable operational levels, the component shall be immediately repaired or replaced with substitute equipment. Bypassed storm water run-on that mixes with non-storm water or storm water runoff from high risk areas shall be treated prior to disposal as described within "Collection and Conveyance System" and "Treatment Systems" in this section. Inspection reports shall be submitted to the Engineer along with the Daily Inspection Report (DIR) described elsewhere in this section.

EXCAVATION DEWATERING Accumulated precipitation and groundwater encountered in all excavations shall be considered as non-storm water. This work includes dewatering, collection, conveyance, treatment, and disposal of non-storm water encountered in all excavations including, but not limited to tunnel excavations, structure excavations for footings, walls, excavations for storm drain systems, sanitary sewer systems, utilities and appurtenances to complete the work.

Concrete washout water from delivery trucks and shotcrete spraying equipment used in the construction of the tunnel shall not be allowed to mix with non-storm water. Disposal of concrete washout water shall be in accordance with "Temporary Concrete Washout Bin" of these special provisions.

The Department's "Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual" (Preparation Manual) is available at:

http://www.dot.ca.gov/hq/construc/SWPPP_WPCP_Preparation.pdf

The "Field Guide to Construction Site Dewatering" (Dewatering Guide) provides guidance on this work. and is available at:

http://www.dot.ca.gov/hq/construc/stormwater/DewateringGuide.htm

Discharge non-storm water using any of the following methods:

1. Discharge into a Publicly Owned Treatment Works (POTW) facility (sanitary sewer) under a batch discharge permit. Apply for and comply with the provisions contained in the permit and pay all fees assessed by the POTW facility in connection with the discharge.
2. Discharge into a storm drain system in compliance with general waste discharge requirements for Order No. R2-2006-0075, NPDES General Permit No. CAG912002, issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) for "Discharge Or Reuse Of Extracted and Treated Groundwater polluted by Fuel Leaks and Other Related Wastes at Service Stations and Similar Sites and these special provisions. This permit is hereafter referred to as the "Order No. R2-2006-0075" in this section, and can be obtained from the SFBRWQCB. Attention is directed to "Relations With California Regional Water Quality Control Board," for discharges to the storm drain system. If the discharge is to the storm drain system, comply with the provisions of Order No. R2-2006-0075 and pay all fees in connection with obtaining coverage under the Order No. R2-2006-0075.
3. Use water treated under Order No. R2-2006-0075 for dust control.
4. Percolate water treated under Order No. R2-2006-0075 into soil in inactive work areas.

Maintain copies of the permits at the job site and make them available during construction.

Submittals

Before discharging submit:

1. Dewatering and Discharge Plan (DDP).
2. POTW permit including sampling and analysis data for the non-storm water to be discharged to the sanitary sewer.

3. Notice of Intent (NOI) of discharge under Order No. R2-2006-0075.
4. A report certifying the adequacy of each component of the planned TNSWTS and an Operation and Maintenance Manual in conformance with Order No. R2-2006-0075 and these special provisions.

Dewatering and Discharge Plan

The dewatering and discharge plan (DDP) must include:

1. Title sheet;
2. Table of contents;
3. Certification and approval sheet (Section 100 of the Preparation Manual);
4. Amendment log and format (Section 200 of the Preparation Manual);
5. Storm Water Run-On Bypass Plan (SRBP);
6. Description and schedule of the dewatering and discharge operations;
7. Discharge alternatives, including dust control, percolation, storm sewers, and surface waters;
8. Treatment system description, components;
9. Coagulant Prevention Plan for chemical coagulants and/or flocculants used in the treatment system, that describes the best management practices (BMPs) to prevent accidental spillage, overfeeding into the treatment system, or other mishandling of coagulant agents; and, a monitoring plan for all coagulants to be used; description of the agent (chemical and trade name description); Pure product freshwater and/or marine aquatic toxicity data for the agent; Monitoring proposal to detect residual agent at concentrations at or below established freshwater and/or marine acute toxicity levels for that agent;
10. Anticipated flow rates;
11. Operation and system maintenance procedures and example maintenance log;
12. Field-recorded data, visual inspection, and calibration procedures and example logs;
13. Measuring equipment descriptions; and
14. Working drawings of dewatering and discharge operations showing:

    14.1. Section and plan views of storm water effluent treatment systems;
    14.2. Location of sampling points for water quality measurements;
    14.3. Flow path and placement of pipes, hoses, pumps, holding tanks, and other equipment used to convey water;
    14.4. General position of treatment dewatering and discharge components relative to excavations or other operations requiring dewatering; and
    14.5. Point of non-storm water discharge.

15. Permit applications, NOI and Permits authorizing discharge to storm drain system and/or sanitary sewer.

Within 10 days after contract approval, follow this process for DDP approval:

1. Submit 3 copies of the DDP and allow 15 days for the Engineer's review. If revisions are required, the Engineer provides comments and specifies the date that the review stopped
2. Change and resubmit the DDP within 5 days of receipt of the Engineer's comments. The Engineer's review resumes when the complete DDP is resubmitted. Allow 5 days for the Engineer's second review

3. Revise and resubmit within 5 days of the Engineer's second review
. When the Engineer accepts the DDP as complete, the Engineer will submit the DDP to the San Francisco Bay RWQCB for their review and approval
5. If the San Francisco Bay RWQCB provides comments to the DDP, the contractor shall incorporate these comments within 5 days of the receipt. The contractor shall submit four (4) copies of the final DDP upon notification of final approval
6. Construction activities shall begin no sooner than 30 days after the Engineer approves the DDP
7. After 30 days, the Engineer may conditionally approve the DDP while minor revisions are being completed

If the Engineer fails to complete the review within the time allowed and if, in the opinion of the Engineer, completion of the work is delayed or interfered with because of the Engineer's or the RWQCB's review, the Department pays you for resulting losses, and grants an extension of time.

A Non-Stormwater Information Package (Information Package) has been prepared for this contract and is available as described in "Supplemental Project Information" of these special provisions. This Information Package includes:

1. Estimated groundwater seepage rates in the project area.
2. Web site address where a copy of the RWQCB General Waste Discharge Requirements for Order No. R2-2006-0075, NPDES General Permit No. CAG912002 can be obtained
3. Local POTW facility information.
4. Final Environmental Groundwater Investigation Report, September 2009 prepared for the Doyle Drive Replacement Project, San Francisco, California.

Temporary Non-Storm Water Treatment System (TNSWTS)

Design and implement an appropriate water treatment system for the site conditions and anticipated flow rate to achieve and maintain compliance with receiving water limitations and discharge effluent limitations. System components may include:

1. Treatment system.
2. Collection and conveyance system.
3. Temporary holding tanks.
4. Discharge attenuator.

Design the TNSWTS to remove pollutants expected or introduced by the Contractor's construction methods and materials employed, in the non-storm water influent to achieve and maintain compliance with the effluent limitations and receiving water limitations listed in the Order No. R2-2006-0075.

Treatment Systems

Treatment systems must be designed to remove turbidity-producing suspended solids and other constituents found in the non-storm water, constituents found in groundwater that are listed in the Final Environmental Groundwater Investigation Report, September 2009 prepared for the Doyle Drive Replacement Project, San Francisco, California.

Attention is directed to "Supplemental Project Information," of these special provisions for obtaining a copy of the Site Investigation Report.

If settling tanks alone do not provide sufficient sediment removal to meet the water quality limits for turbidity, use other control measures to meet discharge standards. Primary and secondary treatment may be required, or the design of the treatment system may require combined use of the various treatment components in series to achieve effective treatment. Ensure that the treatment system components are steam cleaned to remove any residual contaminants. Treatment system components may include:

1. Desilting basins,
2. Weir tanks,
3. Settling tanks,
4. Sediment traps,
5. Gravity bag filters,
6. Sand media filters,
7. Pressurized bag filters,
8. Cartridge filters,
9. In-line chemical coagulants and/or flocculants,
10. Activated clay filters,
11. Activated carbon filters, or
12. A combination of these systems to provide primary and secondary treatment.

Chemical coagulants and/or flocculants proposed for use in the treatment of groundwater must be approved by the RWQCB. You are fully and solely responsible for securing approval from the RWQCB. Written approval from the RWQCB must be submitted to the Engineer for review prior to any use of flocculants on this project. The Information Package includes an outline of the information required by the RWQCB for approval of the chemical coagulants and/or flocculants for use in the Treatment System.

Disposal of sediments removed during maintenance of the Treatment System must comply with Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

If necessary, treat water discharged to surface water or storm water drainage systems to adjust the pH and dissolved oxygen. Treatment for water with high pH may include the addition of carbon dioxide, sulfuric acid, phosphoric acid, citric acid, or nitric acid in conformance with the supplier's specifications. Treatment for water with low pH may include filtration through a limestone bed or the addition of sodium hydroxide. Treatment for water with low dissolved oxygen may include aeration.

Attention is directed to "Supplemental Project Information," in these special provisions for "Log of Test Borings," and the "Non-Stormwater Information Package," for estimating the groundwater seepage (flow rate) in the area to design the treatment facilities to accommodate anticipated flow rates. Continuous pumping from well points outside the excavation is prohibited.

The various components must be maintained to prevent leaks and provide proper function. If a component of the dewatering equipment is not functioning properly, the dewatering operation must be discontinued and the component must be repaired or replaced.

Collection and Conveyance System

You may divert the water pumped during dewatering operations from one footing excavation to another footing excavation. Prior to backfilling the excavation, the remaining groundwater must be pumped from the excavation and treated prior to discharge.

Provide all pumps and piping to convey the water to temporary holding tanks and the point of discharge.

Use a flow meter, as described in "Flow Rate Monitoring" of this section, to measure all discharges from dewatering operations.

Materials shall conform to the provisions in Section 6, "Control of Materials," Section 7-1.16, "Contractor's Responsibility for the Work and Materials," and Section 74-2, "Drainage Pumping Equipment," of the Standard Specifications and these special provisions.

Temporary Holding Tanks

Water pumped during dewatering operations that is not diverted to other excavations must be stored in temporary holding tanks placed at the work area for treatment to remove sediment.

Use temporary holding tanks including transportable closed top holding tanks or tanker trucks. A sufficient number of holding tanks shall be provided based on the following:

1. Anticipated flow rates,
2. Pumping rates,
3. Capacity inefficiencies due to sediment retention within the holding tanks,
4. Sediment settling rates
5. Sediment removal frequency
6. Anticipated water loss or reuse rates.

Provide temporary holding tanks with a holding capacity sufficient to handle the water removed from dewatering operations, and prevent delay of work.

Each temporary holding tank must have an inlet and outlet capable of receiving and discharging flows at a sufficient rate to dewater the excavation.

Maintain a minimum freeboard of 1 foot in each of the temporary holding tanks at all times. Clean the holding tanks when 25 percent of the tank's volume is filled with sediments.

Discharging Water

Use treated non-storm water or uncontaminated ground or surface water for dust control in active work areas when possible, or discharge the water to an inactive area where the grade prevents sheet flow and the soil will allow percolation. The discharge point in the inactive area must include a velocity dissipator. The discharge volume must not exceed the area's capacity for percolation.

The Contractor may propose to reuse treated non-storm water from the TNSWTS as a water supply source for the tire wash system described in "Temporary Tire Wash System," of these special provisions.

Do not discharge into a body of water where erosion, scour, or sedimentary deposits could occur that impact natural bedding or aquatic life. Monitor the water at the discharge point using water quality measurements and visual observation in conformance with the regulatory permit and these special provisions.

Storm water must be diverted away from excavations that would require dewatering in conformance with the SRBP.

MONITORING AND REPORTING PROGRAM (MRP)

Monitoring Locations and Parameters

The Contractor shall be responsible for fully implementing the "Monitoring and Reporting Program (MRP)" as described in Attachment E and Attachment G of the Order No. R2-2006-

0075. The Contractor shall propose and identify site specific monitoring locations in the MRP for the Engineer's approval.

Certified Technician(s)

The Contractor shall furnish Certified Technician(s) with the qualifications described in this section to operate the TNSWTS. The Contractor shall submit to the Engineer a statement of qualifications, describing the training, previous work history and expertise of the individual(s) selected to serve as Certified Technician(s). The Certified Technician(s) shall be certified through an approved Operator's Training Program. The Certified Technician shall provide written proof of operator certification training to the Engineer; Provide names and contact information for all individuals involved with the site design, installation process, maintenance, operation of, and monitoring of the TNSWTS. Operator certification shall consist of a Grade II or Grade III Wastewater Treatment Plant Operator certification issued by the State of California Water Resources Control Board, Office of Operator Certification (OOC) or a Department approved equivalent. The Contractor shall retain competent staff to carry out the tasks listed in provisions VI.C.6, VI.C.7, VI.C.8 and VI.C.9 in the Order No. R2-2006-0075. Valid technician certificate(s) shall be posted onsite.

The Certified Technician shall have the following specific levels of training:

1. Operators shall have training specific to using an TNSWTS and liquid coagulants for storm water discharges in California.
2. The training shall be in the form of a formal class with a certificate and requirements for testing and certificate renewal.
3. Training shall include a minimum of eight hours classroom and 32 hours field training. The course shall cover the following topics:
   a. Coagulation Basics –Chemistry and physical processes
   b. TNSWTS System Design and Operating Principles
   c. TNSWTS Control Systems
   d. Coagulant Selection – Jar testing, dose determination, etc.
   e. Aquatic Safety/Toxicity of Coagulants, proper handling and safety
   f. Monitoring, Sampling, and Analysis
   g. Reporting and Recordkeeping
   h. Emergency Response

Daily Inspection Report (DIR)

The Certified Technician shall be responsible for compiling the Daily Inspection Report (DIR) to be submitted to the Engineer on a weekly basis and performing other monitoring and sampling work. The DIR form shall include the following items: Physical Observations; Discharge Volume Records; Water Quality Monitoring Records described elsewhere in this section. The DIR form shall be developed as part of the NSDCP and approved by the Engineer prior to use.

All information and recorded data collected or submitted as part of the DIR shall be certified as true and accurate and signed by the Certified Technician.

Visual Inspection

During each day of discharge, perform daily inspection of the effluent at the discharge site and include, in the DIR, observations of:

1. Date and Time.
2. Weather conditions,

3. Wind direction and velocity,
4. The presence or absence of water fowl or aquatic wildlife,
5. The color and clarity of the effluent discharge, and
6. Erosion or ponding downstream of the discharge site.

The DIR must include photographs of the discharge point and areas downstream of the discharge location. These photographs must be labeled with the time, date, and location.

Flow Rate Monitoring

A flow meter that has been approved by the Engineer for exclusive use in dewatering during construction must be used to measure all excavation discharges. All calibrations must be done in conformance with the manufacturer's instructions in the presence of the Engineer.

Record the flow-meter totalizer readings and compute average daily volumes for every day that dewatering is conducted.

Penalties and Withholdings

Know and comply with provisions of Federal, State, and local regulations and requirements that govern the work and storm water and non-storm water discharges from the job site and areas of disturbance outside the project limits during construction under Section 7-1.01, "Laws to be Observed," Section 7-1.11, "Preservation of Property," and Section 7-1.12, "Indemnification and Insurance," of the Standard Specifications.

You are responsible for all penalties assessed as a result of your failure to comply with the provisions in "Water Pollution Control" of these special provisions or with the applicable provisions of the Federal, State, and local regulations and requirements.

Penalties include fines, penalties, and damages, whether proposed, assessed, or levied against the Department or you, including those levied under the Federal Clean Water Act and the State Porter-Cologne Water Quality Control Act, by governmental agencies or as a result of citizen suits. Penalties also include payments made or costs incurred in settlement for alleged violations of applicable laws, regulations, or requirements. Costs incurred could include sums spent instead of penalties, in mitigation or to remediate or correct violations.

The Department will withhold payment, in an amount estimated by the Department, to include the full amount of penalties and mitigation costs proposed, assessed, or levied as a result of a violation of the permits, or Federal or State law, regulations, or requirements. Funds will be withheld until final disposition of these costs has been made. You remain liable for the full amount until the potential liability is finally resolved with the entity seeking the penalties. Instead of the withhold, you may provide a suitable bond in favor of the Department to cover the highest estimated liability for any disputed penalties proposed as a result of the violation of the permits, law, regulations, or requirements.

If a regulatory agency identifies a violation of the permits and modifications thereto, or other Federal, State, or local requirements, the Department will withhold payment as follows:

1. The Department will give you 30 days notice of the Department's intention to withhold funds from payments that may become due before acceptance of the contract. After acceptance of the contract, funds will be withheld without prior notice.
2. If the amount being withheld from partial payments under Section 9-1.06, "Partial Payments," of the Standard Specifications exceeds the amount to be withheld for violations, no additional payment will be withheld.
3. If the Department withholds funds and it is subsequently determined that the State is not subject to the entire amount of the costs and liabilities assessed or proposed in connection

with the matter for which the withhold was made, the Department will return the excess amount withheld in the progress payment following the determination. If the matter is resolved for less than the amount withheld, the Department will pay interest at a rate of 6 percent per year on the excess withhold.

Notify the Engineer immediately upon request from a regulatory agency to enter, inspect, sample, monitor, or otherwise access the job site or obtain records pertaining to water pollution control work. Provide copies of correspondence, notices of violation, enforcement actions, or proposed fines by regulatory agencies to the requesting regulatory agency.

PAYMENT

The contract lump sum price paid for temporary storm water run-on bypass and excavation dewatering shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, including providing power to operate all equipment, and for doing all the work involved in this section; and as directed by the Engineer.

10-1.__ TEMPORARY TIRE WASH SYSTEM

GENERAL

Summary

This work includes designing, placing, operating, monitoring, maintaining, and later removing a temporary tire wash system. The tire wash system must be portable and be used to remove sediment from tires and undercarriages of all trucks and equipment prior to exiting areas for contractor's use, and to prevent sediment from being tracked onto public roadways.

The SWPPP must describe and include the use of temporary tire wash system as a water pollution control practice for non-stormwater management and materials pollution control.

For information on documents under these special provisions, refer to the Department's "Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual" (Preparation Manual) and "Construction Site Best Management Practices (BMPs) Manual".

The Preparation Manual and Dewatering Guide are available from the Department's Construction Storm Water and Water Pollution Control web site at:

http://www.dot.ca.gov/hq/construc/stormwater/stormwater1.htm

Treated non-storm water from the Temporary Non-Storm Water Treatment System (TNSWTS) as described in "Temporary Storm Water Run-on Bypass and Non-Storm Water Discharge Control" of these special provisions, may be used as a water supply source for the temporary tire wash system.

Wastewater that can no longer be recycled in the tire washing system shall be considered as non-storm water and shall be collected and conveyed to the TNSWTS for treatment and disposal. If you do not use an TNSWTS, discharge into a POTW system.

If uncontaminated groundwater, stormwater, or both are discharged to a POTW, obtain a municipal batch discharge permit. You are responsible for all costs and pre-treatment requirements related to obtaining the municipal batch discharge permit and discharging the water.

Solids removed from the tire wash system shall be disposed of in accordance with Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the standard Specifications.

Submittals

Submit the following within SWPPP for review and approval of the Engineer:

1. A description of the tire wash system including:

    1.1. Description of all components used in the tire wash system including, but not limited to:

        1.1.1. Estimated tire washes per day
        1.1.2. Water Supply; anticipated flow rates for wash water used per tire wash
        1.1.3. Control panel
        1.1.4. Automatic sensor
        1.1.5. Flocculent pump
        1.1.6. Vacuum truck

1.1.7. Wastewater recycling and disposal; anticipated wastewater flow rates conveyed to the TNSWTS
1.1.8. Solids removal and disposal
1.1.9 Electric power supply to operate tire wash system

1.2. Description of any chemicals used in the process to recycle water for tire washing including but not limited to flocculent and polymers. The documentation and monitoring requirements in the Coagulant Prevention Plan submittal required in "Temporary Storm Water Run-on Bypass and Excavation Dewatering" of these special provisions shall fully apply to any chemicals used in the tire wash system.

1.3. Operation and system maintenance procedures and example maintenance log
1.4. Field-recorded data, visual inspection, and calibration procedures and example logs
1.5. Working drawings for tire wash system including the wastewater and solids handling processes showing:

1.5.1. Section and plan views of tire wash system
1.5.2. Location of sampling points for water quality measurements
1.5.3. Flow path and placement of pipes, hoses, pumps, holding tanks, and other equipment used to convey water supply and wastewater recycling and disposal to TNSWTS
1.5.4. General position of tire wash and discharge components relative to operations requiring tire washing
1.5.5. Point of tire wash waste water discharge

2. Daily Inspection Report. The report form must:

2.1. Be approved by the Engineer before use
2.2. Include tire wash wastewater discharge volumes and number of trucks washed per day
2.3. Date and time
2.4. Photographs labeled with the time, date, and location
2.5. Inspection of roadways to ensure tracking of sediment is being prevented successfully by the tire wash system
2.6. Inspection of all components of the tire wash system to ensure proper functioning of these systems

3. POTW municipal batch discharge permit, if used
4. If you use chemical coagulants, in-line flocculants, or both, in the tire wash system, submit a Coagulant Prevention Plan (CPP) within the SWPP. The CPP must include:

4.1. Description of the best management practices (BMPs) to prevent accidental spillage, overfeeding into the treatment system, or other mishandling of coagulant agents
4.2. Monitoring plan for all coagulant or flocculant agents to be used
4.3. Description of the agent (chemical and trade name description)
4.4. Determination of acute and chronic toxicity for aquatic organisms conforming to EPA methods for the agents

4.5. Monitoring proposal to detect residual agent at concentrations at or below established acute toxicity levels for freshwater and marine conditions for that agent
4.6. Copy of the documentation showing RWQCB approval of the CPP and approval of the chemical coagulants or in-line flocculants proposed

The CPP must be approved by the RWQCB. It is your responsibility to obtain approval of the CPP from the RWQCB. If the RWQCB does not approve your proposal to use chemical coagulants or in-line flocculants, you must propose an alternative treatment system component to comply with the receiving water and effluent discharge limitations.

Quality Control and Assurance

Retain and submit records of temporary tire wash system including:

1. Delivery and removal of temporary tire wash system components.
2. Daily inspection report that includes all information and recorded data collected. This report must be certified as true and accurate and signed by those who gather the information.

MATERIALS

Tire Wash System

Design and implement an appropriate tire wash system for the site conditions including number of truck trips per day that need tire washing, the anticipated wash water needed per tire wash, disposal of wastewater that cannot be recycled and solids generated from the system and designed to withstand the weights and widths of trucks. The tire wash system must include components including but not limited to:

1. Collection and conveyance of treated effluent from the TNSWTS that may be used as a water supply source for the tire washing system
2. Control Panel and automatic sensors to activate washers when trucks are driven through the system
3. Flocculent pump
4. Vacuum truck
5. Solids separation tank to remove the solids from the waste generated from tire washing
6. System to recycle water for tire washing
7. Scraper conveyor to automatically evacuate solids
8. Collection and conveyance system for conveying wastewater that can be no longer recycled to TNSWTS

The allowable alternatives for temporary tire wash system shall consist of one of the following or a Department approved equivalent system:

1. MAXIMUS Series – Portable Tire Wash System manufactured by Innovative Equipment Solutions 174 Cornerstone Blvd, Ste. B, Hot Springs, AR 71913. Office: 501-525-8484, Toll Free: 1-866-303-4IES (4437). Information and details can be found at : http://www.innovativeequipment.org/portable.html

2. Portable STB 30 Tire Wash - Portable Tire Wash System manufactured by Stanton Systems, 50 Richard Road, Ivyland, PA 18974. Toll Free: 1-800-884-9281. Information

and details can be found at: http://www.stantonsystems.com/portable-tire-wash/portable-tire-wash.html

3. MobyDick "Quick" 220 C+ Tire Washer - Portable Tire Wash System manufactured by InterClean Equipment, Inc., 3939 Bestech Drive Suite B, Ypsilanti, MI 48197. Phone: (734) 975-2967 or 1-800-INTERCLEAN (1-800-468-3725). Information and details can be found at: http://www.interclean.com/

CONSTRUCTION

Placement

Place tire wash system components at the job site:

1. Before tunnel excavation work
2. In the ingress/egress areas used by trucks as approved by the Engineer
3. Away from construction traffic or public access areas

Operation

Divert storm water away from the tire wash system to prevent mixing with tire wash wastewater.

If observations in the daily inspection report confirm tracking of sediment on roadways past the tire wash system:

1. Inspect the tire wash system immediately
2. Notify the Engineer
3. Start corrective measures to modify, repair, or replace the equipment used in the tire wash system, and propose alternative means to perform tire washing until the corrective measures are implementedAfter the Engineer inspects and accepts corrective measures:

1. Resume tire washing operations
2. Start inspecting every tire washing operations every 4 hours for a 24 hour period and document the observations in the Daily Inspection Report
3. Start regular-daily inspectionsRelocate tire washing system as needed.

Monitoring

Comply with the manufacturer's instructions for all calibrations of the flow meter. Perform calibrations in the presence of the Engineer.

While the tire wash system is operated, perform:

1. Flow rate monitoring to:

    1.1. Record daily discharge volumes for tire wash wastewater
    1.2. Compute average daily volumes

Inspection

Inspect tire washing system:

1. Daily if tire washing work occurs daily
2. Weekly if tire washing work does not occur daily

Reporting

If observations and measurements confirm that tire wash wastewater is discharged to a storm drain system:

1. Submit a Notice of Discharge Report as shown in the Preparation Manual within 3 business days
2. Document the reasons and corrective work performed to prevent a reoccurrence in the Notice of Discharge

Maintenance

Maintain the various components to prevent leaks and provide proper function. If a component of the tire wash system equipment is not functioning properly, discontinue the tire washing operation and repair or replace the component.

Removal

Backfill and repair ground disturbance, including holes and depressions, caused by the installation and removal of the temporary tire wash system. Comply with Section 15-1.02, "Preservation of Property," of the Standard Specifications.

PAYMENT

The contract lump sum price paid for the temporary tire wash system shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, for doing all the work involved in installing, operating, maintaining, and removing all components of the tire wash system, as specified in the Standard Specifications, and these special provisions, and as directed by the Engineer.

10-1.__ CONSTRUCTION SITE MANAGEMENT

GENERAL

Summary

This work includes controlling potential sources of water pollution before they come in contact with storm water systems or watercourses.

Control material pollution and manage waste and non-storm water at the job site by implementing effective handling, storage, use, and disposal practices.

For information on documents under these special provisions, refer to the Department's Preparation Manual, Dewatering Guide, and BMP Manual.

Preparation Manual, Dewatering Guide, and BMP Manual are available from the Department's Construction Storm Water and Water Pollution Control web site at:

http://www.dot.ca.gov/hq/construc/stormwater/stormwater1.htm

Definitions

BMP Manual: The Department's Construction Site Best Management Practices (BMP) Manual.

Dewatering Guide: The Department's Field Guide to Construction Site Dewatering.

Minor spills: Small quantities of oil, gasoline, paint, or other material that are small enough to be controlled by a first responder upon discovery of the spill.

Preparation Manual: The Department's Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual.

Semi-significant spills: Spills that can be controlled by a first responder with help from other personnel.

Significant or hazardous spills: Spills that cannot be controlled by construction personnel.

Submittals

Submit the following:

1. Material Safety Data Sheet (MSDS) at least 5 days before material is used or stored
2. Monthly inventory records for material used or stored
3. Stormwater training:

    3.1. Include training dates and subject for employees and subcontractors with SWPPP or WPCP. Include dates and subject for ongoing training, including tailgate meetings.

    3.2. Employee training records:

        3.2.1. Within 5 days of SWPPP or WPCP approval for existing employees

        3.2.2. Within 5 days of training for new employees

        3.2.3. At least 5 days before subcontractors begin work for subcontractor's employees

4. Manifest forms for hazardous waste disposal within 5 days of transport and disposal
5. Copy of written approval to discharge into a sanitary sewer system at least 5 days before beginning discharge activities

Quality Control and Assurance

Train all employees and subcontractors in these subjects:

1. Material pollution prevention and control
2. Waste management
3. Non-storm water management
4. Identifying and handling hazardous substances
5. Potential dangers to humans and the environment from spills and leaks or exposure to toxic or hazardous substances

Training must take place before starting work on this job. New employees must receive the complete training before starting work on this job. Conduct weekly meetings to discuss and reinforce spill prevention and control; material delivery, storage, use, and disposal; waste management; and non-storm water management procedures.

MATERIALS

Not used.

CONSTRUCTION

Spill Prevention and Control

Implement spill and leak prevention procedures for chemicals and hazardous substances stored on the job site.

As soon as it is safe, contain and clean up spills of petroleum products, sanitary and septic waste substances listed under CFR Title 40, Parts 110, 117, and 302.

Minor Spills: Clean up minor spills using these procedures:

1. Contain spread of the spill
2. Recover spilled material using absorption
3. Clean contaminated area
4. Dispose of contaminated material promptly and properly

Semi-significant Spills: Clean up semi-significant spills immediately using these procedures:

1. Contain spread of the spill
2. Recover spilled material using absorption where the spill occurs on paved or an impermeable surface
3. Contain the spill with an earthen dike and dig up contaminated soil for disposal where the spill occurs on soil
4. When the spill occurs during precipitation, cover the spill with plastic or other material to prevent contaminated runoff
5. Dispose of contaminated material promptly and properly

Significant or Hazardous Spills: Immediately notify qualified personnel of significant or hazardous spills. Take these steps:

1. Construction personnel must not attempt to cleanup the spill until qualified staff have arrived
2. Notify the Engineer and follow up with a written report

3. Obtain the services of a spills contractor or hazardous material team immediately
4. Notify the local emergency response team by dialing 911 and county officials at the emergency phone numbers kept on the job site
5. Notify the Governor's Office of Emergency Services Warning Center at (805) 852-7550
6. Notify the National Response Center at (800) 424-8802 regarding spills of Federal reportable quantities under CFR Title 40, Parts 110, 119, and 302
7. Notify other agencies as appropriate, including:

    7.1. Fire Department
    7.2. Public Works Department
    7.3. Coast Guard
    7.4. Highway Patrol
    7.5. City Police or County Sheriff Department
    7.6. Department of Toxic Substances
    7.7. California Division of Oil and Gas
    7.8. Cal OSHA
    7.9. Regional Water Resources Control Board

Report minor, semi-significant, and significant spills to the WPC (Water Pollution Control) manager. WPC manager must notify the Engineer immediately. WPC manger must oversee and enforce proper spill prevention and control measures.

Prevent spills from entering storm water runoff before and during cleanup. Spills must not be buried or washed with water.

Keep material or waste storage areas clean, well organized, and equipped with enough cleanup supplies for the material being stored.

Material Management

General

Material must be delivered, used, and stored for this job in a way that minimizes or eliminates discharge of material into the air, storm drain systems, or watercourses.

Implement the practices described in this section while taking delivery of, using, or storing these materials:

1. Hazardous chemicals including:

    1.1. Acids
    1.2. Lime
    1.3. Glues
    1.4. Adhesives
    1.5. Paints
    1.6. Solvents
    1.7. Curing compounds

2. Soil stabilizers and binders
3. Fertilizers
4. Detergents
5. Plaster
6. Petroleum products including:

6.1. Fuel
6.2. Oil
6.3. Grease

7. Asphalt components and concrete components
8. Pesticides and herbicides

Employees trained in emergency spill cleanup procedures must be present during unloading of hazardous materials or chemicals.

If practical, use less hazardous products.

Material Storage

Use these storage procedures:

1. Store liquids, petroleum products, and substances listed in CFR Title 40, Parts 110, 117, and 302 in containers or drums approved by the United States Environmental Protection Agency, and place them in secondary containment facilities.
2. Secondary containment facilities must be impervious to the materials stored there for a minimum contact time of 72 hours.
3. Throughout the rainy season, cover secondary containment facilities during non-working days and when precipitation is predicted. Secondary containment facilities must be adequately ventilated.
4. Keep secondary containment facility free of accumulated rainwater or spills. After precipitation, or in the event of spills or leaks, collect accumulated liquid and place into drums within 24 hours. Handle these liquids as hazardous waste under "Hazardous Waste" unless testing determines them to be nonhazardous.
5. Do not store incompatible materials, such as chlorine and ammonia, in the same secondary containment facility.
6. Store materials in the original containers with the original product labels maintained in legible condition. Replace damaged or illegible labels immediately.
7. Secondary containment facility must have the capacity to contain precipitation from a 24-hour-long, 25-year storm; and 10 percent of the aggregate volume of all containers, or entire volume of the largest container within the facility, whichever is greater.
8. Store bagged or boxed material on pallets. Throughout the rainy season, protect bagged or boxed material from wind and rain during non-working days and while precipitation is predicted.
9. Provide sufficient separation between stored containers to allow for spill cleanup or emergency response access. Storage areas must be kept clean, well organized, and equipped with cleanup supplies appropriate for the materials being stored.
10. Repair or replace perimeter controls, containment structures, covers, and liners as necessary. Inspect storage areas before and after precipitation, and at least weekly during other times.

Stockpile Management

Implement practices described in this section for managing stockpiles:

1. During the rainy season
2. During the non-rainy season when the National Weather Service predicts precipitation with a probability of at least 30 percent

Use these stockpile management procedures:

1. Reduce or eliminate potential air and water pollution from stockpiled material including soil, paving material, or pressure treated wood.
2. Locate stockpiles:

    2.1. If within the floodplain, at least 100 feet from concentrated flows of storm water, drainage courses, or inlets unless approved
    2.2. If outside the floodplain, at least 50 feet from concentrated flows of storm water, drainage courses, or inlets unless approved

Active and inactive soil stockpiles must be:

1. Covered with soil stabilization measures, plastic sheeting, or geosynthetic fabric
2. Surrounded with a linear sediment barrier

Portland cement concrete rubble, AC, HMA, AC and HMA rubble, aggregate base or aggregate sub-base stockpiles must be:

1. Covered with plastic sheeting, or geosynthetic fabric
2. Surrounded with a linear sediment barrier

Pressure treated wood stockpiles must be:

1. Placed on pallets
2. Covered with impermeable material

Cold mix asphalt concrete stockpiles must be:

1. Placed on impervious surface
2. Covered with impermeable material
3. Protected from run-on and runoff

If you discontinue adding or removing material for up to 21 days the stockpile is considered still active during that period.

Control wind erosion during the non-rainy season and dry weather under Section 10, "Dust Control".

Repair or replace linear sediment barriers and covers as needed to keep them functioning properly. If sediment accumulates to 1/3 of the linear sediment barrier height, remove sediment.

Waste Management

Solid Waste

Do not allow litter or debris to accumulate anywhere on the job site, including storm drain grates, trash racks, and ditch lines. Pick up and remove trash and debris from the job site at least once a week. WPC manager must monitor solid waste storage and disposal procedures on the job site.

If practicable, recycle nonhazardous job site waste and excess material. If recycling is not practicable, disposal must comply with Section 7-1.13, "Disposal of Material Outside the Highway Right of Way."

Furnish enough closed-lid dumpsters of sufficient size to contain the solid waste generated by work activities. When refuse reaches the fill line, empty dumpsters. Dumpsters must be watertight. Do not wash out dumpsters at the job site. Furnish additional containers and more frequent pickup during the demolition phase of construction.

Solid waste includes:

1. Brick
2. Mortar
3. Timber
4. Metal scraps
5. Sawdust
6. Pipe
7. Electrical cuttings
8. Non-hazardous equipment parts
9. Styrofoam and other packaging materials
10. Vegetative material and plant containers from highway planting
11. Litter and smoking material, including litter generated randomly by the public
12. Other trash and debris

Furnish and use trash receptacles in the job site yard, field trailers, and locations where workers gather for lunch and breaks.

Hazardous Waste

Use hazardous waste management practices if waste is generated on the job site from these substances:

1. Petroleum products
2. Asphalt products
3. Concrete curing compound
4. Pesticides
5. Acids
6. Paints
7. Stains
8. Solvents
9. Wood preservatives
10. Roofing tar
11. Road flares
12. Lime
13. Glues and adhesives
14. Materials classified as hazardous by California Code of Regulations, Title 22, Division 4.5; or listed in CFR Title 40, Parts 110, 117, 261, or 302

WPC manager must oversee and enforce hazardous waste management practices. Minimize the production of hazardous materials and hazardous waste at the job site. If damaged, repair or replace perimeter controls, containment structures, and covers.

If hazardous material levels are unknown, use a laboratory certified by the Environmental Laboratory Accreditation Program (ELAP) under the California Department of Public Health (CDPH) to sample and test waste to determine safe methods for storage and disposal.

Separate potentially hazardous waste from nonhazardous waste at the job site. Hazardous waste must be handled, stored, and disposed of under California Code of Regulations, Title 22, Division 4.5, Section 66262.34; and in CFR Title 49, Parts 261, 262, and 263.

Store hazardous waste in sealed containers constructed and labeled with the contents and date accumulated under California Code of Regulations, Title 22, Division 4.5; and in CFR Title 49, Parts 172, 173, 178, and 179. Keep hazardous waste containers in temporary containment facilities under "Material Storage" of these special provisions.

Furnish containers with adequate storage volume at convenient locations for hazardous waste collection. Do not overfill hazardous waste containers. Do not mix hazardous wastes. Do not allow potentially hazardous waste to accumulate on the ground. Store containers of dry waste that are not watertight on pallets. Store hazardous waste away from storm drains, watercourses, moving vehicles, and equipment.

Clean water based or oil based paint from brushes or equipment within a contained area and in a way that does not contaminate soil, watercourses, or storm drain systems. Handle and dispose of these as hazardous waste: paints, thinners, solvents, residues, and sludges that cannot be recycled or reused. When thoroughly dry, dispose of these as solid waste: dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths.

Dispose of hazardous waste within 90 days of being generated. Use a licensed hazardous waste transporter to take hazardous waste to a Class I Disposal Site. Submit a copy of uniform hazardous waste manifest forms within 24 hours of transporting hazardous waste.

WPC manager must inspect these daily:

1. Storage areas for hazardous materials and wastes
2. Hazardous waste disposal and transporting activities
3. Hazardous material delivery and storage activities

Contaminated Soil

Identify contaminated soil from spills or leaks by noticing discoloration, odors, or differences in soil properties. Soil with evidence of contamination must be sampled and tested by a laboratory certified by ELAP.

If levels of contamination are found to be hazardous, handle and dispose of the soil as hazardous waste.

Prevent the flow of water, including ground water, from mixing with contaminated soil by using one or a combination of these measures:

1. Berms
2. Cofferdams
3. Grout curtains
4. Freeze walls
5. Concrete seal course

If water mixes with contaminated soil and becomes contaminated, sample and test the water using a laboratory certified by ELAP. If levels of contamination are found to be hazardous, handle and dispose of the water as hazardous waste.

Concrete Waste

Use practices to prevent the discharge of portland cement concrete, AC, or HMA waste into storm drain systems or watercourses.

Collect and dispose of portland cement concrete, AC, or HMA waste at locations where:

1. Concrete material, including grout, is used
2. Concrete dust and debris result from demolition
3. Sawcutting, coring, grinding, grooving, or hydro-concrete demolition of portland cement concrete, AC, or HMA creates a residue or slurry
4. Concrete truck or other concrete-coated equipment is cleaned at the job site

Sanitary and Septic Waste

Do not bury or discharge wastewater from sanitary or septic systems within Department right of way. WPC manager must inspect sanitary or septic waste storage and monitor disposal procedures at least weekly. Sanitary facilities that discharge to the sanitary sewer system must be properly connected and free from leaks. Place sanitary facilities at least 50 feet away from storm drains, watercourse, and flow lines.

Obtain written approval from local health agency, city, county, and sewer district before discharging from a sanitary or septic system directly into a sanitary sewer system, and submit a copy to the Engineer. Comply with local health agency provisions while using an on-site disposal system.

Liquid Waste

Use practices to prevent job site liquid waste from entering storm drain systems or watercourses. Liquid wastes include the following:

1. Drilling slurries or fluids
2. Grease-free or oil-free wastewater or rinse water
3. Dredgings, including liquid waste from drainage system cleaning
4. Liquid waste running off a surface including wash or rinse water
5. Other non-storm water liquids not covered by separate permits

Hold liquid waste in structurally sound, leak proof containers such as:

1. Roll-off bins
2. Portable tanks

Liquid waste containers must be of sufficient quantity and volume to prevent overflow, spills and leaks.

Store containers:

1. At least 50 feet from moving vehicles and equipment
2. If within the floodplain, at least 100 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved
3. If outside the floodplain, at least 50 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved

Remove and dispose of deposited solids from sediment traps under "Solid Waste" unless the Engineer authorizes another method.

Liquid waste may require testing to determine hazardous material content before disposal.

Drilling fluids and residue must be disposed of outside the highway right of way.

If an approved location is available within the job site, fluids and residue exempt under California Code of Regulations, Title 23, Section 2511(g) may be dried by evaporation in a leak proof container. Dispose of remaining solid waste under "Solid Waste" of these special provisions.

Non-Storm Water Management

Water Control and Conservation

Manage water used for work activities to prevent erosion or discharge of pollutants into storm drain systems or watercourses. Obtain approval before washing anything on the job site with water that could discharge into a storm drain system or watercourse. Report discharges immediately.

If water is used at the job site, implement water conservation practices . Inspect irrigation areas. Adjust watering schedules to prevent erosion, excess watering, or runoff. Shut off water source to broken lines, sprinklers, or valves, and repair breaks within 24 hours. If possible, reuse water from waterline flushing for landscape irrigation. Sweep and vacuum paved areas: do not wash with water.

Direct job site water runoff, including water from water line repair, to areas where it can infiltrate into the ground and not enter storm drain systems or watercourses. Do not allow spilled water to escape water truck filling areas. If possible, direct water from off-site sources around the job site. Minimize the contact of off-site water with job site water.

Illegal Connection and Discharge Detection and Reporting

Inspect the job site and the site perimeter before starting work for evidence of illegal connections, discharges, or dumping. After starting work, inspect the job site and perimeter on a daily schedule.

When illegal connections, discharges, or dumping are discovered, notify the Engineer immediately. Take no further action unless ordered by the Engineer. Assume unlabeled or unidentifiable material is hazardous.

Look for the following evidence of illegal connections, discharges, or dumping:

1. Debris or trash piles
2. Staining or discoloration on pavement or soils
3. Pungent odors coming from drainage systems
4. Discoloration or oily sheen on water
5. Stains or residue in ditches, channels or drain boxes
6. Abnormal water flow during dry weather
7. Excessive sediment deposits
8. Nonstandard drainage junction structures
9. Broken concrete or other disturbances near junction structures

Vehicle and Equipment Cleaning

Limit vehicle and equipment cleaning or washing at the job site except what is necessary to control vehicle tracking or hazardous waste. Notify the Engineer before cleaning vehicles and equipment at the job site with soap, solvents, or steam. Contain and recycle or dispose of

resulting waste under "Liquid Waste" or "Hazardous Waste" of these special provisions, whichever is applicable. Do not use diesel to clean vehicles or equipment, and minimize the use of solvents.

Clean or wash vehicles and equipment in a structure equipped with disposal facilities. If using a structure is not possible, vehicles and equipment must be cleaned or washed in an outside area:

1. Paved with AC, HMA, or portland cement concrete
2. Surrounded by a containment berm
3. Equipped with a sump to collect and dispose of wash water
4. If within the floodplain, located at least 100 feet from concentrated flows of storm water, drainage courses, watercourses, ESAs, or storm drain inlets unless approved
5. If outside the floodplain, located at least 50 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved

When washing vehicles or equipment with water, use as little water as possible. Hoses must be equipped with a positive shutoff valve.

Discharge liquid from wash racks to a recycle system or to another approved system. Remove liquids and sediment as necessary.

WPC manger must inspect vehicle and equipment cleaning facilities:

1. Daily when vehicle and equipment cleaning occurs daily
2. Weekly when vehicle and equipment cleaning does not occur daily

Vehicle and Equipment Fueling and Maintenance

If practicable, perform maintenance on vehicles and equipment off the job site.

If fueling or maintenance must be done at the job site, designate a site, or sites, and obtain approval before using. Minimize mobile fueling or maintenance.

If vehicle and equipment fueling and maintenance must be done on the job site, areas for these activities must be:

1. On level ground
2. Protected from stormwater run-on
3. If within the floodplain, located at least 100 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved
4. If outside the floodplain, located at least 50 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved

Use containment berms or dikes around the fueling and maintenance area. Keep adequate quantities of absorbent spill cleanup material and spill kits in the fueling and maintenance area and on fueling trucks. Dispose of spill cleanup material and kits immediately after use. Use drip pans or absorbent pads during fueling or maintenance.

Fueling or maintenance activities must not be left unattended. Fueling nozzles must be equipped with an automatic shutoff control. Vapor recovery fueling nozzles must be used where required by the Air Quality Management District. When not in use, nozzles must be secured upright. Do not top-off fuel tanks.

Recycle or properly dispose of used batteries and tires.

WPC manager must inspect vehicle and equipment maintenance and fueling areas:

1. Daily when vehicle and equipment maintenance and fueling occurs daily
2. Weekly when vehicle and equipment maintenance and fueling does not occur daily

WPC manager must inspect vehicles and equipment at the job site for leaks and spills on a daily schedule. Operators must inspect vehicles and equipment each day of use.

If leaks cannot be repaired immediately, remove the vehicle or equipment from the job site.

Material and Equipment Used Over Water

Place drip pans and absorbent pads under vehicles or equipment used over water. Keep an adequate supply of spill cleanup material with the vehicle or equipment. If the vehicle or equipment will be idle for more than one hour, place drip pans or plastic sheeting under vehicles or equipment on docks, barges, or other surfaces over water.

Furnish watertight curbs or toe boards on barges, platforms, docks, or other surfaces over water to contain material, debris, and tools. Secure material to prevent spills or discharge into water due to wind.

Structure Removal Over or Adjacent to Water

Do not allow demolished material to enter storm water systems or watercourses. Use approved covers and platforms to collect debris. Use attachments on equipment to catch debris on small demolition activities. Empty debris catching devices daily and handle debris under "Waste Management" of these special provisions.

WPC manager must inspect demolition sites within 50 feet of storm water systems or watercourses daily.

Paving, Sealing, Sawcutting, and Grinding Activities

Prevent these materials from entering storm drain systems or water courses:

1. Cementitious material
2. Asphaltic material
3. Aggregate or screenings
4. Grinding or sawcutting residue
5. Pavement chunks
6. Shoulder backing
7. Methacrylate

Cover drainage inlets and use linear sediment barriers to protect downhill watercourses until paving, sealing, sawcutting, or grinding activities are completed and excess material has been removed. Cover drainage inlets and manholes during the application of seal coat, tack coat, slurry seal, or fog seal.

During the rainy season or when precipitation is predicted, limit paving, sawcutting, and grinding to places where runoff can be captured.

Do not start seal coat, tack coat, slurry seal, or fog seal activities when precipitation is predicted during application or curing period. Do not excavate material from existing roadways during precipitation.

Use a vacuum to remove slurry from sawcutting activities immediately after slurry is produced. Do not allow slurry to run onto lanes open to public traffic or off the pavement.

Collect residue from portland cement concrete grinding activities with a vacuum attachment on the grinding machine. Do not leave residue on pavement or allow residue to flow across pavement.

If approved, material excavated from existing roadways may be stockpiled under "Stockpile Management" of these special provisions.

Do not coat asphalt trucks and equipment with substances that contain soap, foaming agents, or toxic chemicals.

When paving equipment is not in use, park over drip pans or plastic sheeting with absorbent material to catch drips.

Thermoplastic Striping and Pavement Markers

Thermoplastic striping and preheating equipment shutoff valves must work properly at all times. Do not preheat, transfer, or load thermoplastic within 50 feet of drainage inlets or watercourses. Do not fill preheating container above a level that is 6 inches below the top. Truck beds must be cleaned daily of scraps or melted thermoplastic.

Do not unload, transfer, or load bituminous material for pavement markers within 50 feet of drainage inlets or watercourses. Release all pressure from melting tanks before removing the lid to fill or service. Do not fill melting tanks above a level that is 6 inches below the top.

Collect bituminous material from the roadway after marker removal.

Pile Driving

Keep spill kits and cleanup material at pile driving locations. Pile driving equipment must be parked over drip pans, absorbent pads, or plastic sheeting with absorbent material. When precipitation is predicted, protect pile driving equipment by parking on plywood and covering with plastic.

When not in use, store pile driving equipment:

1. On level ground
2. Protected from stormwater run-on
3. If within the floodplain, at least 100 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved
4. If outside the floodplain, at least 50 feet from concentrated flows of storm water, drainage courses, watercourses, or storm drain inlets unless approved

If practicable, use vegetable oil instead of hydraulic fluid.

WPC manager must inspect pile driving area for leaks and spills:

1. Daily when pile driving occurs daily
2. Weekly when pile driving does not occur daily

Concrete Curing

Do not overspray chemical curing compound. Minimize drift by spraying as close to the concrete as possible. Cover drainage inlets before applying curing compound.

Minimize the use and discharge of water by using wet blankets or similar methods to maintain moisture while curing concrete.

Concrete Finishing

Collect and dispose of water and solid waste from high-pressure water blasting. Cover drainage inlets within 50 feet before sandblasting. Minimize drift of dust and blast material by keeping the nozzle close to the surface of the concrete. Blast residue may contain hazardous material.

Inspect containment structures for concrete finishing activities for damage before each day of use and before predicted precipitation. Remove liquid and solid waste from the containment structure after each work shift.

Sweeping

Sweeping must be done using hand or mechanical methods such as vacuuming.

Sweeping must be done:

1. At the end of each work shift
2. When the National Weather Service predicts precipitation with a probability of at least 30 percent
3. On paved roads at job site entrance and exit locations
4. On paved areas within the job site that flow to storm drains or water bodies

You may stockpile collected material at the job site. Dispose of collected material at least once per week. Remove collected material including sediment from paved shoulders, drain inlets, curbs and dikes, and other drainage areas.

Sediment collected from the roadway during sweeping may be disposed of within the job site. Protect disposal areas against erosion.

Remove and dispose of trash collected during sweeping under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way".

Dewatering

Dewatering consists of discharging accumulated storm water, ground water, or surface water from excavations or temporary containment facilities.

If dewatering and discharging activities are specified under another work item such as "Temporary Active Treatment System" or "Dewatering and Discharge", then perform dewatering work as specified in those sections.

If dewatering and discharging activities are not specified under another work item, then:

1. At least 10 days before starting dewatering, submit a Dewatering and Discharge Plan under Section 5-1.02, "Plans and Working Drawings," and "Water Pollution Control" of the Standard Specifications. Dewatering and Discharge Plan must include:

    1.1. Title sheet and table of contents
    1.2. Description of dewatering and discharge activities detailing locations, quantity of water, equipment, and discharge point
    1.3. Estimated schedule for dewatering and discharge (start and end dates, intermittent or continuous)
    1.4. Discharge alternatives such as dust control or percolation
    1.5. Visual monitoring procedures with inspection log

2. Conduct dewatering activities under the Field Guide for Construction Dewatering.

3. Ensure that dewatering discharge does not cause erosion, scour, or sedimentary deposits that impact natural bedding materials.
4. Discharge water within project limits. If water cannot be discharged within project limits due to site constraints, dispose of it in the same way specified for material in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way".
6. Do not discharge storm water or non-storm water that has an odor, discoloration other than sediment, an oily sheen, or foam on the surface. Notify the Engineer immediately upon discovering any of those conditions.
7. WPC manager must inspect dewatering activities:

    7.1. Daily when dewatering work occurs daily
    7.2. Weekly when dewatering work does not occur daily

PAYMENT

The contract lump sum price paid for construction site management includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in spill prevention and control, material management, waste management, non-storm water management, and dewatering and identifying, sampling, testing, handling, and disposing of hazardous waste, as specified in the Standard Specifications and these special provisions, and as ordered by the Engineer.

10-1.__ STREET SWEEPING

GENERAL

Summary

This work includes street sweeping.

The SWPPP must describe and include the use of street sweeping as a water pollution control practice for sediment control and tracking control.

Submittals

At least 5 business days before starting clearing and grubbing, earthwork, or other activities with the potential for tracking sediment or debris, submit:

1. Number of sweepers described in the SWPPP
2. Type of sweeper technology

Quality Control and Assurance

Retain and submit records of street sweeping including:

1. Quantity of sweeping waste disposal
2. Sweeping times and locations

CONSTRUCTION

Street Sweepers

Sweepers must use one of these technologies:

1. Mechanical sweeper followed by a vacuum-assisted sweeper
2. Vacuum-assisted dry (waterless) sweeper
3. Regenerative-air sweeper

Operation

Street sweeping must be done at:

1. Paved roads at job site entrance and exit locations
2. Paved areas within the job site that flow to storm drains or water bodies

Street sweeping must be done:

1. During clearing and grubbing activities
2. During earthwork activities
3. During trenching activities
4. During roadway structural section activites
5. When vehicles are entering and leaving the job site
6. After soil disturbing activities
7. After observing offsite tracking of material

Monitor paved areas and roadway within the jobsite. Street sweeping must be done:

1. Within 1 hour, if sediment or debris is observed during activities that require sweeping
2.. Within 24 hours, if sediment or debris is observed during activities that do not require sweeping

At least 1 sweeper must be on the job site at all times when sweeping work is required. The sweeper must be in good working order.

Perform street sweeping to minimize dust. If dust generation is excessive or sediment pickup is ineffective, use water or a vacuum.

You may stockpile collected material on the jobsite according to the approved SWPPP. Dispose of collected material at least once per week.

Material collected during street sweeping must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Your WPCM must inspect paved roads at job site access points:

1. Daily if earthwork and other sediment or debris generating activities occur daily
2. Weekly if earthwork and other sediment or debris generating activities do not occur daily
3. When the National Weather Service predicts precipitation with a probability of at least 30 percent

MEASUREMENT AND PAYMENT

The contract lump sum price paid for street sweeping includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in street sweeping, including disposal of collected material, as shown on the plans, as specified in the Standard Specifications, these special provisions, and as directed by the Engineer.

10-1.__ TEMPORARY HYDRAULIC MULCH (BONDED FIBER MATRIX)

GENERAL

Summary

This work includes applying, maintaining, and removing temporary hydraulic mulch (bonded fiber matrix). Hydraulic mulch uses a mixture of fiber, tackifier, and water to stabilize active and nonactive disturbed soil areas.

The SWPPP must describe and include the use of temporary hydraulic mulch (bonded fiber matrix) as a water pollution control practice for soil stabilization.

Submittals

At least 5 business days before applying hydraulic mulch, submit:

1. Material Safety Data Sheet for the tackifier.
2. Product label describing the tackifier as an erosion control product.
3. List of pollutant indicators and potential pollutants for the use of temporary hydraulic mulch. Pollutant indicators are described under "Sampling and Analysis Plan for Non-Visible Pollutants" in the Preparation Manual.
4. Determination of acute and chronic toxicity for aquatic organisms conforming to EPA methods for the tackifier.
5. Composition of ingredients including chemical formulation.

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for:

1. Tackifier
2. Fiber

Quality Control and Assurance

Retain and submit records of temporary hydraulic mulch applications including:

1. Compliance with specified rates
2. Application area
3. Application time
4. Quantity

MATERIALS

Tackifier

The tackifier must be:

1. Nonflammable
2. Nontoxic to aquatic organisms
3. Free from growth or germination inhibiting factors
4. Bonded to the fiber or prepackaged with the fiber by the manufacturer
5. At least 10 percent of the weight of the dry fiber and include the weight of the activating agents and additives
6. Organic, high viscosity colloidal polysaccharide with activating agents, or a blended hydrocolloid-based binder

Fiber

Fiber must be:

1. Long strand, whole wood fibers, thermo-mechanically processed from clean, whole wood chips
2. Not made from sawdust, cardboard, paper, or paper byproducts
3. At least 25 percent of fibers 3/8 inch long
4. At least 50 percent held on a No. 25 sieve
5. Free from lead paint, printing ink, varnish, petroleum products, seed germination inhibitors, or chlorine bleach
6. Free from synthetic or plastic materials
7. At most 7 percent ash

Coloring Agent

Use a biodegradable nontoxic coloring agent free from copper, mercury, and arsenic to ensure the hydraulic mulch contrasts with the application area.

CONSTRUCTION

Application

Apply temporary hydraulic mulch when an area is ready to receive temporary erosion control under "Move-in/Move-out (Temporary Erosion Control)."

Dilute hydraulic mulch with water to spread the mulch evenly.

Use hydroseeding equipment to apply hydraulic mulch.

Apply hydraulic mulch:

1. In the proportions indicated in the table below. Successive applications or passes may be needed to achieve the required proportion rate:

Material	Application Rate lbs/acre
Bonded Fiber (includes fiber and tackifier material)	3500lbs/acre

2. To form a continuous mat with no gaps between the mat and the soil surface.
3. From 2 or more directions to achieve a continuous mat.
4. In layers to avoid slumping and to aid drying.
5. During dry weather or at least 24 hours before predicted rain.

Do not apply hydraulic mulch if:

1. Water is standing on or moving across the soil surface
2. Soil is frozen
3. Air temperature is below 40 °F during the tackifier curing period unless allowed by the tackifier manufacturer and approved by the Engineer

Do not over-spray hydraulic mulch onto the traveled way, sidewalks, lined drainage channels, or existing vegetation.

Maintenance

Reapply hydraulic mulch within 24 hours of discovering visible erosion unless the Engineer approves a longer period.

Removal

Remove hydraulic mulch by mechanically blending it into the soil with track laying equipment, disking, or other approved method.

Temporary hydraulic mulch disturbed or displaced by your vehicles, equipment, or operations must be reapplied at your expense.

Cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence are not included in the cost for performing maintenance.

MEASUREMENT AND PAYMENT

Temporary hydraulic mulch (bonded fiber matrix) is measured by the square yard from measurements along the slope of the areas covered by the hydraulic mulch.

The contract price paid per square yard for temporary hydraulic mulch (bonded fiber matrix) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying temporary hydraulic mulch, complete in place, including removal of hydraulic mulch, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The State and you share the cost of maintaining the temporary hydraulic mulch. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY EROSION CONTROL BLANKET

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary erosion control blanket. Temporary erosion control blanket is used to cover and protect disturbed soil areas and soil from erosion by wind or water. Temporary erosion control blanket reduces channel erosion by protecting against scour created by concentrated flow.

The SWPPP must describe and include the use of temporary erosion control blanket as a water pollution control practice for soil stabilization.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for erosion control blanket.

If you substitute the steel wire staple with an alternative attachment device, submit a sample of the device for approval at least 5 business days before installation.

MATERIALS

Erosion Control Blanket

Erosion control blanket must be:

1. Described as a rolled erosion control product (RECP)
2. Classified as temporary and degradable or long-term and non-degradable
3. Machine-made mats
4. Provided in rolled strips
5. Classified by the Erosion Control Technology Council (ECTC)

Erosion control blanket classified as temporary and degradable must be one of the following:

1. Double net excelsior blanket:

    1.1. Classified as ECTC Type 2D
    1.2. Classified as an erosion control blanket
    1.3. Designed to last for at least one year after installation
    1.4. With a Universal Soil Loss Equation (USLE) C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope
    1.5. With 80 percent of the wood excelsior fibers being 6 inches or longer
    1.6. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
    1.7. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
    1.8. With top and bottom surfaces covered with lightweight non-synthetic netting

2. Double net straw and coconut blanket:

    2.1. Classified as ECTC Type 2D
    2.2. Classified as an erosion control blanket
    2.3. Designed to last for at least one year after installation
    2.4. With a USLE C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope

2.5. Comprised of 70 percent straw and 30 percent coconut fiber
2.6. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
2.7. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
2.8. With top and bottom surfaces covered with lightweight non-synthetic netting

3. Jute netting:

4.1. Classified as ECTC Type 3B
4.2. Classified as an open weave textile and have from 14 to 20 strands per foot in each direction
4.3. Designed to last for at least one year after installation
4.4. With a USLE C-Factor of not more than 0.25 at a 1.5:1 (horizontal:vertical) slope
4.5. Comprised of 100 percent unbleached and undyed spun yarn made of jute fiber
4.6. With an average open area from 63 to 70 percent
4.7. From 48 to 72 inches in width
4.8. Capable to withstand a maximum shear stress of 2.0 pounds per square foot under ASTM D6460
4.9. With a minimum tensile strength of 100 pounds per foot under ASTM D 5035
4.10. From 0.90 to 1.20 pounds per square yard in weight

4. Coir netting:

4.1. Classified as ECTC Type 4
4.2. Classified as an open weave textile and from 13 to 18 strands per foot in each direction
4.3. Designed to last for at least three years after installation
4.4. With a USLE C-Factor of not more than 0.25 at a 1:1 (horizontal:vertical) slope
4.5. Comprised of 100 percent unbleached and undyed spun coir yarn made of coconut fiber
4.6. With an average open area from 63 to 70 percent
4.7. From 72 to 158 inches in width
4.8. Capable to withstand a maximum shear stress of 2.25 pounds per square foot under ASTM D6460
4.9. With a minimum tensile strength of 125 pounds per foot under ASTM D 5035
4.10. From 1.20 to 1.67 pounds per square yard in weight

Erosion control blanket classified as long-term and non-degradable must:

1. Be a geosynthetic fabric
2. Comply with the specifications for rock slope protection fabric (Class 8) in Section 88-1.06, "Channel and Shore Protection," of the Standard Specifications

Staples

You may use an alternative attachment device such as a geosynthetic pins or plastic pegs to install erosion control blanket.

CONSTRUCTION

Before placing erosion control blanket, remove obstructions including rocks, clods, and debris greater than 1 inch in diameter from the ground.

If fiber rolls are to be placed in the same area as erosion control blankets, install the blankets before placing the fiber rolls.

If hydroseeding is to be done in the same area as erosion control blanket:

1. You must hydroseed before placing the double net excelsior or straw and coconut blankets
2. You may hydroseed before or after placing the jute or coir netting

If temporary erosion control blanket is installed on disturbed soil areas including embankment and excavation slopes:

1. Place the blanket loosely on the embankment or excavation slope with the longitudinal joints perpendicular to the slope contour lines
3. Place the blanket on the upper portion of the slope overlapping the blanket on the lower portion of the slope for transverse joints
4. Place the blanket on the side of the prevailing wind shall overlapping the blanket on the downwind side of the slope for longitudinal joints
2. Overlap and staple the longitudinal and transverse joints
5. Secure the ends of the blanket in key trenches

If temporary erosion control blanket is installed in area of concentrated runoff including ditches and swales:

1. Place the blanket loosely along the ditch or swale with the longitudinal edges and joints parallel to the centerline of the ditch or swale
2. Place the blanket on the upper portion of the slope overlapping the blanket on the lower portion of the slope for transverse joints
3. Secure transverse joints of blankets in intermediate joint trenches
4. Overlap and staple the longitudinal and transverse joints
5. Secure the ends of the blanket in intermediate and key trenches

MAINTENANCE

Remove sediment deposits, trash, and debris from temporary erosion control blanket as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary erosion control blanket by:

1. Removing sediment from the surface of the blanket when it is deeper than 2 inches
2. Repairing or replacing the blanket when the area treated with temporary erosion control blanket becomes exposed or exhibits visible erosion
3. Repairing or replacing the erosion control blanket when washouts occur between joints or beneath the erosion control blanket
4. Repairing or replacing the erosion control when it becomes detached, torn, or unraveled

Repair temporary erosion control blanket within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary erosion control blanket, repair erosion control blanket at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that temporary erosion control blanket is not required, it must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary erosion control blanket must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary erosion control blanket is measured by the square yard of the actual area covered excluding overlaps.

The contract price paid per square yard for temporary erosion control blanket includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing temporary erosion control blanket, complete in place, including trench excavation and backfill, and removal of temporary erosion control blanket, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The State and you share the cost of maintaining the temporary erosion control blanket. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY COVER

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary cover.

The SWPPP must describe and include the use of temporary cover as a water pollution control practice for soil stabilization and stockpile management.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for:

1. Gravel-filled bag fabric
2. Temporary cover fabric

If you substitute a material in the following list, submit a sample of the alternative material for approval at least 5 business days before installation:

1. Alternative restrainer
2. Alternative linear sediment barrier

MATERIALS

Geosynthetic Fabrics

Geosynthetic fabrics must consist of one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Sample under ASTM D 4354, Procedure C.

7

Test under ASTM D 4759. All properties are based on Minimum Average Roll Value (MARV).

8

Identify, store, and handle under ASTM D 4873.

9

Protect geosynthetics from moisture, sunlight and damage during shipping and storage. Label each unit with the manufacturer's name, identifying information and product identification.

10

Gravel-filled bag fabric must comply with:

Specification	Requirements
Grab breaking load 1-inch grip, lb, min. in each direction	205
Apparent elongation percent, min., in each direction	50
Water Flow Rate max. average roll value, gallons per minute/square foot	80-150
Permittivity 1/sec., min	1.2
Apparent opening size max. average roll value, U.S. Standard sieve size	40-80
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	70

The temporary cover fabric must be geosynthetic cover fabric, plastic sheeting, or a combination of both.

Temporary cover fabric must be either:

1. Plastic sheeting consisting of a single-ply geomembrane material, 10 mils thick, that complies with ASTM D 5199
2. Geosynthetic cover fabric that complies with the following properties:

Specification	Requirements
Grab breaking load 1-inch grip, lb, min. in each direction	200
Apparent elongation percent, min., in each direction	50
Water Flow Rate max. average roll value, gallons per minute/square foot	75-120
Permittivity 1/sec., min	0.08
Apparent opening size max. average roll value, U.S. Standard sieve size	100
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	70

Gravel

Gravel for gravel-filled bags must be:

1. From 3/8 to 3/4 inch in diameter
2. Clean and free from clay balls, organic matter, and other deleterious materials

Gravel-filled Bags

Gravel-filled bags must:

1. Be made from gravel-filled bag fabric.
2. Have inside dimensions from 24 to 32 inches in length, and from 16 to 20 inches in width.
3. Have the opening bound to retain the gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.
4. Weigh from 30 to 50 pounds when filled with gravel.

Restrainers

Restrainers must be used to secure the cover fabric or plastic sheeting to the surface of the slope or stockpile.

Restrainers must be one of the following:

1. Made of gravel-filled bags that are roped together and spaced no more than a 6 feet apart
2. Made of wooden lath and anchor restrainers as shown on the plans and the following:

    2.1 Wooden lath must be 2" x 4" x 8', made from fir or pine, and comply with Section 88-2.12, "Lumber," of the Standard Specifications

    2.2 Anchor restrainers must be made from steel reinforcing bars and spaced no more than 4 feet apart along the wooden lath

3. An approved alternate method

Rope

Rope must be at least 3/8 inch in diameter.

Rope must be one of the following:

1. Biodegradable, such as sisal or manila
2. Nondegradable, such as polypropelene or nylon

Linear Sediment Barrier

Linear sediment barriers consist of one or more of the following:

1. Gravel bag berm
2. Earthen berm
3. Approved alternate method

CONSTRUCTION

Temporary Cover Fabric

Install temporary cover fabric by:

1. Placing the temporary cover fabric loosely on the slope or stockpile with the longitudinal edges perpendicular to the slope contours
2. Placing the temporary cover fabric on the upper portion of the slope to overlap cover fabric on the lower portion of the slope
3. Placing the temporary cover fabric on the side of the prevailing wind to overlap the cover fabric on the downwind side of the slope
4. Anchoring the perimeter edge of the temporary cover fabric in key trenches
5. Overlapping edges of the temporary cover fabric by at least 2 feet
6. Placing restrainers at the overlap area and along the toe of the slope. Between overlaps, the restrainers must be spaced a maximum of 8 feet on center.
7. Ensuring that, if anchor restraints are used, the leg of the steel reinforcing bar pierces the temporary cover fabric and holds the wooden lath firmly against the surface of the slope or stockpile.

Linear Sediment Barrier

Protect excavation and embankment slopes with linear sediment barrier by:

1. Preventing run-on and concentrated flows from damaging the slopes
2. Placing the barrier approximately parallel to the slope contour at the toe of the slope
4. Angling the last 6 feet of the barrier up-slope

Protect stockpiles with linear sediment barrier by:

1. Preventing run-on and concentrated flows from touching the stockpiled material
2. Surrounding the stockpile with a linear sediment barrier
3. Adding more linear sediment barrier within 24 hours of adding more material to the stockpile

If earthen berms are used as a linear sediment barrier, they must be:

1. At least 8 inches high and 36 inches wide
2. Compacted by hand or mechanical method

If gravel bag berms are used as a linear sediment barrier:

1. Place gravel bags as a single layer
2. Place gravel bags end-to-end to eliminate gaps

If you need to increase the height of the gravel bag berm:

1. Increase height by adding rows of gravel-filled bags
2. Stack bags in a way that the bags in the top row overlap the joints in the lower row
3. Stabilize berm by adding rows at the bottom

If you remove the temporary cover to do other work, replace and secure temporary cover within one hour.

MAINTENANCE

Maintain temporary cover to minimize exposure of the slopes or stockpile and prevent movement of the material beyond the linear sediment barrier.

Maintain temporary cover by:

1. Relocating and securring restrainers to keep the erosion control blankets in place. Temporary cover fabric that breaks free must be immediately secured.
2. Repairing or replacing the temporary cover fabric when the area covered by temporary cover becomes exposed or exhibits visible erosion.
3. Repairing or replacing the linear sediment barrier when washouts occur between joints or beneath the linear sediment barrier.
4. Repairing or replacing the temporary cover fabric when it becomes detached, torn, or unraveled.

Repair temporary cover within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary cover, repair temporary cover at your expense.

REMOVAL

When the Engineer determines that temporary cover is not required, it must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary cover must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary cover is measured by the square yard of the actual area covered excluding overlaps.

The contract price paid per square yard for temporary cover includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing temporary cover, complete in place, including restrainers and removal of temporary cover, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ TEMPORARY CONCRETE WASHOUT (PORTABLE)

GENERAL

Summary

This work includes removal and disposal of concrete waste by furnishing, maintaining, and removing portable temporary concrete washouts.

SWPPP must describe and include the use of a portable temporary concrete washout as a water pollution control practice for waste management and materials pollution control.

Submittals

At least 5 business days before concrete activities start, submit:

1. Name and location of off-site concrete waste disposal facility to receive concrete waste
2. Copy of permit issued by RWQCB for off-site commercial disposal facility
3. Copy of license for off-site commercial disposal facility
4. Copy of permit issued by state or local agency having jurisdiction over disposal facility if disposal site is located outside of the State of California

Quality Control and Assurance

Retain and submit records of disposed concrete waste including:

1. Weight tickets
2. Delivery and removal of temporary concrete washouts

MATERIALS

Portable Temporary Concrete Washout

Portable temporary concrete washout must:

1. Be a commercially available watertight container.
2. Have sufficient capacity to contain all liquid and concrete waste generated by washout activities without seepage or spills.
3. Have at least 55-gallon capacity.
4. Be labeled for the exclusive use as a concrete waste and washout facility. Stencil "Concrete Waste material" in 3-inch high letters on white background. Top of stenciling must be 12 inches from the top of the container.

Concrete Washout Sign

Concrete washout sign must comply with the provisions in Section 12-3.06B, "Portable Signs" of the Standard Specifications and:

1. Be approved by the Engineer
2. Consist of base, framework, and sign panel
3. Be made of plywood
4. Be minimum 2' x 4' in size
5. Read "Concrete Washout" with 3 inches high black letters on white background

CONSTRUCTION

Placement

Place portable temporary concrete washouts at job site:

1. Before concrete placement activities start
2. In the immediate area of concrete work as approved by the Engineer
3. No closer than 50 feet from storm drain inlets, open drainage facilities, ESAs, or watercourses
4. Away from construction traffic or public access areas

Install a concrete washout sign adjacent to each portable temporary concrete washout location.

Operation

Use portable temporary concrete washouts for:

1. Washout from concrete delivery trucks
2. Slurries containing portland cement concrete or hot mix asphalt from sawcutting, coring, grinding, grooving, and hydro-concrete demolition
3. Concrete waste from mortar mixing stations

Relocate portable temporary concrete washouts as needed for concrete construction work.

Replace portable temporary concrete washouts when filled to capacity. Do not fill higher than 6 inches below rim.

Your WPC manager must inspect portable temporary concrete washouts:

1. Daily if concrete work occurs daily
2. Weekly if concrete work does not occur daily

Maintenance

When relocating or transporting a portable temporary concrete washout within the job site, secure it to prevent spilling of concrete waste material. If any spilled material is observed, remove spilled material and place it into portable temporary concrete washout.

Removal

Dispose of concrete waste material at a facility specifically licensed to receive solid concrete waste, liquid concrete waste, or both. When portable temporary concrete washout is full, remove and dispose of concrete waste within 2 days.

PAYMENT

The contract lump sum price paid for temporary concrete washout (portable) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing, maintaining, and removing the portable temporary concrete washout, including removal and disposal of concrete waste, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ TEMPORARY CHECK DAM

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary check dams.

The SWPPP must describe and include the use of temporary check dams as a water pollution control practice for soil stabilization in flow conveyances.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for:

1. Fiber rolls
2. Gravel-filled bag fabric

MATERIALS

Fiber Rolls

Fiber rolls must:

1. Last for at least one year after installation
2. Be Type 1 or Type 2

If specified, Type 1 fiber rolls must be:

1. Made from an erosion control blanket:

    1.1. Classified by the Erosion Control Technology Council (ECTC) as ECTC 2D
    1.2. With a Universal Soil Loss Equation (USLE) C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope
    1.3. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
    1.4. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
    1.5. With top and bottom surfaces covered with lightweight non-synthetic netting
    1.6. Either of the following:

        1.6.1. Double net straw and coconut blanket with 70 percent straw and 30 percent coconut fiber
        1.6.2. Double net excelsior blanket with 80 percent of the wood excelsior fibers being 6 inches or longer

2. Rolled along the width
3. Secured with natural fiber twine every 6 feet and 6 inches from each end
4. Finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 0.5 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 2 pounds per linear foot

If specified, Type 2 fiber rolls must:

1. Be filled with rice or wheat straw, wood excelsior, or coconut fiber
2. Be covered with a photodegradable plastic netting or a biodegradable jute, sisal, or coir fiber netting
3. Have the netting secured tightly at each end
4. Be finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 1.1 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 3 pounds per linear foot

Wood Stakes

Wood stakes must be:

1. Untreated fir, redwood, cedar, or pine and cut from sound timber
2. Straight and free of loose or unsound knots and other defects which would render the stakes unfit for use
3. Pointed on the end to be driven into the ground

For fiber rolls, wood stakes must be at least:

1. 1" x 1" x 24" in size for Type 1 installation
2. 1" x 2" x 24" in size for Type 2 installation

Rope

For Type 2 installation, rope must:

1. Be biodegradable, such as sisal or manila
2. Have a minimum diameter of 1/4 inch

Gravel-filled Bag Fabric

Geosynthetic fabric for temporary gravel bag berm must consist of one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Sample under ASTM D 4354, Procedure C.

11

Test under ASTM D 4759. All properties are based on Minimum Average Roll Value (MARV).

12

Identify, store, and handle under ASTM D 4873.

13

Protect geosynthetics from moisture, sunlight and damage during shipping and storage. Label each unit with the manufacturer's name, identifying information and product identification.

14

Gravel-filled bag fabric must comply with:

Specification	Requirements
Grab breaking load 1-inch grip, lb, min. in each direction	205
Apparent elongation percent, min., in each direction	50
Water Flow Rate max. average roll value, gallons per minute/square foot	80-150
Permittivity 1/sec., min	1.2
Apparent opening size max. average roll value, U.S. Standard sieve size	40-80
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	70

Gravel

Gravel for gravel-filled bags must be:

1. From 3/8 to 3/4 inch in diameter
2. Clean and free from clay balls, organic matter, and other deleterious materials

Gravel-filled Bags

Gravel-filled bags must:

1. Be made from gravel-filled bag fabric.
2. Have inside dimensions from 24 to 32 inches in length, and from 16 to 20 inches in width.
3. Have the opening bound to retain the gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.
4. Weigh from 30 to 50 pounds when filled with gravel.

CONSTRUCTION

Before placing temporary check dam, remove obstructions including rocks, clods, and debris greater than one inch in diameter from the ground.

If check dams are to be placed in the same areas as erosion control blankets, then install the blankets before placing the check dams.

Temporary check dams must be:

1. Placed approximately perpendicular to the centerline of the ditch or drainage line
2. Installed with sufficient spillway depth to prevent flanking of concentrated flow around the ends of the check dam
3. Type 1 for lashed fiber rolls, Type 2 for gravel-filled bags, or a combination:

3.1. If the ditch is lined with concrete or hot mix asphalt, use temporary check dam (Type 2)
3.2. If the ditch is unlined, you may use temporary check dam (Type 1) or (Type 2)

Temporary check dam (Type 1) must be:

1. Secured with rope and notched wood stakes.
2. Installed by driving stakes into the soil until the notch is even with the top of the fiber roll.
3. Installed by lacing the rope between stakes and over the fiber roll. Knot the rope at each stake.
4. Tightened by driving the stakes further into the soil forcing the fiber roll against the surface of the ditch or drainage line.

Temporary check dam (Type 2) must be:

1. Placed as a single layer of gravel bags
2. End-to-end to eliminate gaps

If you need to increase the height of the temporary check dam (Type 2):

1. Increase height by adding rows of gravel-filled bags
2. Stack bags in a way that the bags in the top row overlap the joints in the lower row
3. Stabilize dam by adding rows of bags at the bottom

MAINTENANCE

Maintain temporary check dams to provide sediment holding capacity and to reduce concentrated flow velocities.

Remove sediment deposits, trash, and debris from temporary check dams as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary check dams by:

1. Removing sediment from behind the check dam when sediment is 1/3 the height of the check dam above ground
2. Repairing or adjusting the check dams when scour and other evidence of concentrated flow occur beneath the fiber roll
3. Repairing or replacing the fiber rolls or gravel-filled bags when they become split, torn, or unraveled
4. Adding stakes when the fiber rolls slump or sag
5. Replacing broken or split wood stakes

Repair temporary check dams within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary check dams, repair temporary check dams at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that temporary check dams are not required, they must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary check dams must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary check dam is measured by the linear foot along the centerline of the check dams. Where temporary fiber rolls are joined and overlapped, the overlap is measured as a single installed check dam.

The contract price paid per linear foot for temporary check dams includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the temporary check dams, complete in place, including removal of materials, cleanup and disposal of retained sediment and debris, and backfilling and repairing holes, depressions and other ground disturbance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer

The State and you share the cost of maintaining the temporary check dams. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY FIBER ROLL

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary fiber roll.

The SWPPP must describe and include the use of temporary fiber roll as a water pollution control practice for sediment control.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for fiber roll.

MATERIALS

Fiber Roll

Fiber roll must:

1. Last for at least one year after installation
2. Be Type 1 or Type 2

If specified, Type 1 fiber roll must be:

1. Made from an erosion control blanket:

    1.1. Classified by the Erosion Control Technology Council (ECTC) as ECTC 2D
    1.2. With a Universal Soil Loss Equation (USLE) C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope
    1.3. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
    1.4. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
    1.5. With top and bottom surfaces covered with lightweight non-synthetic netting
    1.6. That complies with one of the following:

        1.6.1. Double net straw and coconut blanket with 70 percent straw and 30 percent coconut fiber
        1.6.2. Double net excelsior blanket with 80 percent of the wood excelsior fibers being 6 inches or longer

2. Rolled along the width
3. Secured with natural fiber twine every 6 feet and 6 inches from each end
4. Finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 0.5 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 2 pounds per linear foot

If specified, Type 2 fiber roll must:

1. Be filled with rice or wheat straw, wood excelsior, or coconut fiber
2. Be covered with a photodegradable plastic netting or a biodegradable jute, sisal, or coir fiber netting
3. Have the netting secured tightly at each end
4. Be finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 1.1 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 3 pounds per linear foot

Wood Stakes

Wood stakes must be:

1. Untreated fir, redwood, cedar, or pine and cut from sound timber
2. Straight and free of loose or unsound knots and other defects which would render the stakes unfit for use
3. Pointed on the end to be driven into the ground

For fiber roll, wood stakes must be at least:

1. 1" x 1" x 24" in size for Type 1 installation
2. 1" x 2" x 24" in size for Type 2 installation

Rope

For Type 2 installation, rope must:

1. Be biodegradable, such as sisal or manila
2. Have a minimum diameter of 1/4 inch

CONSTRUCTION

Before placing fiber roll, remove obstructions including rocks, clods, and debris greater than one inch in diameter from the ground.

If fiber roll is to be placed in the same area as erosion control blanket, install the blanket before placing the fiber roll. For other soil stabilization practices such as hydraulic mulch or compost, place the fiber roll and then apply the soil stabilization practice.

Place fiber roll on slopes at the following spacing unless the plans show a different spacing:

1. 10 feet apart for slopes steeper than 2:1 (horizontal:vertical)
2. 15 feet apart for slopes from 2:1 to 4:1 (horizontal:vertical)
3. 20 feet apart for slopes from 4:1 to 10:1 (horizontal:vertical)
4. 50 feet apart for slopes flatter than 10:1 (horizontal:vertical)

Place fiber roll approximately parallel to the slope contour. For any 20 foot section of fiber roll, do not allow the fiber roll to vary more then 5 percent from level.

Type 1 and Type 2 fiber roll may be installed using installation method Type 1, Type 2, or a combination:

For installation method Type 1, install fiber roll by:

1. Placing in a furrow that is from 2 to 4 inches deep
2. Securing with wood stakes every 4 feet along the length of the fiber roll
3. Securing the ends of the fiber roll by placing a stake 6 inches from the end of the roll
4. Driving the stakes into the soil so that the top of the stake is less then 2 inches above the top of the fiber roll

For installation method Type 2, install fiber roll by:

1. Securing with rope and notched wood stakes.
2. Driving stakes into the soil until the notch is even with the top of the fiber roll.
3. Lacing the rope between stakes and over the fiber roll. Knot the rope at each stake.
4. Tightening the fiber roll to the surface of the slope by driving the stakes further into the soil.

MAINTENANCE

Maintain temporary fiber roll to provide sediment holding capacity and to reduce runoff velocities.

Remove sediment deposits, trash, and debris from temporary fiber roll as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary fiber roll by:

1. Removing sediment from behind the fiber roll when sediment is 1/3 the height of the fiber roll above ground
2. Repairing or adjusting the fiber roll when rills and other evidence of concentrated runoff occur beneath the fiber roll.
3. Repairing or replacing the fiber roll when they become split, torn, or unraveled
4. Adding stakes when the fiber roll slump or sag
5. Replacing broken or split wood stakes

Repair temporary fiber roll within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary fiber roll, repair temporary fiber roll at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that temporary fiber roll is not required, they must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary fiber roll must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary fiber roll is measured by the linear foot along the centerline of the installed roll. Where temporary fiber roll is joined and overlapped, the overlap is measured as a single installed roll.

The contract price paid per linear foot for temporary fiber roll includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the temporary fiber roll, complete in place, including removal of materials, cleanup and disposal of retained sediment and debris, and backfilling and repairing holes, depressions and other ground disturbance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer

The State and you share the cost of maintaining the temporary fiber roll. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY SILT FENCE

GENERAL

Summary

This work includes installing, maintaining, and removing temporary silt fence.

The SWPPP must describe and include the use of temporary silt fence as a water pollution control practice for sediment control.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for silt fence fabric.

MATERIALS

Silt Fence Fabric

Geosynthetic fabric for temporary silt fence must consist of one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Sample under ASTM D 4354, Procedure C.

Test under ASTM D 4759. All properties must be based on Minimum Average Roll Value (MARV).

Identify, store, and handle under ASTM D 4873.

Protect geosynthetics from moisture, sunlight, and damage during shipping and storage. Label each unit with the manufacturer's name, identifying information, and product identification.

Silt fence fabric must comply with:

Property	ASTM Designation	Specification	
		Woven	Non-woven
Grab breaking load 1-inch grip, lb, min. in each direction	D 4632	120	120
Apparent elongation percent, min., in each direction	D 4632	15	50
Water Flow Rate max. average roll value, gallons per minute/square foot	D 4491	10-50	100-150
Permittivity 1/sec., min.	D 4491	0.05	0.05
Apparent opening size max. average roll value, U.S. Standard sieve size	D 4751	30	30
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	D 4595	70	

Posts

Posts must be wood or metal.

Wood posts must be:

1. Untreated fir, redwood, cedar, or pine and cut from sound timber
2. Straight and free of loose or unsound knots and other defects that would render the stakes unfit for use
3. Pointed on the end to be driven into the ground
4. At least 2" x 2" in size, and 4 feet long

Metal posts must:

1. Be made of steel.
2. Have a "U," "T," "L," or other cross sectional shape that can resist failure from lateral loads.
3. Be pointed on the end to be driven into the ground.
4. Weigh at least 0.75-pound per foot.
5. Be at least 4 feet long.
6. Have a safety cap attached to the exposed end. The safety cap must be orange or red plastic and fit snugly to the metal post.

CONSTRUCTION

Silt fence must be:

1. Constructed with silt fence fabric, posts, and fasteners
2. Prefabricated or assembled at the job site

Silt fence fabric must be attached to posts using these methods:

1. If prefabricated silt fence is used, posts must be inserted into sewn pockets
2. If assembled on the job site:

    2.1. If wood posts are used, fasteners must be staples or nails
    2.2. If steel posts are used, fasteners must be tie wires or locking plastic fasteners
    2.3. Spacing of the fasteners must be no more than 8 inches apart

Place silt fence approximately parallel to the slope contour. For any 50 foot section of silt fence, do not allow the elevation at the base of the fence to vary more than 1/3 of the fence height.

Install silt fence by:

1. Placing the bottom of the fabric in a trench that is 6 inches deep
2. Securing with posts placed on the downhill side of the fabric
3. Backfilling the trench with soil and hand or mechanically tamping to secure the fabric in the trench

If you reinforce the silt fence fabric with wire or plastic mesh, you may increase the post spacing to a maximum of 10 feet. The field-assembled reinforced silt fence must be able to retain saturated sediment without collapsing.

Connect silt fence sections by:

1. Joining separate sections of silt fence to form reaches that are no more than 500 feet long

2. Securing the end posts of each section by wrapping the tops of the posts with at least two wraps of 16-gage diameter tie wire
3. Ensuring that each reach is a continuous run of silt fence from end to end or from an end to an opening, including joined panels

If you mechanically push the silt fence fabric vertically through the soil, you must demostrate that the silt fence fabric will not be damaged and will not slip out of the soil, resulting in sediment passing under the silt fence fabric.

MAINTENANCE

Maintain temporary silt fence to provide sediment holding capacity and to reduce runoff velocities.

Remove sediment deposits, trash, and debris from temporary silt fence as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary silt fence by:

1. Removing sediment from behind the silt fence when sediment is 1/3 the height of the silt fence above ground
2. Repairing or adjusting the silt fence when rills and other evidence of concentrated runoff occur beneath the silt fence fabric
3. Repairing or replacing the silt fence fabric when it become split, torn, or unraveled

Repair temporary silt fence within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary silt fence, repair temporary silt fence at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that temporary silt fence is not required, remove and dispose of fence under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary silt fence must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary silt fence is measured by the linear foot along the centerline of the installed fence.

The contract price paid per linear foot for temporary silt fence includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the temporary silt fence, complete in place, including removal of materials, cleanup and disposal of retained sediment and debris, and backfilling and repairing holes, depressions and other ground disturbance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The State and you share the cost of maintaining the temporary silt fence. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY GRAVEL BAG BERM

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary gravel bag berm.

The SWPPP must describe and include the use of temporary gravel bag berm as a water pollution control practice for sediment control.

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for gravel-filled bag fabric.

MATERIALS

Gravel-filled Bag Fabric

Geosynthetic fabric for temporary gravel bag berm must consist of one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Sample under ASTM D 4354, Procedure C.

5

Test under ASTM D 4759. All properties must be based on Minimum Average Roll Value (MARV).

6

Identify, store, and handle under ASTM D 4873.

7

Protect geosynthetics from moisture, sunlight, and damage during shipping and storage. Label each unit with the manufacturer's name, identifying information, and product identification.

8

Gravel-filled bag fabric must comply with:

Specification	Requirements
Grab breaking load 1-inch grip, lb, min. in each direction	205
Apparent elongation percent, min., in each direction	50
Water Flow Rate max. average roll value, gallons per minute/square foot	80-150
Permittivity 1/sec., min	1.2
Apparent opening size max. average roll value, U.S. Standard sieve size	40-80
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	70

Gravel

Gravel for gravel-filled bags must be:

1. From 3/8 to 3/4 inch in diameter
2. Clean and free from clay balls, organic matter, and other deleterious materials

Gravel-filled Bags

Gravel-filled bags must:

1. Be made from gravel-filled bag fabric.
2. Have inside dimensions from 24 to 32 inches in length, and from 16 to 20 inches in width.
3. Have the opening bound to retain the gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.
4. Weigh from 30 to 50 pounds when filled with gravel.

CONSTRUCTION

Before constructing temporary gravel bag berm, remove obstructions including rocks, clods, and debris greater than 1 inch in diameter from the ground.

Temporary gravel bag berm must:

1. Be placed as a single layer of gravel bags to create a linear sediment barrier
2. Be placed end-to-end to eliminate gaps
3. Be placed approximately parallel to the slope contour
4. Have the last 6 feet of the gravel bag berm angled up-slope

If you need to increase the height of the temporary gravel bag berm:

1. Increase height by adding rows of gravel-filled bags
2. Stack bags in a way that the bags in the top row overlap the joints in the lower row
3. Stabilize berm by adding rows at the bottom

If used within shoulder area, gravel-filled bags must be placed behind temporary railing (Type K).

MAINTENANCE

Maintain temporary gravel bag berm to provide sediment holding capacity and to reduce runoff velocities.

Remove sediment deposits, trash, and debris from temporary gravel bag berm as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary gravel bag berm by:

1. Removing sediment from behind the gravel bag berm when sediment is 1/3 the height of the gravel bag berm above ground

2. Repairing or adjusting the gravel-filled bags when rills and other evidence of concentrated runoff occur beneath the gravel-filled bags
3. Repairing or replacing the gravel-filled bags when they become split, torn, or unraveled

Repair temporary gravel bag berm within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary gravel bag berm, repair temporary gravel bag berm at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that temporary gravel bag berm is not required, they must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary gravel bag berm must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary gravel bag berm is measured by the linear foot along the centerline of the installed berm.

The contract price paid per linear foot for temporary gravel bag berm includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the temporary gravel bag berm, complete in place, including removal of materials, cleanup and disposal of retained sediment and debris, and backfilling and repairing holes, depressions and other ground disturbance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The State and you share the cost of maintaining the temporary gravel bag berm. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ TEMPORARY CONSTRUCTION ENTRANCE

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary construction entrance to provide temporary access.

The SWPPP must describe and include the use of temporary construction entrance as a water pollution control practice for tracking control.

Temporary construction entrance must be Type 1, Type 2, or a combination.

Submittals

Submit a Certificate of Compliance under Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for:

1. Temporary entrance fabric
2. Rock

Submit details for alternatives at least 5 business days before installation. You may propose alternatives for the following items:

1. Alternative sump
2. Alternative corrugated steel panels

If the Engineer approves, you may eliminate the sump.

MATERIALS

Temporary Entrance Fabric

Temporary entrance fabric must comply with Section 88-1.04, "Rock Slope Protection Fabric," of the Standard Specifications and be woven Type B or non-woven Type B.

Rock

Rock must be Type A or Type B.

Rock (Type A) must comply with:

1. Requirements under Section 72-2.02, "Materials," of the Standard Specifications
2. Following sizes:

Square Screen Size (inch)	Percentage Passing	Percentage Retained
6	100	0
3	0	100

Rock (Type B) must be Railway Ballast Number 25. Do not use blast furnace slag. Railway Ballast Number 25 must comply with:

1. Description in AREMA Manual for Railway Engineering.
2. Following sizes:

Nominal Size Square Opening	Percentage Passing								
	3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
2-1/2"-3/8"	100	80-100	60-85	50-70	25-50	-	5-20	0-10	0-3

3. Following properties:

Specification	Requirements
Percent material passing No. 200 sieve, max. ASTM: C 117	1.0
Bulk specific gravity, min. ASTM: C 127	2.60
Absorption, percent min. ASTM: C 127	1.0
Clay lumps and friable particles, percent max. ASTM: C 142	0.5
Degradation, percent max. ASTM: C 535	30
Soundness (Sodium Sulfate), percent max. ASTM: C 88	5.0
Flat, elongated particles, or both, percent max. ASTM: D 4791	5.0

Corrugated Steel Panels

Corrugated steel panels must:

1. Be made of steel.
2. Be pressed or shop welded
3. Have a slot or hook for connecting panels together

CONSTRUCTION

Prepare location for temporary construction entrance by:

1. Removing vegetation to ground level and clear away debris
2. Grading ground to uniform plane
3. Grading ground surface to drain
4. Removing sharp objects that may damage fabric
5. Compacting the top 1.5 feet of soil to at least 90 percent relative compaction

If temporary entrance (Type 1) is specified, use rock (Type A).

If temporary construction entrance (Type 2) is specified, use Rock (Type B) under corrugated steel panels. Use at least 6 corrugated steel panels for each entrance. Couple panels together.

Install temporary construction entrance by:

1. Positioning fabric along the length of the entrance
2. Overlapping sides and ends of fabric by at least 12 inches
3. Spreading rock over fabric in the direction of traffic
4. Covering fabric with rock within 24 hours
5. Keeping a 6 inch layer of rock over fabric to prevent damage to fabric by spreading equipment

Do not drive on fabric until rock is spread.

Unless the Engineer eliminates the sump, install a sump within 20 feet of each temporary construction entrance.

Repair fabric damaged during rock spreading by placing a new fabric over the damaged area. New fabric must be large enough to cover damaged area and provide at least 18-inch overlap on all edges.

Maintenance

Maintain temporary construction entrance to minimize generation of dust and tracking of soil and sediment onto public roads. If dust or sediment tracking increases, place additional rock unless the Engineer approves another method.

Repair temporary construction entrance if:

1. Fabric is exposed
2. Depressions in the entrance surface develop
3. Rock is displaced

Repair temporary construction entrance within 24 hours of discovering damage unless the Engineer approves a longer period.

During use of temporary construction entrance, do not allow soil, sediment, or other debris tracked onto pavement to enter storm drains, open drainage facilities, or watercourses. When material is tracked onto pavement, remove it within 24 hours unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace the temporary construction entrance, repair it at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

Removal

When the Engineer determines that temporary construction entrance is not required, remove and dispose of it under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Backfill and repair ground disturbance, including holes and depressions, caused by installation and removal of temporary construction entrance under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Temporary construction entrance is determined from actual count in place. Temporary construction entrance is measured one time only and no additional measurement will be recognized.

The contract price paid for temporary construction entrance includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing temporary construction entrance, complete in place, including removal of temporary construction entrance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

No additional compensation will be made if the temporary construction entrance is relocated during the course of construction.

The State and you share the cost of maintaining temporary construction entrance. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ MOVE-IN/MOVE-OUT (TEMPORARY EROSION CONTROL)

GENERAL

Summary

This work includes moving onto the project when an area is ready to receive temporary erosion control, setting up required personnel and equipment for the application of erosion control materials, and moving out all personnel and equipment when temporary erosion control in that area is completed.

Temporary erosion control consists of any water pollution control practice for soil stabilization.

When notified by the Engineer that an area is ready for temporary erosion control, start erosion control work within 5 business days.

MEASUREMENT AND PAYMENT

Move-in/move-out (temporary erosion control) is measured as units from actual count. A move-in followed by a move-out is considered one unit.

The contract unit price paid for move-in/move-out (temporary erosion control) includes full compensation for furnishing all labor, materials (excluding temporary erosion control materials), tools, equipment, and incidentals and for doing all the work involved in moving in and removing from the project all personnel and equipment necessary for application of temporary erosion control, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ TEMPORARY DRAINAGE INLET PROTECTION

GENERAL

Summary

This work includes constructing, maintaining, and removing temporary drainage inlet protection. Drainage inlet protection settles and filters sediment before stormwater runoff discharges into storm drainage systems.

The SWPPP must describe and include the use of temporary drainage inlet protection as a water pollution control practice for sediment control.

Provide temporary drainage inlet protection to meet the changing conditions around the drainage inlet. Temporary drainage inlet protection must be:

1. Appropriate type to meet the conditions around the drainage inlet
2. Type 1, Type 2, Type 3A, Type 3B, Type 4, Type 4B, Type 5, Type 6A, Type 6B, or a combination

Submittals

Submit a Certificate of Compliance as specified in Section 6-1.07, "Certificates of Compliance" of the Standard Specifications for:

1. Erosion control blanket
2. Fiber rolls
3. Safety cap for metal posts
4. Silt fence fabric
5. Sediment filter bag
6. Foam barrier
7. Rigid plastic barrier
8. Gravel-filled bag fabric

If you substitute the steel wire staple with an alternative attachment device, submit a sample of the device for approval at least 5 business days before installation.

MATERIALS

Geosynthetic Fabrics

Geosynthetic fabrics for temporary drainage inlet protection must consist of one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Geosynthetic fabrics for temporary drainage inlet must comply with the specifications for water pollution control in Section 88-1.05, "Water Pollution Control," of the Standard Specifications.

Foam barrier must comply with:

Foam Barrier

Property	ASTM Designation	Specification
Grab breaking load 1-inch grip, lb, min. in each direction	D 4632	200
Apparent elongation percent, min., in each direction	D 4632	15
Water Flow Rate max. average roll value, gallons per minute/square foot	D 4491	100-150
Permittivity 1/sec., min.	D 4491	0.05
Apparent opening size max. average roll value, U.S. Standard sieve size	D 4751	40
Ultraviolet Degradation percent of original unexposed grab breaking load 500 hr, minimum	D 4595	70

Sample under ASTM D 4354, Procedure C.

Test under ASTM D 4759. All properties are based on Minimum Average Roll Value (MARV).

Identify, store, and handle under ASTM D 4873.

Erosion Control Blanket

Erosion control blanket must be:

1. Described as a rolled erosion control product (RECP)
2. Classified as temporary and degradable or long-term and non-degradable
3. Machine-made mats
4. Provided in rolled strips
5. Classified by the Erosion Control Technology Council (ECTC)

Erosion control blanket classified as temporary and degradable must be one of the following:

1. Double net excelsior blanket:

    1.1. Classified as ECTC Type 2D
    1.2. Classified as an erosion control blanket
    1.3. Designed to last for at least one year after installation
    1.4. With a Universal Soil Loss Equation (USLE) C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope
    1.5. With 80 percent of the wood excelsior fibers being 6 inches or longer

1.6. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
1.7. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
1.8. With top and bottom surfaces covered with extruded photodegradable plastic netting or lightweight non-synthetic netting

2. Double net straw and coconut blanket:

2.1. Classified as ECTC Type 2D
2.2. Classified as an erosion control blanket
2.3. Designed to last for at least one year after installation
2.4. With a USLE C-Factor of not more than 0.20 at a 2:1 (horizontal:vertical) slope
2.5. Comprised of 70 percent straw and 30 percent coconut fiber
2.6. Capable to withstand a maximum shear stress of 1.75 pounds per square foot under ASTM D 6460
2.7. With a minimum tensile strength of 75 pounds per foot under ASTM D 5035
2.8. With top and bottom surfaces covered with extruded photodegradable plastic netting or lightweight non-synthetic netting

3. Jute netting:

3.1. Classified as ECTC Type 3B
3.2. Classified as an open weave textile and have from 14 to 20 strands per foot in each direction
3.3. Designed to last for at least one year after installation
3.4. With a USLE C-Factor of not more than 0.25 at a 1.5:1 (horizontal:vertical) slope
3.5. Comprised of 100 percent unbleached and undyed spun yarn made of jute fiber
3.6. With an average open area from 63 to 70 percent
3.7. From 48 to 72 inches in width
3.8. Capable to withstand a maximum shear stress of 2.0 pounds per square foot under ASTM D 6460
3.9. With a minimum tensile strength of 100 pounds per foot under ASTM D 5035
3.10. From 0.90 to 1.20 pounds per square yard in weight

4. Coir netting:

4.1. Classified as ECTC Type 4
4.2. Classified as an open weave textile and from 13 to 18 strands per foot in each direction
4.3. Designed to last for at least three years after installation
4.4. With a USLE C-Factor of not more than 0.25 at a 1:1 (horizontal:vertical) slope
4.5. Comprised of 100 percent unbleached and undyed spun coir yarn made of coconut fiber
4.6. With an average open area from 63 to 70 percent
4.7. From 72 to 158 inches in width
4.8. Capable to withstand a maximum shear stress of 2.25 pounds per square foot under ASTM D6460
4.9. With a minimum tensile strength of 125 pounds per foot under ASTM D 5035
4.10. From 1.20 to 1.67 pounds per square yard in weight

Erosion control blanket classified as long-term and non-degradable must:

1. Be a geosynthetic fabric
2. Comply with the specifications for rock slope protection fabric (Class 8) in Section 88-1.06, "Channel and Shore Protection," of the Standard Specifications

Staples

You may use an alternative attachment device such as a geosynthetic pins or plastic pegs to install erosion control blanket.

Rock

Rock must comply with:

1. Requirements under Section 72-2.02, "Materials," of the Standard Specifications
2. Following sizes:

Square Screen Size (inch)	Percentage Passing	Percentage Retained
6	100	0
3	0	100

Rope

Rope for fiber rolls must be:

1. Biodegradable, such as sisal or manila
2. At least 1/4 inch in diameter

Fiber Rolls

Fiber rolls must:

1. Last for at least one year after installation
2. Be Type 1 or Type 2

For Type 1, fiber rolls must be:

1. Made from an erosion control blanket classified as temporary and degradable
2. Rolled along the width
3. Secured with natural fiber twine every 6'-6" from each end
4. Finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 0.5 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 2 pounds per linear foot

For Type 2, fiber rolls must:

1. Be filled with rice or wheat straw, wood excelsior, or coconut fiber

2. Be covered with photodegradable plastic netting, biodegradable jute, sisal, or coir fiber netting
3. Have netting secured tightly at each end
4. Be finished to be either:

    4.1. From 8 to 10 inches in diameter, from 10 to 20 feet long, and at least 1.1 pounds per linear foot
    4.2. From 10 to 12 inches in diameter, at least 10 feet long, and at least 3 pounds per linear foot

Wood Stakes

Wood stakes must be:

1. Untreated fir, redwood, cedar, or pine and cut from sound timber
2. Straight and free of loose or unsound knots and other defects which would render the stakes unfit for use
3. Pointed on the end to be driven into the ground

For fiber rolls, wood stakes must be at least:

1. 1" x 1" x 24" in size for Type 1 installation
2. 1" x 2" x 24" in size for Type 2 installation

Posts

Posts must be wood or metal.

Wood posts must be:

1. Untreated fir, redwood, cedar, or pine and cut from sound timber
2. Straight and free of loose or unsound knots and other defects that would render the stakes unfit for use
3. Pointed on the end to be driven into the ground
4. At least 2" x 2" in size, and 4 feet long

Metal posts must:

1. Be made of steel.
2. Have a "U," "T," "L," or other cross sectional shape that can resist failure from lateral loads.
3. Be pointed on the end to be driven into the ground.
4. Weigh at least 0.75-pound per foot.
5. Be at least 4 feet long.
6. Have a safety cap attached to the exposed end. The safety cap must be orange or red plastic and fit snugly to the metal post.

Silt Fence

Silt fence must be:

1. Constructed with silt fence fabric, posts, and fasteners
2. Prefabricated or assembled at the job site

Silt fence fabric must be attached to posts using these methods:

1. If prefabricated silt fence is used, posts must be inserted into sewn pockets
2. If assembled on the job site:

    2.1. If wood posts are used, fasteners must be staples or nails
    2.2. If steel posts are used, fasteners must be tie wires or locking plastic fasteners
    2.3. Spacing of the fasteners must be at least 8 inches

Gravel-filled Bags

Gravel-filled bags must:

1. Be made from fabric.
2. Have inside dimensions from 24 to 32 inches in length, and from 16 to 20 inches in width.
3. Have the opening bound to retain the gravel. The opening must be sewn with yarn, bound with wire, or secured with a closure device.
4. Weigh from 30 to 50 pounds when filled with gravel.

Gravel for gravel-filled bags must be:

1. From 3/8 to 3/4 inch in diameter
2. Clean and free from clay balls, organic matter, and other deleterious materials

Sediment Filter Bag

Sediment filter bag must:

1. Be made of fabric
2. Be sized to fit the catch basin or drainage inlet
3. Include a high-flow bypass

Sediment filter bag may include a metal frame. Sediment filter bags that do not have a metal frame and are deeper than 18 inches must:

1. Include lifting loops and dump straps
2. Include a restraint cord to keep the sides of the bag away from the walls of the catch basin

Foam Barriers

Foam barriers must:

1. Be filled with a urethane foam core
2. Have a geosynthetic fabric cover and flap
3. Have a triangular, circular, or square shaped cross section
4. Have a vertical height of at least 5 inches after installation

5. Have a horizontal flap of at least 8 inches in width
6. Have a length of at least 4 feet per unit
7. Have the ability to interlock separate units into a longer barrier so that water does not flow between the units
8. Be secured to:

    8.1. Pavement with 1-inch concrete nails with 1-inch washers and solvent-free adhesive
    8.2. Soil with 6-inch nails with 1-inch washers

Rigid Plastic Barriers

Rigid plastic barriers must:

1. Have an integrated filter
2. Have a formed outer jacket of perforated high density polyethylene (HDPE) or polyethylene terephthalate (PET)
3. Have a flattened tubular shaped cross section
4. Be made from virgin or recycled materials
5. Be free from biodegradable filler materials that degrade the physical or chemical characteristics of the finished filter core or outer jacket
6. Have a length of at least 4 feet per unit
7. Have the ability to interlock separate units into a longer barrier so that water does not flow between the units
8. Be secured to:

    8.1 Pavement with 1-inch concrete nails with 1-inch washers and solvent-free adhesive, with gravel-filled bags, or a combination
    8.2 Soil with 6-inch nails with 1-inch washers and wood stakes

9. Comply with the following properties:

Specification	Requirements
Grab tensile strength of outer jacket material, pounds/square inch, min. in each direction ASTM D 4632*	4000
Break strength of outer jacket, pounds/square inch ASTM D 4632*	1300
Permittivity of filter core, 1/sec., min. ASTM D 4491	0.38
Flow rate of filter core, gallons per minute per square foot, ASTM D 4491	100 min. 200 max.
Filter core aperture size, max., Average Opening Size (AOS), microns	425
Ultraviolet stability (outer jacket & filter core), percent tensile strength retained after 500 hours, min. ASTM D 4355 (xenon-arc lamp and water spray weathering method)	90

* or appropriate test method for specific polymer

If used at a curb inlet without a grate, rigid plastic barriers must:

1. Have a horizontal flap of at least 6 inches with an under-seal gasket to prevent underflows
2. Include a high-flow bypass

3. Have a vertical height of at least 7 inches after installation
4. Be sized to fit the catch basin or drainage inlet

If used at a grated catch basin without a curb inlet, rigid plastic barriers must:

1. Cover the grate by at least 2 inches on each side and have an under-seal gasket to prevent underflows
2. Include a high-flow bypass
3. Have a vertical height of at least 1.5 inches after installation
4. Be sized to fit the catch basin or drainage inlet

If used at a curb inlet with a grate, rigid plastic barriers must:

1. Have a horizontal flap that covers the grate by at least 2 inches on the 3 sides away from the curb opening and have an under-seal gasket to prevent underflows
2. Include a high-flow bypass
3. Have a vertical section that covers the curb opening by at least 5 inches after installation
4. Be sized to fit the catch basin or drainage inlet

If used as a linear sediment barrier, rigid plastic barriers:

1. Must have an installed height of at least 6 inches
2. May have a horizontal flap of at least 4 inches

Linear Sediment Barrier

Linear sediment barriers must consist of one or more of the following:

1. Silt fence
2. Gravel-filled bags
3. Fiber roll
4. Rigid plastic barrier
5. Foam barrier

Flexible Sediment Barrier

Flexible sediment barriers consist of one or more of the following:

1. Rigid plastic barrier
2. Foam barrier

CONSTRUCTION

For drainage inlet protection at drainage inlets in paved and unpaved areas:

1. Prevent ponded runoff from encroaching on the traveled way or overtopping the curb or dike. Use linear sediment barriers to redirect runoff and control ponding.
2. Clear the area around each drainage inlet of obstructions including rocks, clods, and debris greater than one inch in diameter before installing the drainage inlet protection.
3. Install a linear sediment barrier up-slope of the existing drainage inlet and parallel with the curb, dike, or flow line to prevent sediment from entering the drainage inlet.

Erosion Control Blanket

To install erosion control blanket and geosynthetic fabric:

1. Secure blanket or fabric to the surface of the excavated sediment trap with staples and embed in a trench adjacent to the drainage inlet
2. Anchor the perimeter edge of the erosion control blanket in a trench

Silt Fence

If silt fence is used as a linear sediment barrier:

1. Place fence along the perimeter of the erosion control blanket, with the posts facing the drainage inlet
2. Install fence with the bottom edge of the silt fence fabric in a trench. Backfill the trench with soil and compact manually

Gravel Bag Berm

If gravel bag berm is used as a linear sediment barrier:

1. Place gravel-filled bags end-to-end to eliminate gaps
2. Stack bags in a way that the bags in the top row overlap the joints in the lower row

If gravel bag berms are used for Type 3A and Type 3B:

1. Place gravel-filled bags end-to-end to eliminate gaps
2. Stack bags in a way that the bags in the top row overlap the joints in the lower row
3. Arrange bags to create a spillway by removing one or more gravel-filled bags from the upper layer

If used within shoulder area, place gravel-filled bags behind temporary railing (Type K).

Fiber Rolls

If fiber rolls are used as a linear sediment barrier:

1. Place fiber rolls in a furrow.
2. Secure fiber rolls with stakes installed along the length of the fiber rolls. Stakes must be installed from 6 to 12 inches from the end of the rolls.

If fiber rolls are used as a linear sediment barrier for Type 4A, place them over the erosion control blanket.

Foam Barriers

If foam barriers are used as a linear sediment barrier:

1. Install barriers with the horizontal flap in a 3 inch deep trench and secured with nails and washers placed no more than 4 feet apart
2. Secure barriers with 2 nails at the connection points where separate units overlap
3. Place barriers without nails or stakes piercing the core

Flexible Sediment Barriers

If flexible sediment barriers are used:

1. Secure barriers to the pavement with nails and adhesive, gravel-filled bags, or a combination
2. Install barriers flush against the sides of concrete, asphalt concrete, or hot mix asphalt curbs or dikes
3. Place barriers to provide a tight joint with the curb or dike and anchored in a way that runoff cannot flow behind the barrier

If flexible sediment barriers are used for Type 4B:

1. Secure barriers to the pavement according to the angle and spacing shown on the plans
2. Place barriers to provide a tight joint with the curb or dike. Cut the cover fabric or jacket to ensure a tight fit

Rigid Sediment Barriers

If rigid sediment barriers are used at a grated catch basin without a curb inlet:

1. Place barriers using the gasket to prevent runoff from flowing under the barrier
2. Secure barriers to the pavement with nails and adhesive, gravel-filled bags, or a combination

If rigid sediment barriers are used for linear sediment barriers:

1. Install barriers in a trench. Backfill the trench with soil and compact manually
2. Place barrier with separate units overlapping at least 4 inches
3. Reinforce barriers with a wood stake at each overlap
4. Fasten barriers to the wood stakes with steel screws, 16 gauge galvanized steel wire, or with UV stabilized cable ties that are from 5 to 7 inches in length

Sediment Filter Bags

Install sediment filter bags for Type 5 by:

1. Removing the drainage inlet grate
2. Placing the sediment bag in the opening
3. Replacing the grate to secure the sediment filter bag in place

MAINTENANCE

Maintain temporary drainage inlet protection to provide sediment holding capacity and to reduce runoff velocities.

Remove sediment deposits, trash, and debris from temporary drainage inlet protection as needed or when directed by the Engineer. If removed sediment is deposited within project limits, it must be stabilized and not subject to erosion by wind or water. Trash and debris must be removed and disposed of as specified in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Maintain temporary drainage inlet protection by removing sediment from:

1. Behind flexible sediment barriers when sediment exceeds 1 inch in depth
2. Surface of the erosion control blanket when sediment exceeds 1 inch in depth
3. Sediment trap for Type 2 when the volume has been reduced by approximately one-half
4. Behind silt fence when the sediment is 1/3 the height of the silt fence fabric above ground
5. Sediment filter bags when filled or when the restraint cords are no longer visible

If rills and other evidence of concentrated runoff occur beneath the linear sediment barrier, repair or adjust the barrier.

If silt fence fabric becomes split, torn, or unraveled, repair or replace silt fence.

If geosynthetic fabric becomes split, torn, or unraveled, repair or replace foam barriers.

Repair or replace sagging or slumping linear sediment barriers with additional stakes. Replace broken or split wood stakes.

Reattach foam barriers and rigid plastic barriers that become detached or dislodged from the pavement.

Repair split or torn rigid plastic barriers with 16 gauge galvanized steel wire or UV stabilized cable ties that are from 5 to 7 inches in length.

For sediment filter bags without metal frames, empty by placing one inch steel reinforcing bars through the lifting loops and then lift the filled bag from the drainage inlet. For sediment filter bags with metal frames, empty by lifting the metal frame from the drainage inlet. Rinse before replacing in the drainage inlet. When rinsing the sediment filter bags, do not allow the rinse water to enter a drain inlet or waterway.

Repair temporary drainage inlet protection within 24 hours of discovering damage unless the Engineer approves a longer period.

If your vehicles, equipment, or activities disturb or displace temporary drainage inlet protection, repair temporary drainage inlet protection at your expense.

The Department does not pay maintenance costs for cleanup, repair, removal, disposal, or replacement due to improper installation or your negligence.

REMOVAL

When the Engineer determines that the temporary drainage inlet protection is not required, it must be removed and disposed of under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Ground disturbance, including holes and depressions, caused by the installation and removal of the temporary drainage inlet protection must be backfilled and repaired under Section 15-1.02, "Preservation of Property," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Quantities of temporary drainage inlet protection will be determined from actual count in place. The protection will be measured one time only and no additional measurement will be recognized.

The contract unit price paid for temporary drainage inlet protection includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the temporary drainage inlet protection, complete in place, including removal of materials, cleanup and disposal of retained sediment and debris, and backfilling and repairing holes, depressions and other ground disturbance, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

No additional compensation will be made if the temporary drainage inlet protection is relocated during the course of construction.

The State and you share the cost of maintaining the temporary drainage inlet protection. The State determines the maintenance cost under Section 9-1.03, "Force Account Payment," of the Standard Specifications and pays you one-half of that cost.

10-1.__ DISPOSAL OF PORTLAND CEMENT CONCRETE (PCC) PAVEMENT GROOVING AND GRINDING RESIDUES

Disposal of portland cement concrete (PCC) pavement grooving and grinding residues shall be in conformance with the provisions in Section 42, "Groove and Grind Pavement," of the Standard Specifications and these special provisions.

The Contractor shall include water pollution control measures to address the handling of the grinding pavement residue within the Storm Water Pollution Prevention Plan or Water Pollution Control Program, as specified in "Water Pollution Control" of these special provisions.

Temporary storage of PCC pavement grooving and grinding residues shall not be allowed within the highway right of way. The Contractor may transport liquid PCC pavement grooving and grinding residues to an offsite drying location if the Engineer provides written approval. The offsite drying location shall be identified and protected in conformance with "Water Pollution Control" of these special provisions.

Temporary storage locations shown on the plans for PCC pavement grooving and grinding residues within the highway right of way may be used to dry the material before disposal outside the highway right of way. Temporary storage facilities for PCC pavement grooving and grinding residues shall be in conformance with WM-8, Concrete Waste Management in the Construction Site BMPs Manual or "Temporary Concrete Washout Facility" of these special provisions.

A Materials Information Handout is not available for disposal of PCC pavement grooving or grinding residues. The Contractor shall dispose of PCC pavement grooving and grinding residues in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside of the Right of Way," of the Standard Specifications. The facilities listed below were permitted by Regional Water Quality Control Board (RWQCB) or other agencies that may accept PCC pavement grinding and grooving residues as of July 1, 2004. If the Contractor is planning to use one of these sites, the Contractor shall determine if the facility has a current permit to accept PCC pavement grooving and grinding residues and if the facility can accept the waste at the time of generation.

Site Name	Location	Telephone	Waste Types / Restrictions
Clean Harbors Environmental Services Buttonwillow	2500 West Lokern Road Buttonwillow, CA	(562) 432-5445	Hazardous Solids and Non-Hazardous Liquids and Solids
Clean Harbors Environmental Services San Jose	1021 Berryessa San Jose, CA	(408) 451-5000	Hazardous and Non-Hazardous Liquids
Crosby & Overton, Inc.	1610 W. 17th Street Long Beach, CA	(562) 432-5445	Hazardous and Non-Hazardous Liquids
D/K Environmental	3650 East 26th Street Vernon, CA	(323) 268-5056	Hazardous and Non-Hazardous Liquids and Solids
DeMenno-Kerdoon	200 N. Alameda Street Compton, CA	(323) 268-5057 (310) 537-7100	Hazardous and Non-Hazardous Liquids and Solids
Filter Recycling Services, Inc.	180 West Monte Avenue Rialto, CA	(909) 424-1630	Hazardous and Non-Hazardous Liquids
K-Pure Water Works	8910 Rochester Ave Rancho Cucamonga, CA	(909) 476-2308	Non-Hazardous Liquids
Liquid Waste Management McKittrick	56533 Highway 58 McKittrick, CA	(559) 386-6104	Non-Hazardous Liquids and Solids
Onyx Environmental Services LLC	1704 W. First Street Azusa, CA	(626) 334-5117	Hazardous and Non-Hazardous Liquids and Solids
Phibro-Tech, Inc.	8851 Dice Road Santa Fe Springs, CA	(562) 698-8036	Hazardous and Non-Hazardous Liquids and Solids
Romic Environmental Technologies Corporation	2081 Bay Road East Palo Alto, CA	(650) 324-1638	Hazardous and Non-Hazardous Liquids
Seaport Environmental	700 Seaport Boulevard Redwood City, CA	(650) 364-8154	Non-Hazardous Liquids
Southwest Treatment Systems, Inc.	4120 Bandini Boulevard Los Angeles, CA	(800) 900-3366	Non-Hazardous Liquids
US Filter Recovery Services, Inc.	5375 S. Boyle Avenue Vernon, CA	(323) 277-1495	Hazardous and Non-Hazardous Liquids and Solids
Waste Management Kettleman City	35251 Old Skyline Road Kettleman City, CA	(559) 386-6104	Hazardous and Non-Hazardous Liquids and Solids

If the Contractor disposes of PCC pavement grooving and grinding residues at locations not listed above, the disposal shall be in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications, and the following:

A. If the disposal facility is located within the State of California, the facility must be permitted by the RWQCB or other applicable agency, or the Contractor must obtain written approval from the RWQCB or other applicable agency.
B. If located outside of the State of California, the facility must be permitted by the applicable local, state, or federal agencies, or the Contractor must obtain written approval from the applicable local, state, or federal agencies.

The following shall be delivered to the Engineer at least 5 days before disposal of PCC pavement grooving and grinding residues:

A. The name, address, and telephone number of the disposal facility.
B. If the facility is not listed above:

1. Copy of the facility's RWQCB or other applicable agency permit, or

2. RWQCB's or other applicable agency's approval, or
3. Copy of the applicable agency permit if the final disposal location is located outside of the State of California.

The Contractor shall deliver landfill receipts and weight ticket of disposal of residues from PCC pavement grooving and grinding to the Engineer within 5 days of completing of PCC pavement grooving and grinding activities.

The Contractor shall make all arrangements and agreements for the disposal at the time of bidding. Costs related to obtaining approval for disposal within the State of California from the RWQCB or other applicable agency, or the applicable agency if the disposal location is located outside of the State of California, shall be borne by the Contractor and no additional payment shall be made therefore. Full compensation for all costs involved in disposing of PCC pavement grooving or grinding residues as specified in this section, including all costs of handling, temporary storage, hauling and disposal fees, shall be considered as included in the price paid for the contract item of work involving PCC pavement grooving or grinding residues and no additional compensation will be allowed therefore.

Attachment C

Amendments

SWPPP Amendment No. _____

Project Name:

Caltrans Contract Number: _____

To Be Completed by Contractor

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Contractor's Signature	Date
Contractor's Name and Title	Contractor's Telephone Number

For Use When Local Agency / Private Entity is Administering Project

For Local Agency / Private Entity Use Only
Resident Engineer's Approval and
Local Agency / Private Entity Certification of the
Stormwater Pollution Prevention Plan
or Water Pollution Control Plan
Amendment

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Resident Engineer's Signature	Date
Resident Engineer's Name	Resident Engineer's Telephone Number

For Caltrans Use Only
Caltrans Oversight Engineer's Approval and
Caltrans Certification of the
Stormwater Pollution Prevention Plan Amendment

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Oversight Engineer's Signature	Date
Oversight Engineer's Name	Oversight Engineer's Telephone Number

Contract 4 CSWPPP - Attachment D

Run-Off Coefficient Weighted Average

A. Existing

Total construction area =	47.2	acres
Existing pavement =	32.0	acres
Existing pervious =	15.2	acres
Runoff coefficient paved =	0.95	
Runoff coefficient unpaved =	0.44	

C=((32.0*0.95)+(15.2*0.44))/47.2 = **0.79**

B. Proposed

Total construction area =	47.2	acres
Impervious area @ completion =	34.4	acres
final pervious area =	12.8	acres
Runoff coefficient paved =	0.95	
Runoff coefficient unpaved =	0.44	

C=((34.4*0.95)+(12.8*0.44))/47.2 = **0.81**

ATTACHMENT E

Storm Water Flow Calculation

Q: Water Quality Flow, cu ft/sec
i: rainfall intensity for region 2-SF Bay, 2 in/hr
A: Total Costruction Site Area, 47.2 Acre
C: average runoff coefficiant at construction completion, 0.70 (see attachment D)

$$Q=C*I*A = 0.70*0.2*47.2 = 6.61 \text{ cu ft/sec}$$

Q: Water Quality Flow, cu ft/sec
i: 1.86 in/hr (rainfall intensity value (10-yr, 15-minute)
A: run-on area
Coefficient of runoff: 0.44 (Unpaved Area from Storm Drainage Report, Section 2.1.3)

	Area (ft2)	Area (ac)	C	i	Q-CiA
A1	1,313	0.030142	0.44	1.86	0.02
A2	7,221	0.165771	0.44	1.86	0.14
A3	47,082	1.080854	0.44	1.86	0.88
A4		0	0.44	1.86	0.00
A5		0	0.44	1.86	0.00
A6		0	0.44	1.86	0.00

Attachment F

Notice of Construction (NOC) / Notice of Intent (NOI)

Attachment G

Maintenance, Inspection, and Repair of Construction Site BMPs

SWPPP Inspection, Maintenance and Repair Program			
BEST MANAGEMENT PRACTICES (BMPs)	INSPECTION FREQUENCY		MAINTENANCE/REPAIR PROGRAM
	Rainy	Non-Rainy	
TEMPORARY SOIL STABILIZATION BMPs			
			■ ■
			■ ■
TEMPORARY SEDIMENT CONTROL BMPs			
			■ ■ ■ ■ ■
			■ ■ ■ ■ ■
WIND EROSION CONTROL BMPs			
TRACKING CONTROL BMPs			
			■ ■
NON-STORM WATER MANAGEMENT BMPs			
			■ ■ ■ ■ ■ ■

SAMPLE

Attachment G
Sample Maintenance, Inspection and Repair of Construction Site BMPs

SWPPP Inspection, Maintenance and Repair Program			
BEST MANAGEMENT PRACTICES (BMPs)	**INSPECTION FREQUENCY**		**MAINTENANCE/REPAIR PROGRAM**
	Rainy	**Non-Rainy**	
WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL BMPs			
			■ ■ ■ ■ ■ ■
			■ ■ ■ ■ ■ ■

Site inspections shall be conducted by the Contractor's WPCM or other Caltrans approved 24-hour trained staff at the following minimum frequencies:

- Prior to a forecast storm;
- After a rain event that causes runoff from the construction site;
- At 24-hour intervals during extended rain events;
- Daily inspections within the Lake Tahoe Hydrologic Unit;
- Weekly during the rainy season;
- Every 2 weeks during the non-rainy season; and
- At any other time(s) or intervals of time specified in the Contract Special Provisions.

Completed inspection checklists shall be submitted to the Resident Engineer within 24 hours of inspection. Copies of the completed checklists will be kept with the SWPPP. A tracking or follow-up procedure shall follow any inspection that identifies deficiencies in BMPs.

SAMPLE

Attachment H

Stormwater Quality Construction Site Inspection Checklist

GENERAL INFORMATION				
Project Name				
Caltrans Contract No.				
Contractor				
Inspector's Name				
Inspector's Title				
Signature				
Date of Inspection				
Inspection Type (Check Applicable)	☐ Prior to forecast rain		☐ After a rain event	
	☐ 24-hr intervals during extended rain		☐ Other _____	
Season (Check Applicable)	☐ Rainy		☐ Non-Rainy	
Storm Data	Storm Start Date & Time:		Storm Duration (hrs):	
	Time elapsed since last storm (Circle Applicable Units)	Min. Hr. Days	Approximate Rainfall Amount (mm)	

PROJECT AREA SUMMARY AND DISTURBED SOIL AREA (DSA) SIZE LIMITS FROM SPECIAL PROVISIONS				
Total Project Area	_____	Hectares	_____	Acres
Rainy Season DSA Limit	_____	Hectares	_____	Acres
Field Estimate of Non-Active DSAs	_____	Hectares	_____	Acres
Field Estimate of Active DSAs	_____	Hectares	_____	Acres

OTHER REQUIREMENTS				
Requirement	**Yes**	**No**	**N/A**	**Corrective Action**
Preservation of Existing Vegetation				
Is temporary fencing provided to preserve vegetation in areas where no construction activity is planned?				
Location:				
Location:				
Location:				
Location:				
Temporary Soil Stabilization				
Does the applied temporary soil stabilization provide 100% coverage for the required areas?				
Are any non-vegetated areas that may require temporary soil stabilization?				
Is the area where temporary soil stabilization required free from visible erosion?				
Location:				
Location:				
Location:				
Location:				
Temporary Linear Sediment Barriers				
Are temporary linear sediment barriers properly installed in accordance with the details, functional and maintained?				
Are temporary linear sediment barriers free of accumulated litter?				
Is the built-up sediment less than 1/3 the height of the barrier?				
Are cross barriers installed where necessary and properly spaced?				
Are fiber rolls installed and maintained on required slopes in accordance with the details, functional and maintained?				
Location:				
Location:				
Location:				
Location:				
Location:				
Storm Drain Inlet Protection				
Are storm drain inlets internal to the project properly protected with either Type 1, 2 or 3 inlet protection?				
Are storm drain inlet protection devices in working order and being properly maintained?				
Location:				
Location:				
Location:				
Location:				

OTHER REQUIREMENTS				
Requirement	**Yes**	**No**	**N/A**	**Corrective Action**
Location:				
Desilting Basins				
Are basins maintained to provide the required retention/detention?				
Are basin controls (inlets, outlets, diversions, weirs, spillways, and racks) in working order?				
Location:				
Location:				
Location:				
Location:				
Stockpiles				
Are all locations of temporary stockpiles, including soil, hazardous waste, and construction materials in approved areas?				
Are stockpiles protected from run-on, run-off from adjacent areas and from winds?				
Are stockpiles located at least 50 ft from concentrated flows, downstream drainage courses and storm drain inlets?				
Are required covers and/or perimeter controls in place?				
Location:				
Location:				
Location:				
Location:				
Concentrated Flows				
Are concentrated flow paths free of visible erosion?				
Location:				
Location:				
Location:				
Location:				
Tracking Control				
Are points of ingress/egress to public/private roads inspected, swept, and vacuumed daily?				
Are all paved areas free of visible sediment tracking or other particulate matter?				
Is rock at Temporary Construction Entrance(s) 12-inches or more in thickness?				
Does sediment need to be removed from the rock, or does the rock need to be replaced?				
For Type 2 Construction Entrance, does sediment need to be removed from ribbed plates?				
Location:				
Location:				
Location:				

OTHER REQUIREMENTS				
Requirement	Yes	No	N/A	Corrective Action
Location:				
Wind Erosion Control				
Is dust control implemented in conformance with Section 10 of the Standard Specifications?				
Location:				
Location:				
Location:				
Location:				
Dewatering Operations				
Is dewatering handled in conformance with the dewatering permit issued by the RWQCB?				
Is required treatment provided for dewatering effluent?				
Location:				
Location:				
Location:				
Location:				
Vehicle & Equipment Fueling, Cleaning, and Maintenance				
Are vehicle and equipment fueling, cleaning and maintenance areas reasonably clean and free of spills, leaks, or any other deleterious material?				
Are vehicle and equipment fueling, cleaning and maintenance activities performed on an impermeable surface in dedicated areas?				
If no, are drip pans used?				
Are dedicated fueling, cleaning, and maintenance areas located at least 15 m away from downstream drainage facilities and watercourses, and protected from run-on and runoff?				
Is wash water contained for infiltration/ evaporation and disposed of outside the highway right of way?				
Is on-site cleaning limited to washing with water (no soap, soaps substitutes, solvents, or steam)?				
On each day of use, are vehicles and equipment inspected for leaks and if necessary, repaired?				
Location:				
Location:				
Location:				
Location:				
Waste Management & Materials Pollution Control				
Are material storage areas and washout areas protected from run-on and runoff, and located at least 50 ft from concentrated flows and downstream drainage facilities?				
Are all material handling and storage areas clean; organized; free of spills, leaks, or any other deleterious material; and stocked with appropriate clean-up supplies?				

OTHER REQUIREMENTS				
Requirement	Yes	No	N/A	Corrective Action
Are liquid materials, hazardous materials, and hazardous wastes stored in temporary containment facilities?				
Are bagged and boxed materials stored on pallets?				
Are hazardous materials and wastes stored in appropriate, labeled containers?				
Are proper storage, clean-up, and spill-reporting procedures for hazardous materials and wastes posted in open, conspicuous and accessible locations adjacent to storage areas?				
Are temporary containment facilities free of spills and rainwater?				
Are temporary containment facilities and bagged/boxed materials covered?				
Are temporary concrete washout facilities designated and being used?				
Are temporary concrete washout facilities functional for receiving and containing concrete waste and are concrete residues prevented from entering the drainage system?				
Do temporary concrete washout facilities provide sufficient volume and freeboard for planned concrete operations?				
Are the temporary concrete washout facilities' PVC liners free from punctures and holes?				
Are concrete wastes, including residues from cutting and grinding, contained and disposed of off-site or in concrete washout facilities?				
Are spills from mobile equipment fueling and maintenance properly contained and cleaned up?				
Is the site free of litter?				
Are trash receptacles provided in the Contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods?				
Is litter from work areas within the construction limits of the project site collected and placed in watertight dumpsters?				
Are waste management receptacles free of leaks?				
Are the contents of waste management receptacles properly protected from contact with storm water or from being dislodged by winds?				
Are waste management receptacles filled at or beyond capacity?				
Location:				
Location:				
Location:				
Location:				
Temporary Water Body Crossing or Encroachment				
Are temporary water body crossings and encroachments constructed as shown on the plans or as approved by the engineer?				
Does the project conform to the requirements of the 404 permit and/or 1601agreement?				
Location:				
Location:				
Location:				

OTHER REQUIREMENTS				
Requirement	**Yes**	**No**	**N/A**	**Corrective Action**
Location:				
Illicit Connection/Illegal Discharge Detection and Reporting				
Is there any evidence of illicit discharges or illegal dumping on the project site?				
If yes, has the Engineer been notified?				
Location:				
Location:				
Location:				
Location:				
Discharge Points				
Are discharge points and discharge flows free from noticeable pollutants?				
Are discharge points free of any significant erosion or sediment transport?				
Location:				
Location:				
Location:				
Location:				
WPCP/SWPPP Update				
Do the WPCP/SWPPP, Project Schedule/Water Pollution Control Schedule and WPCDs adequately reflect the current site conditions and contractor operations?				
Are all BMPs shown on the WPCDs installed in the proper location(s) and according to the details for the plan?				
Location:				
Location:				
Location:				
Location:				
General				
Are there any other potential water pollution control concerns at the site?				
Location:				
Location:				
Location:				
Location:				
Storm Water Monitoring				
Does storm water discharge directly to an water body listed as impaired for sediment/sedimentation or turbidity in the General Construction Activity Permit?				
If yes, were samples for sediment/sedimentation or turbidity collected pursuant to the sampling and analysis plan, if required, during rain events?				

OTHER REQUIREMENTS				
Requirement	**Yes**	**No**	**N/A**	**Corrective Action**
Were there any BMPs not properly implemented, or breaches, malfunctions, leakages or spills observed, which could result in the discharge of pollutants to surface waters that would not be visually detectable in storm water?				
If yes, were samples for non-visually detectable pollutants collected pursuant to the sampling and analysis plan during rain events?				
Were soil amendments (e.g., gypsum) used on the project?				
If yes, were samples for non-visually detectable pollutants collected pursuant to the sampling and analysis plan during rain events?				
Did storm water contact stored materials or waste and resulted in a discharge from the construction site? (Materials not in watertight containers, etc.)				
If yes, were samples for non-visually detectable pollutants collected pursuant to the sampling and analysis plan during rain events?				

Attachment I

Trained Contractor Personnel Log

Stormwater Management Training Log

Project Name: _____

Caltrans Contract Number: _____

Storm Water Management Topic: (check as appropriate)

- ☐ Temporary Soil Stabilization
- ☐ Temporary Sediment Control
- ☐ Wind Erosion Control
- ☐ Tracking Control
- ☐ Non-storm water management
- ☐ Waste Management and Materials Pollution Control
- ☐ Storm Water Sampling

Specific Training Objective: _____

Location: _____ Date: _____

Instructor: _____ Telephone: _____

Course Length (hours): _____

Attendee Roster (attach additional forms if necessary)

Name	Company	Phone

Attachment I
Trained Contractor Personnel Log Sheet

Name	Company	Phone

COMMENTS:

Attachment J

Subcontractor Notification Letter (Sample) and Notification Log

SWPPP Notification

ABC Construction Inc,
123 Sunset Blvd., Suite 456
Hollywood, CA 90000

Dear Sir/Madam,

Please be advised that the California State Water Resources Control Board has adopted the NPDES Statewide Storm Water Permit (Permit) to the State of California, Department of Transportation (Caltrans) in 1999 (CAS000003, Order No. 99-06-DWQ); and the General Permit (General Permit) for Storm Water Discharges Associated with Construction Activity (CAS000002, Order No. 99-08-DWQ), and modifications thereto. The goal of these permits is prevent the discharge of pollutants associated with construction activity from entering the storm drain system, ground and surface waters.

[Contractor] has developed a Storm Water Pollution Prevention Plan (SWPPP) in order to implement the requirements of the Permits.

As a subcontractor, you are required to comply with the SWPPP and the Permits for any work that you perform on site. Any person or group who violates any condition of the Permits may be subject to substantial penalties in accordance with state and federal law. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP and the Permits. A copy of the Permits and the SWPPP are available for your review at the construction office. Please contact me if you have further questions.

SAMPLE

Sincerely,

John Doe
Project Superintendent

SUBCONTRACTOR NOTIFICATION LOG

Project Name: _____

Caltrans Contract Number: _____

SUBCONTRACTOR COMPANY NAME	CONTACT NAME	ADDRESS	PHONE NUMBER	PAGER/ FIELD PHONE	DATE NOTIFICATION LETTER SENT	TYPE OF WORK

USE ADDITIONAL PAGES AS NECESSARY

Attachment K

Notice of Discharge

INSTRUCTIONS

- This form be will used to report instances of discharges. The completed form will be submitted to the Resident Engineer within 7 days (3 days for Districts 7 and 11), or as specified by the Special Provisions, of the assessment of discharge, written notice or orders from a regulatory agency.
- Submit photographs (before and after the discharge) with this report.

To: Name of Caltrans Resident Engineer Date: Insert Date

Subject: Notice of Discharge

Project Name: Insert Project Name

Caltrans Contract Number: contract number

In accordance with the Caltrans NPDES Statewide Permit for Storm Water Discharges Associated with Construction Activity, the following instance of discharge is noted:

Date, time, and location of discharge

Insert description and date of event

Nature of the operation that caused the discharge

Insert description of operation

Initial assessment of any impact caused by the discharge

Insert assessment

Existing BMP(s) in place prior to discharge event

List BMPs in place

Date of deployment and type of BMPs deployed after the discharge.

BMPs deployed after the discharge (with dates)

Steps taken or planned to reduce, eliminate and/or prevent recurrence of the discharge

Insert steps taken to prevent recurrence

Implementation and maintenance schedule for any affected BMPs

Insert implementation and maintenance schedule

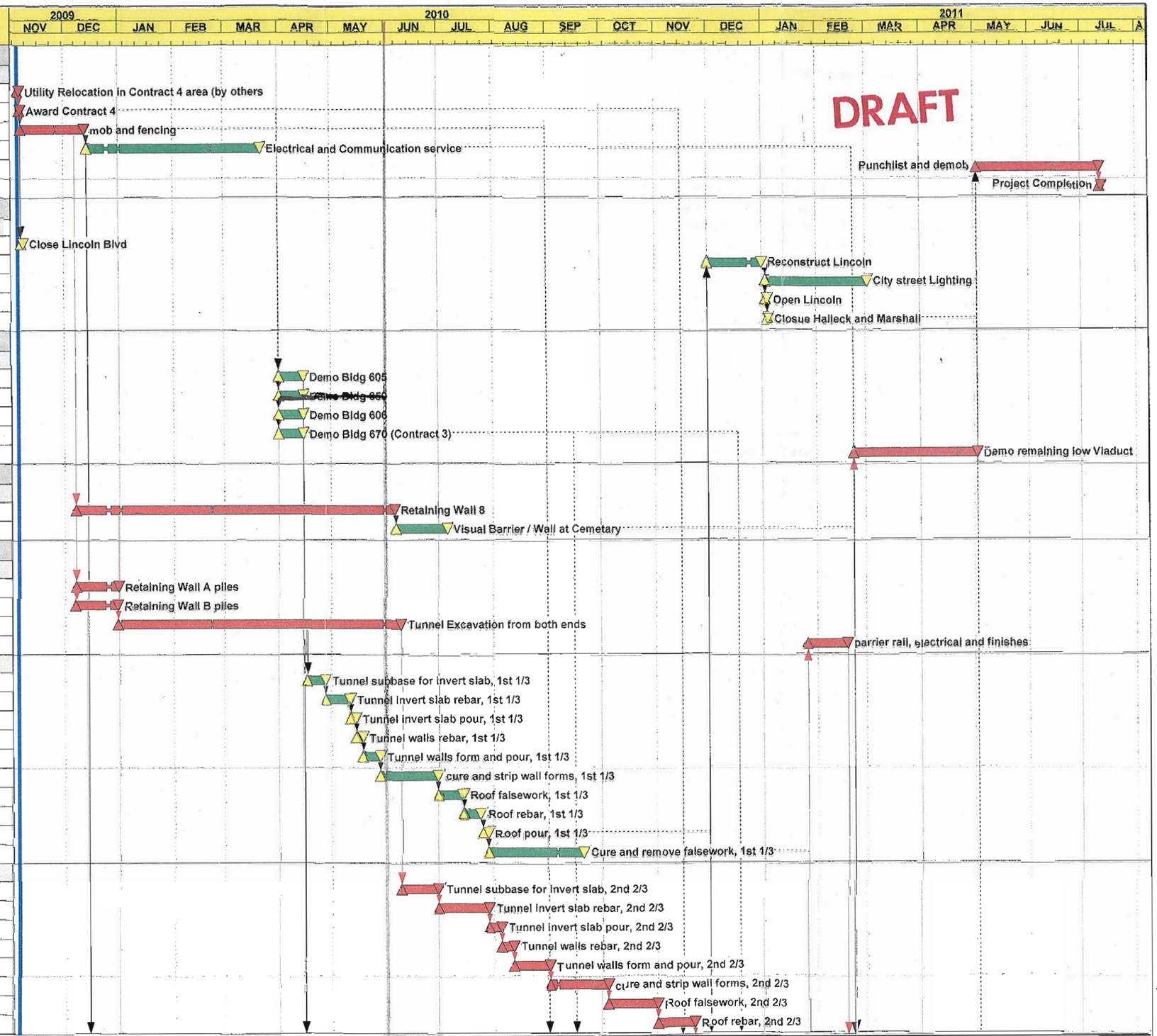
If further information or a modification to the above schedule is required, notify the contact person below.

Name of Contact Person	Title
Company	Telephone Number
Signature	Date

ATTACHMENT L

CONSTRUCTION SCHEDULE

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
General				
General				
10	Utility Relocation in Contract 4 area (by others	1	05NOV09	05NOV09
20	Award Contract 4	1	06NOV09	06NOV09
30	mob and fencing	30	07NOV09	12DEC09
180	Electrical and Communication service	80	14DEC09	22MAR10
1480	Punchlist and demob	60	03MAY11	11JUL11
1490	Project Completion	1	12JUL11	12JUL11
Lincoln Blvd				
Lincoln Blvd				
40	Close Lincoln Blvd	1	07NOV09	07NOV09
240	Reconstruct Lincoln	25	01DEC10	31DEC10
170	City street Lighting	50	03JAN11	01MAR11
250	Open Lincoln	1	03JAN11	03JAN11
260	Closue Halleck and Marshall	1	04JAN11	04JAN11
Demolition				
Demolition				
50	Demo Bldg 605	12	01APR10*	14APR10
60	Demo Bldg 650	12	01APR10*	14APR10
70	Demo Bldg 606	12	01APR10*	14APR10
80	Demo Bldg 670 (Contract 3)	12	01APR10*	14APR10
280	Demo remaining low Viaduct	60	22FEB11	02MAY11
Retaining Wall 8				
Retaining wall 8				
290	Retaining Wall 8	150	07DEC09	05JUN10
200	Visual Barrier / Wall at Cemetary	25	07JUN10	05JUL10
Tunnel				
Tunnel				
300	Retaining Wall A piles	18	07DEC09	30DEC09
310	Retaining Wall B piles	18	07DEC09	30DEC09
320	Tunnel Excavation from both ends	135	31DEC09	09JUN10
1430	barrier rail, electrical and finishes	20	26JAN11	17FEB11
1st 1/3 of Tunnel				
330	Tunnel subbase for invert slab, 1st 1/3	9	17APR10	27APR10
340	Tunnel invert slab rebar, 1st 1/3	12	28APR10	11MAY10
350	Tunnel invert slab pour, 1st 1/3	3	12MAY10	14MAY10
360	Tunnel walls rebar, 1st 1/3	3	15MAY10	18MAY10
370	Tunnel walls form and pour, 1st 1/3	9	19MAY10	28MAY10
380	cure and strip wall forms, 1st 1/3	27	29MAY10	30JUN10
390	Roof falsework, 1st 1/3	12	01JUL10	14JUL10
400	Roof rebar, 1st 1/3	9	15JUL10	24JUL10
410	Roof pour, 1st 1/3	3	26JUL10	28JUL10
420	Cure and remove falsework, 1st 1/3	45	29JUL10	20SEP10
2nd 2/3 of Tunnel				
1330	Tunnel subbase for invert slab, 2nd 2/3	18	10JUN10	30JUN10
1340	Tunnel invert slab rebar, 2nd 2/3	24	01JUL10	28JUL10
1350	Tunnel invert slab pour, 2nd 2/3	6	29JUL10	04AUG10
1360	Tunnel walls rebar, 2nd 2/3	6	05AUG10	11AUG10
1370	Tunnel walls form and pour, 2nd 2/3	18	12AUG10	01SEP10
1380	cure and strip wall forms, 2nd 2/3	27	02SEP10	04OCT10
1390	Roof falsework, 2nd 2/3	24	05OCT10	01NOV10
1400	Roof rebar, 2nd 2/3	18	02NOV10	22NOV10



Start Date	05NOV09
Finish Date	12JUL11
Data Date	05NOV09
Run Date	27JUL09 09:32

Early Bar
Progress Bar
Critical Activity

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CON4

Sheet 1 of 2

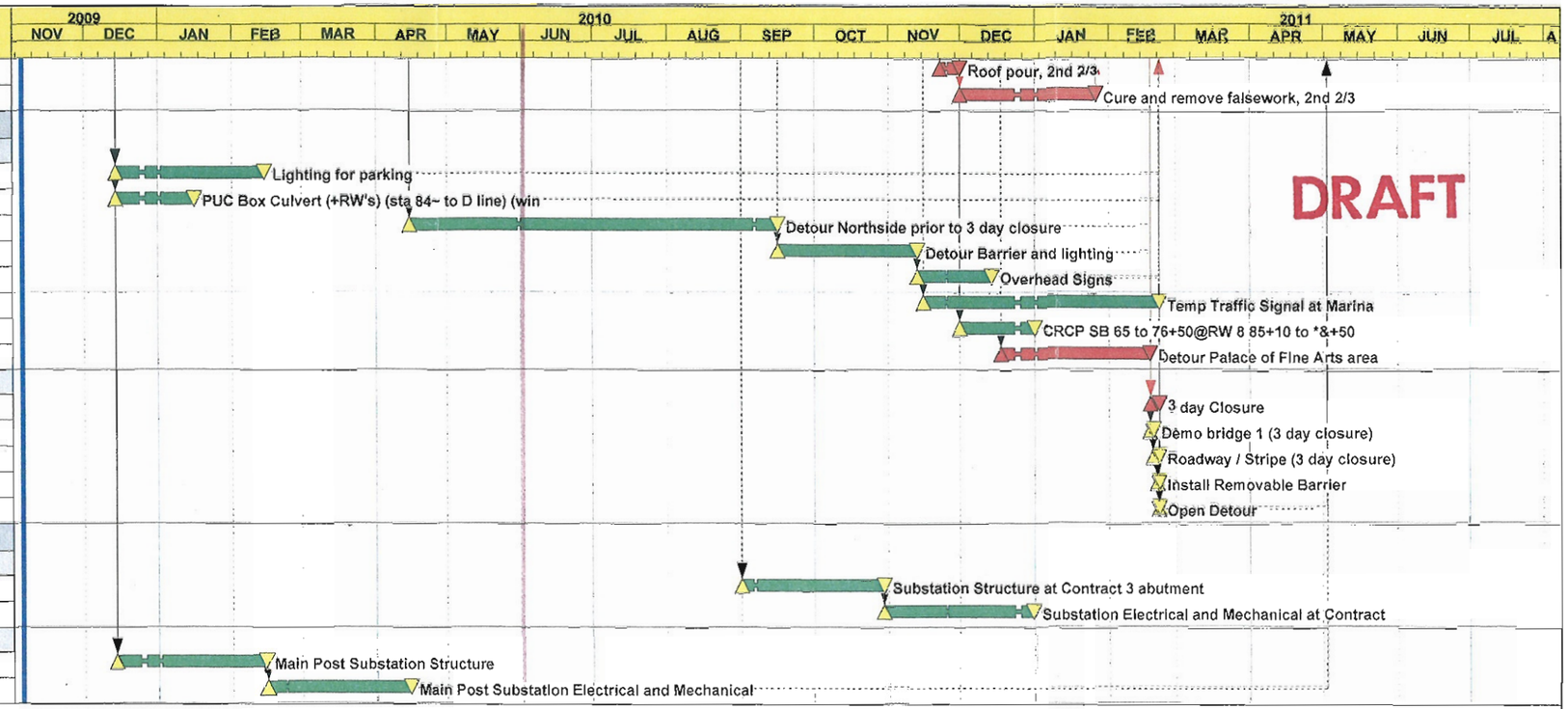
Caltrans District 4 Construction

Contract 4

Classic Schedule Layout

Date	Revision	Checked	Approved

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
1410	Roof pour, 2nd 2/3	6	23NOV10	30NOV10
1420	Cure and remove falsework, 2nd 2/3	45	01DEC10	25JAN11
Detour				
Detour prior to Closure				
190	Lighting for parking	50	14DEC09	13FEB10
270	PUC Box Culvert (+RW's) (sta 84~ to D line) (win	25	14DEC09	15JAN10
90	Detour Northside prior to 3 day closure	130	15APR10	15SEP10
110	Detour Barrier and lighting	50	16SEP10	12NOV10
210	Overhead Signs	25	13NOV10	13DEC10
160	Temp Traffic Signal at Marina	80	16NOV10	21FEB11
220	CRCP SB 65 to 76+50@RW 8 85+10 to *&+50	25	01DEC10	31DEC10
100	Detour Palace of Fine Arts area	50	18DEC10	17FEB11
Detour During Closure				
120	3 day Closure	3	18FEB11	21FEB11
130	Demo bridge 1 (3 day closure)	1	18FEB11	18FEB11
140	Roadway / Stripe (3 day closure)	2	19FEB11	21FEB11
230	Install Removable Barrier	1	21FEB11	21FEB11
150	Open Detour	0	22FEB11	21FEB11
Substations				
Substation at Contract 3 Abutment				
1440	Substation Structure at Contract 3 abutment	50	01SEP10*	29OCT10
1460	Substation Electrical and Mechanical at Contract	50	30OCT10	30DEC10
Main Post Substation				
1450	Main Post Substation Structure	50	14DEC09	13FEB10
1470	Main Post Substation Electrical and Mechanical	50	15FEB10	14APR10



DRAFT

Start Date	05NOV09
Finish Date	12JUL11
Data Date	05NOV09
Run Date	27JUL09 09:32

Early Bar
Progress Bar
Critical Activity

© Primavera Systems, Inc.

CON4

Caltrans District 4 Construction

Contract 4

Classic Schedule Layout

Date	Revision	Checked	Approved

Attachment M

Annual Certification of Compliance Form

Annual Certification of Compliance for the Construction Contractor

Project Name: _____

Caltrans Contract Number: _____

Contractor Company Name: _____

Contractor Address: _____

Annual Certification Inspection Date: _____

Description of Work:	description of work
Work Now in Progress:	work in progress
Work Planned for Next 12 Months:	work planned

Water Pollution Control Manager Findings

I, and/or personnel acting under my direction and supervision, have inspected the project site and the work described above and certify:

1. ☐ YES ☐ NO Stormwater pollution control measures are being implemented in accordance with the SWPPP approved for the project.

2. ☐ YES ☐ NO The project site and activities thereon are in compliance with the Caltrans Statewide NPDES Permit No. CAS000003, the NPDES General Permit No. CAS000002, or local NPDES permits, which ever is applicable.

Approval by the Resident Engineer for the Annual Certification of Compliance

Resident Engineer's Findings

I, and/or personnel acting under my direction and supervision, have inspected the project site and the work described above and find as follows:

1. ☐ YES ☐ NO Stormwater pollution control measures are being implemented in accordance with the SWPPP approved for the project.

2. ☐ YES ☐ NO The project site and activities thereon are in compliance with the Caltrans Statewide NPDES Permit No. CAS000003, the NPDES General Permit No. CAS000002, or local NPDES permits, which ever is applicable.

When both 1 and 2 above are checked "yes", the resident engineer must complete the annual certification below.

If either 1 or 2 above are checked "no", the resident engineer must:

- File a notice of non-compliance within 30 days of identification of the noncompliance;
- Document follow up actions below;
- Notify the contractor; and
- Initiate corrective actions in accordance with the contract.

Is a Local Agency administering the project?

☐ Yes ☐ No

Resident Engineer's Follow up Actions:

I, and or personnel acting under my direction and supervision, have reviewed and approved of the Contractor's Annual Certification of Compliance. However, the Contractor remains responsible and liable at all times for compliance with applicable requirements for which compliance is ultimately determined by the Regional Water Quality Control Board and/or the State Water Resources Control Board, and/or the EPA.

CERTIFICATION BY CALTRANS OR LOCAL AGENCY / PRIVATE ENTITY RESIDENT ENGINEER

_____ _____

Resident Engineer's Name and Signature Date

CERTIFICATION BY CALTRANS OVERSIGHT ENGINEER (IF LOCAL AGENCY / PRIVATE ENTITY IS ADMINISTERING PROJECT)

_____ _____

Caltrans Oversight Engineer's Name and Signature Date

Attachment N

Other Plans/Permits/Agreements

INSTRUCTIONS

- Include in this attachment a copy of the Caltrans Statewide Permit CAS000003.
- Include in this attachment a copy of the Construction General Permit CAS000002.
- Also include copies of other local, state, and federal plans , permits, and agreements. List of other plans, permits, and agreements shall be included in Section 400 of the SWPPP. Examples include:
  - RWQCB Waiver of Clean Water Act Section 401 Water Quality Certification.
  - US Army Corps of Engineers, Clean Water Act Section 404, Nationwide Permit 26-authorization letter.
  - California Department of Fish and Game Streambed Alteration Agreement II 564-xx.
- Copies of the above documents shall also be included in the Resident Engineer's file.

Making San Francisco Bay Better

June 12, 2009

California Department of Transportation
111 Grand Avenue
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Jeff Jensen, Office Chief

AND

San Francisco County Transportation Authority
100 Van Ness Avenue, 25th Floor
San Francisco, California 94102

ATTENTION: Leroy L. Saage, PE, Doyle Drive Project Manager

SUBJECT: Consistency Determination No. CN 2-08

Ladies and Gentlemen:

On February 14, 2008, the California Department of Transportation and the San Francisco County of Transportation submitted a description of the project and requested that the Commission concur that the proposed project is consistent with its Amended Coastal Zone Management Program for San Francisco Bay. The Commission concurs with the determination of the California Department of Transportation and the San Francisco County of Transportation that seismically retrofit, use and maintain the roadway along an approximately 1.6-mile-long, 105-foot-wide section of Doyle Drive/Highway 101, at the southern approach to the Golden Gate Bridge, between the Merchant Road and Girard Road access ramps, in the Golden Gate National Recreation Area's Presidio, in the City and County of San Francisco, is consistent with the Commission's Amended Management Program for San Francisco Bay.

The Commission's Letter of Agreement for the subject consistency determination is attached. If you should have any questions regarding the attached Letter of Agreement or need any further assistance, please contact Karen Wolowicz of my staff at 415/352-3669 or karenw@bcdc.ca.gov.

Sincerely,

WILL TRAVIS
Executive Director

WT/KW/ra
Enc.
cc: U.S. Army Corps of Engineers, Attn: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn: Certification Section
Environmental Protection Agency
Federal Highway Administration, Attn: Lanh Phan
Presidio Trust, Attn: Michael Boland

Making San Francisco Bay Better

LETTER OF AGREEMENT FOR CONSISTENCY DETERMINATION NO. CN 2-08

June 12, 2009

California Department of Transportation
111 Grand Avenue
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Jeff Jensen, Office Chief

AND

San Francisco County Transportation Authority
100 Van Ness Avenue, 25th Floor
San Francisco, California 94102

ATTENTION: Leroy L. Saage, PE, Doyle Drive Project Manager

Ladies and Gentlemen:

I. Agreement

A. The San Francisco Bay Conservation and Development Commission agrees with the determination of the California Department of Transportation and the San Francisco County Transportation Authority that the following project is consistent with the Commission's Amended Management Program for San Francisco Bay:

Location: Along an approximately 1.6-mile-long, 105-foot-wide section of Doyle Drive/Highway 101, at the southern approach to the Golden Gate Bridge, between the Merchant Road and Girard Road access ramps, in the Golden Gate National Recreation Area's (GGNRA) Presidio, a Waterfront Park/ Beach Priority Use Area as designated by Bay Plan Map No. Four, in the City and County of San Francisco.

Description: Seismically retrofit, use and maintain the roadway to include the following: (1) an approximately 1,804-foot-long, at-grade roadway, East of the Golden Gate Bridge toll plaza; (2) an approximately 1,279-foot-long, 66- to 115-foot-high viaduct located between the Park Presidio Interchange and the San Francisco National Cemetery; (3) an approximately 213-foot-long at-grade roadway; (4) an approximately 853-foot-long Battery Tunnel with landscaping above the tunnel; (5) an approximately 1,214-foot-long, at-grade roadway with a 13- to 26-foot-high berm along the north side to shield the roadway from park visitors; (6) an approximately 1,017-foot-long Main Post Tunnel with landscaping above the tunnel; (7) an approximately 394-foot-long, 10-foot-high causeway; (8) an approximately 1,460-foot-long, at-grade roadway; and (6) reconfiguration of the Park Presidio

Interchange at the west end of Doyle Drive and the South Doyle Drive exit. The northbound roadway will consist of two 11-foot-wide lanes, one 12-foot-wide lane, one 10-foot-wide outside shoulder, and one 4-foot-wide inside (along the median) shoulder in both directions. The southbound roadway would be configured similarly and include an additional 11-foot-wide lane from the Park Presidio Interchange to Lyon Street. An approximately 122- to 146-foot-wide median will be between the north- and south-bound roadways.

B. This agreement is given based on the information submitted by or on behalf of the Department of Transportation and the San Francisco County of Transportation in their letter dated February 14, 2008.

II. Special Conditions

The authorization made herein shall be subject to the following special conditions:

A. **Specific Plans and Plan Review**

1. **Plan Review.** No work whatsoever shall be commenced pursuant to this authorization until final precise site, demolition, engineering, architectural, grading, public access, landscaping, and best management practices plans and any other relevant criteria, specifications, and plan information for that portion of the work have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The specific drawings and information required will be determined by the staff. To save time, preliminary drawings should be submitted and approved prior to final drawings.

   a. **Site, Architectural, Grading, and Landscaping Plans.** Site, demolition, architectural, grading, public access, and landscaping plans shall include and clearly label property lines, grading, details showing the location, types, dimensions, and materials to be used for all structures, irrigation, landscaping, drainage, seating, parking, signs, lighting, fences, paths, trash containers, utilities and other improvements.

   b. **Engineering Plans.** Engineering plans shall include a complete set of contract drawings and specifications and design criteria. The design criteria shall be appropriate to the nature of the project, the use of any structures, soil and foundation conditions at the site, and potential earthquake-induced forces. Final plans shall be signed by the professionals of record and be accompanied by:

      (1) Evidence that the design complies with all applicable codes; and

      (2) Evidence that a thorough and independent review of the design details, calculations, and construction drawings has been made.

   c. **Preliminary and Final Plans.** Plans submitted shall be accompanied by a letter requesting plan approval, identifying the type of plans submitted, the portion of the project involved, and indicating whether the plans are final or preliminary. Approval or disapproval shall be based upon:

(1) completeness and accuracy of the plans in showing the features required above, particularly property lines, existing and proposed public access improvements, and any other criteria required by this authorization;

(2) consistency of the plans with the terms and conditions of this authorization;

(3) the provision of the amount and quality of public access to and along the shoreline and in and through the project to the shoreline required by this authorization;

(4) consistency of the plans with the recommendations of the Design Review Board;

(5) assuring that appropriate provisions have been incorporated for safety in case of seismic event; and

(6) assuring that appropriate elevations have been met to prevent overtopping, flooding, and 100-year storm events in all public access areas.

Plan review shall be completed by or on behalf of the Commission within 45 days after receipt of the plans to be reviewed.

2. **Conformity with Final Approved Plans.** All work, improvements, and uses shall conform to the final approved plans. Prior to any use of the facilities authorized herein, the appropriate design professional(s) of record shall certify in writing that, through personal knowledge, the work covered by the authorization has been performed in accordance with the approved design criteria and in substantial conformance with the approved plans. No noticeable changes shall be made thereafter to any final plans or to the exterior of any constructed structure, outside fixture, lighting, landscaping, signage, landscaping, or parking area, without first obtaining written approval of the change(s) by or on behalf of the Commission.

3. **Discrepancies between Approved Plans and Special Conditions.** In case of any discrepancy between final approved plans and Special Conditions of this authorization or legal instruments approved pursuant to this authorization, the Special Condition or the legal instrument shall prevail. The permittees are responsible for assuring that all plans accurately and fully reflect the Special Conditions of this authorization and any legal instruments submitted pursuant to this authorization.

4. **Appeals of Plan Review Decisions.** Any plan approval, conditional plan approval or plan denial may be appealed by the permittees or any other interested party to the Design Review Board or, if necessary, subsequently to the Commission. Such appeals must be submitted to the Executive Director within 30 days of the plan review action and must include the specific reasons for appeal. The Design Review Board shall hold a public hearing and act on the appeal within 60 days of the receipt of the appeal. If subsequently appealed to the Commission, the Commission shall hold a public hearing and act on the appeal within 90 days of the receipt of the subsequent appeal.

B. **Public Access Areas and Trails**

1. **Restoring Access Areas and Paths.** At project completion, all public access trails existing as of the date of this consistency shall be maintained, replaced, or enhanced to conditions that are equal to or better than those existing at the time of issuance of

this consistency determination. Adequate signage shall be installed to inform park users of all new and existing public access areas and trails.

2. **Minimizing Construction Interruptions.** The Department of Transportation shall make every effort to minimize closures and impacts to existing public access areas adjacent to Doyle Drive during project construction. Every effort shall be made to keep the existing public access areas affected by work described in the consistency determination open to the public after 5 p.m. and on weekends, whenever possible. The existing public access areas affected by authorized work may be closed temporarily to the public during part or all of the construction for public safety. Any public paths closed temporarily due to construction activities authorized shall be clearly identified on signs notifying the public of suitable detour(s). In addition, signs shall be installed at all affected public access entrances informing the public of why the road or path is closed, when the road or path is open, possible detours, and when project construction will be completed.

C. **Construction Best Management Practices**

1. **Debris Removal.** All construction debris shall be removed to and disposed at an authorized location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the permittee, its assigns, or successors in interest, or the owner of the improvements, shall remove such material, at its expense, within ten days after it has been notified by the Executive Director of such placement.

2. **Construction Operations.** All construction operations shall be performed to prevent construction materials from falling into the Bay and Crissy Marsh. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the permittee shall immediately retrieve and remove such material at its expense.

III. Findings and Declarations

A. On February 14, 2008, the Department of Transportation and the San Francisco County Transportation Authority submitted a description of the project and requested that the Commission concur that the project is consistent with its Amended Coastal Zone Management Program for San Francisco Bay.

The project to seismically retrofit Doyle Drive will be funded by the Federal Highway Administration and involves a similar activity, as defined by Commission Regulation Section 10601(e)(3) to the placement of small amounts of inert inorganic fill that would not have a significant adverse effect on present or possible future maximum feasible public access to the Bay or on the environment as defined by Commission Regulation Section 10601(b)(1). Overall, the project will preserve existing recreational opportunities at and to the waterfront. Additionally, the retrofitted highway would pass partly underground, reducing the highway's impact on the Presidio and providing an opportunity to develop a new, approximately 6.0-acre public park area above the proposed Main Post Tunnel. This new 6.0-acre park area will provide a direct pedestrian connection from the Presidio's Main Post area to Crissy Field. The retrofitted project will also result in extending public transit (bus) bays along both sides of Richardson Avenue.

At project completion, access between areas separated by Doyle Drive will be different but equal to existing access between these areas, yet a variety of vehicle roads and recreational trails in the vicinity of the project will be closed for varying lengths of time during project construction. The Construction Traffic Management Plan has not yet been completed, but the Department of Transportation intends to keep the public informed about construction-related vehicle traffic impacts (e.g., road closures and detours) using outreach tools, e.g., press releases, websites, signage, and public service announcements. According to the Department of Transportation, recreational trails would experience short-term, intermittent closures during low traffic periods only, and alternative recreational trail routes would be provided. Special Conditions have been included to ensure that all roadway and trail closures are adequately signed and noticed, that alternative routes are provided, that once construction is complete that similar or superior public access areas and trails to those existing at the date of this consistency determination are provided, and that best construction management practices are used.

According to the Department of Transportation, the park experience will be enhanced, as portions of the roadway will be in tunnels or shielded from view by berms. Views of the Bay for vehicles driving through the proposed tunnels and along the at-grade roadway (between the tunnels) where a berm alongside the north-edge shoulder will be constructed will be obstructed, but the Department of Transportation maintains that the benefits of road reconfiguration to park users outweighs the loss of views from vehicles on Doyle Drive, that the road will be much safer than the existing Doyle Drive, and that the newly configured Doyle Drive will also afford superb view.

B. An environmental review conducted by the Department of Transportation to seismically repair, maintain and use the approximately 1.6 mile long section of Doyle Drive resulted in approval of an Environmental Impact Report/ Statement under the California Environmental Quality Act (CEQA) and the National Environmental Protection Act (NEPA) on October 14, 2008.

C. The Commission, pursuant to the Coastal Zone Management Act of 1972, as amended (16 USC Section 1451), and the implementing Federal Regulations in 15 CFR Part 930, is required to review Federal projects within San Francisco Bay and agree or disagree with the Federal agency's determination that the project is consistent with the Commission's Amended Coastal Zone Management Program for San Francisco Bay. This letter constitutes such review and comment.

D. Pursuant to Regulation Section 10620, the project was listed with the Commission on May 7, 2009.

Executed in San Francisco, California, on behalf of the San Francisco Bay Conservation and Development Commission on the date first above written.

WILL TRAVIS
Executive Director
San Francisco Bay Conservation and
Development Commission

WT/KW/ra

cc: U.S. Army Corps of Engineers, Attn: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn: Certification Section
Environmental Protection Agency
Federal Highway Administration, Attn: Lanh Phan
Presidio Trust, Attn: Michael Boland

California Regional Water Quality Control Board
San Francisco Bay Region

Linda S. Adams
Agency Secretary

1515 Clay Street, Suite 1400, Oakland, California 94612
(510) 622-2300 • Fax (510) 622-2460
http://www.waterboards.ca.gov/sanfranciscobay

Arnold Schwarzenegger
Governor

June 3, 2009
CIWQS Place No. 728683 (BT)
401 Database Site No. 02-38-C0122

Sent via electronic mail: No hard copy to follow

California Department of Transportation
Attn: Mr. Nidal Tuquan
Nidal_Tuquan@dot.ca.gov
111 Grand Ave.
Oakland, CA 94612-3717

Subject: Water Quality Certification for the Doyle Drive Golden Gate Bridge South Access Project, San Francisco, San Francisco County

Department Project No.: EA 04-16370

Dear Mr. Tuquan:

We have reviewed and hereby issue water quality certification to the California Department of Transportation (Department) for the project referenced above (hereinafter Project). The Department has applied for and received a U.S. Army Corps of Engineers (Corps) Nationwide Permit No. 14, *Linear Transportation*, pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344). As such, the Department has applied to the Water Board for a Clean Water Act Section 401 water quality certification that the Project will not violate State water quality standards.

Project: The Department proposes to replace the seismically-deficient, existing viaduct structure that carries traffic to and from the Golden Gate Bridge through the Presidio (Doyle Drive). The existing structure will be replaced with a six-lane facility and a southbound auxiliary lane between the Park Presidio Interchange and the new Presidio access at Girard Road. The Project involves construction of eight sections, listed here sequentially from west to east: an at-grade roadway, the "Presidio" elevated viaduct, another at-grade roadway, the "Battery Tunnel," another section of an at-grade roadway, the "Marina Boulevard Tunnel," a low causeway, and an at-grade roadway near the Palace of Fine Arts.

Impacts: Project implementation will permanently fill approximately 0.81 acres of jurisdictional seasonal freshwater wetlands and due to construction access and staging, temporarily impact approximately 0.16 acres of jurisdictional seasonal freshwater wetlands. Project implementation will also result in approximately 1,391 linear feet (0.11 acres) of

temporary impacts to jurisdictional waters as a result of restoration activities in Dragonfly Creek, the Battery East bluffs, and at Tennessee Hollow.

Project implementation would result in added impervious area. Stormwater runoff from impervious areas may contain hydrocarbons, metals, volatile organic compounds, trash, and sediment at levels that may significantly impact waters of the State if left untreated.

Construction of the Project tunnel(s) may disrupt the flow of groundwater resulting in indirect impacts to approximately 1.77 acres of down-gradient wetlands that are sustained by groundwater (wetlands 4, 6d, and 7, upon the Battery-Blaney bluffs—the bluffs are north of Doyle Drive and south of Crissy Field).

Future Project-Related Impacts: Prior to Project completion, two existing outfalls shall be upgraded to provide drainage to San Francisco Bay from the Project area. The new outfalls may have larger diameters and be lengthened into the Bay to prevent sand drifts from blocking the outlets. At the time of issuance of this certification, the Department did not yet have design plans beyond the conceptual level and therefore, impact information was not available. This certification does not certify construction of these new outfall structures. The outfall structures must be certified in the future, either as a modification to this certification, or as a new certification.

Mitigation: To mitigate for permanent impacts to jurisdictional wetlands, the Department shall provide wetland creation, and wetland and riparian restoration and enhancement on National Park Service land and land subject to Presidio Trust's jurisdiction within the Presidio. Because the Department is receiving economic stimulus funding for the Project and on an accelerated schedule, the Final Mitigation and Monitoring Plans (MMPs) are not yet available and will be submitted subsequent to certification issuance. As such, exact levels of compensatory mitigation available at each mitigation location will not be available until the Final MMPs are completed.

The Department shall mitigate for the 0.81 acres of permanent impacts to jurisdictional wetlands by creating 1.6 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of riparian habitat by removing creeks from culverts. A combination of these creation and restoration may be approved provided restoration activities are provided in greater quantities than creation.

Mitigation activities are proposed at the following locations:

- *Upper Dragonfly Creek*: Dragonfly Creek is a perennial stream. The Department proposes to restore approximately 0.78 acres of freshwater wetland and willow/oak riparian habitats. Invasive species removal at this location began in 2006 in anticipation of the Project.

- *Middle Dragonfly Creek*: Dragonfly Creek is currently underground at this location. The Department proposes to create approximately 0.41 acres of willow/oak riparian habitat at this location.

- *Lower Dragonfly Creek*: The Department proposes to create approximately 0.64 acres of willow riparian habitat and enhance approximately 0.26 acres of freshwater wetland. Planting of native riparian plantings have already commenced at this location.

- *Quartermaster Reach Connection*: The Department proposes to create approximately 0.17 acres of willow riparian habitat and restore the creek by day-lighting 280 feet of the creek.

- *North Fort Scott*: The Department proposes to enhance approximately 0.44 acres of freshwater wetland meadow at this location.

- *West Crissy Bluffs*: The Department proposes to enhance approximately 0.19 acres of freshwater wetland at this location.

- *Battery East/Marine Drive*: The Department proposes to enhance approximately 0.62 acres of freshwater wetland at this location.

- *Tennessee Hollow*: At this location, the Department proposes to restore by day-lighting approximately 800 linear feet of the eastern tributary of Tennessee Hollow and restore an additional 250 linear feet of a degraded creek section.

Temporary impacts to wetlands shall be mitigated by in-kind, in-place restoration after construction. Because riparian habitats shall be restored and/or enhanced, mitigation for temporary impacts at these locations is not required.

As mitigation for increased pollutant loads associated with impervious areas, the Department shall provide treatment of stormwater runoff from an area equivalent to the added and reworked impervious areas (26.9 acres). Additionally, the Department shall provide permanent stormwater treatment for an additional 0.4 acres of Project impervious area to compensate for absence of treatment during the operation of the 4.1 acre temporary detour structure.

The Department shall implement a long-term hydrogeologic and biological monitoring plan to evaluate potential impacts to the hydrogeology and biological resources at wetlands 4, 6d, and 7 as a result of any up-gradient disturbance of groundwater flow. Impacts to wetlands shall be subject to additional mitigation requirements.

CEQA Compliance: An Environmental Impact Report was prepared and approved for this project pursuant to the provisions of the California Environmental Quality Act by the San Francisco Transportation Authority (SFTA). The SFTA filed a Notice of Determination on December 17, 2008 (SCH No. 2000032006).

Wetland Tracker System: It has been determined through regional, state, and national studies that tracking of mitigation/restoration projects must be improved to better assess the performance of these projects, following monitoring periods that last several years. In addition, to effectively

carry out the State's No Net Loss Policy for wetlands, the State needs to closely track both wetland losses and mitigation/restoration project success. Therefore, we require that the Department use a standard form to provide Project information related to impacts and mitigation/restoration measures. An electronic copy of the form and instructions can be downloaded at: http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml. Project information concerning impacts and mitigation/restoration will be made available at the web link: http://www.wetlandtracker.org.

Certification: I hereby issue an order certifying that any discharge from the referenced project will comply with the applicable provisions of sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality Standards and Implementation Plans), 306 (National Standards of Performance), and 307 (Toxic and Pretreatment Effluent Standards) of the Clean Water Act, and with other applicable requirements of State law. This discharge is also regulated under State Water Resources Control Board Order No. 2003 - 0017 – DWQ, "General Waste Discharge Requirements for Dredge and Fill Discharges That Have Received State Water Quality Certification" which requires compliance with all conditions of this Water Quality Certification. The following conditions are associated with this certification:

1. The Department shall adhere to the Standard conditions imposed by Nationwide Permit No. 14, issued to the Department by the Corps;

2. All jurisdictional wetlands and waters temporarily impacted by construction activities shall be immediately returned to pre-construction or improved conditions upon cessation of construction activities in these locations. Native seed and plantings shall be used for all revegetation activities, except where the Presidio Trust mandates certain plant varieties;

3. The Department shall provide post-construction treatment of stormwater runoff from no less than 27.3 acres of impervious area within the Project limits using vegetation-based treatment systems (e.g., biofiltration strips, biofiltration swales);

4. All permanent stormwater treatment controls shall be fully operational by the completion of Contract #7 which will build the Northbound High Viaduct, Northern Park Presidio Interchange and Northbound roadway to Merchant Road;

5. The Department shall submit, acceptable to the Executive Officer, a long-term hydrogeologic and biological monitoring plan to evaluate the extent of impacts to the hydrogeology and biological resources at wetlands 4, 6d, and 7, no later than July 15, 2009. The plan shall include a minimum monitoring period of five years. Any long-term hydrogeologic and biological impacts to wetlands 4, 6d, and/or 7 shall be subject to additional mitigation requirements;

6. The Department shall submit, subject to acceptance by the Executive Officer, final, post-construction stormwater treatment plans including details on design, installation, regular

inspections, and long-term operation and maintenance for Contract No. 3 (Southbound High Viaduct/Southern Park Presidio Interchange), no later than August 1, 2009;

7. The Department shall submit, subject to acceptance by the Executive Officer, final, post-construction stormwater treatment plans including details on design, installation, regular inspections, and long-term operation and maintenance for Contract Nos. 4-7 (Southbound Battery Tunnel; Girard Road Under-Crossing/Main Post Tunnels/Low Viaduct; Northbound Battery Tunnel; Northbound High Viaduct/Northern Park Presidio Interchange/Northbound Roadway to Merchant Road), no later than November 1, 2009;

8. The Department shall mitigate for the 0.81 acres of permanent impacts to jurisdictional wetlands by creating 1.6 acres of freshwater seasonal or perennial wetlands, or, restoring 2.4 acres of either freshwater seasonal or perennial wetlands, or riparian habitat by means of day-lighting culverted portions of creek within the Presidio. A combination of creation and restoration mitigation may be approved by the Executive Officer. All required mitigation shall be fully constructed by completion of the final roadway construction contract, "Contract #7: Northbound Presidio Viaduct, Northern Park Presidio Interchange, Northbound Roadway to Merchant Road." Failure to construct the abovementioned level of mitigation, by the abovementioned deadline, shall result in additional mitigation requirements and/or enforcement action by the Water Board;

9. Final MMPs for the following mitigation projects shall be submitted by the following dates:

   - *Battery East/Marine Drive*: October 1, 2009
   - *West Crissy Bluffs*: October 1, 2009
   - *Upper, Middle, and Lower Dragonfly Creek*: April 1, 2010
   - *North Fort Scott*: July 1, 2010
   - *Quartermaster Reach Connection*: July 1, 2011
   - *Tennessee Hollow*: October 1, 2011

Final MMPs shall be subject to the acceptance of the Executive Officer. Any of the proposed mitigation areas identified in this certification may be replaced or complemented with another project on land subject to the jurisdiction of the Presidio Trust, subject to the acceptance of the Executive Officer. Failure to fully implement mitigation by the dates and at the amounts noted in the Final, Water Board Executive Officer-accepted MMP, shall result in enforcement action and/or additional mitigation requirements from the Water Board. Because the Final MMPs have not yet been reviewed and accepted by the Executive Officer, there is a possibility the proposed mitigation may not be considered acceptable. In

the event that all, or any portion of the Final MMPs are not accepted by the Executive Officer, the Department shall still be required to fully comply with condition number 8 of this certification;

10. Construction of the following mitigation projects shall be completed by whichever occurs first; either the dates listed below, or by completion of the final roadway construction contract (see certification condition 8):

    - *Upper, Middle, and Lower Dragonfly Creek*: April 1, 2011;
    - *North Fort Scott*: April 1, 2011;
    - *Quartermaster Reach Connection*: April 1, 2012;
    - *Tennessee Hollow*: April 1, 2013 and,
    - *Battery East/Marine Drive and West Crissy Bluffs*: Mitigation construction has been completed at these two mitigation sites. Adequacy of the mitigation shall be determined by the Executive Officer upon submission of the Final Mitigation and Monitoring Plans.

    Any delays in mitigation construction shall be subject to additional mitigation requirements and/or enforcement action by the Water Board.

11. All Final MMPs shall include:
    a. Detailed success criteria;
    b. Final success criteria shall not be considered achieved until ten years have passed from the time of completion of mitigation construction;
    c. A proposal to implement contingency measures if mitigation monitoring data demonstrates mitigation goals have not been met;
    d. A time schedule for submittal of periodic monitoring reports to the Water Board;
    e. Pre-established photographic monitoring points be marked on a map and used during the monitoring period, with color photos included in every monitoring report;
    f. Planting plans incorporating native plant species, using locally-gathered nursery stock when available; and,
    g. Grading details based on survey data for all areas where wetland creation and creek realignment or day-lighting is proposed.

12. The discharge of sediment to San Francisco Bay, or to areas where sediment may discharge to San Francisco Bay, is prohibited. The Department shall implement all appropriate sediment and erosion control construction best management practices;

13. The Department is required to use the standard Wetland Tracker form to provide Project information describing impacts and mitigation/restoration measures no later than November 1, 2010. The completed Wetland Tracker form shall be submitted electronically to wetlandtracker@waterboards.ca.gov, or, shall be submitted as a hard copy to both: 1) San Francisco Bay Regional Water Quality Control Board (see letterhead for address), to the attention of Wetland Tracker, and, 2) San Francisco Estuary Institute, 7770 Pardee Lane, Oakland, CA 94621-1424, to the attention of Mike May;

14. Not later than 30 days prior to the beginning of construction of any Project component, the Department shall submit, acceptable to the Executive Officer, a final SWPPP to address the Project's expected construction stage impacts, prepared pursuant to the State Water Resources Control Board Water Quality Order No. 99-06-DWQ, the NPDES Statewide Permit for Storm Water Discharges From the State of California Department of Transportation Properties, Facilities, and Activities. If the Department is proposing rainy season construction activities, the Department shall provide a detailed schedule of activities and the associated pollution prevention measures that shall be in place to protect State waters;

15. This certification does not allow for the take, or incidental take, of any special status species. The Department shall use the appropriate protocols, as approved by the California Department of Fish and Game and the U.S. Fish and Wildlife Service, to ensure that Project activities do not impact the Beneficial Use of the Preservation of Rare and Endangered Species;

16. The Department shall maintain a copy of this water quality certification at the Project site so as to be available at all times to site operating personnel. It is the responsibility of the Department to assure that all personnel (employees, contractors, and subcontractors) are adequately informed and trained regarding the conditions of this certification;

17. Except as expressly allowed in this Certification, the discharge, or creation of the potential for discharge, of debris, rubbish, or any soil materials including fresh concrete, cement, silts, clay, sand and other organic materials to waters of the State is prohibited. Any of these materials placed within or where they may enter waters of the State by the Department or any party working under contract, or with the permission of the Department, shall be removed immediately. When construction is completed, any excess material shall be removed from the work area and any areas adjacent to the work area where such material may be washed into waters of the State. During construction, the Department and the contractor shall not dump any litter or construction debris within the riparian/stream zone. All such debris and waste shall be picked up daily and properly disposed of at an appropriate site;

18. This Certification applies to the Project as proposed in the application materials. Please be advised that failure to implement the Project as proposed is a violation of this water quality certification;

19. This certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to Section 13330 of the California Water Code (CWC) and Section 3867 of Title 23 of the California Code of Regulations(23 CCR);

20. This certification action does not apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license, unless the pertinent certification application was filed pursuant to California Code of Regulations (CCR) Title 23, Subsection 3855(b) and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought; and,

21. Certification is conditioned upon total payment of the full fee required in State regulations (23 CCR Section 3833). Water Board staff received full payment of $2869.00 on May 26, 2009.

We anticipate your cooperation in implementing these conditions. However, please be advised that any violation of water quality certification conditions is a violation of State law and subject to administrative civil liability pursuant to California Water Code (CWC) section 13350. Failure to respond, inadequate response, late response, or failure to meet any condition of this certification may subject you to civil liability imposed by the Water Board to a maximum of $5,000 per day per violation or $10 for each gallon of waste discharged in violation of this certification.

Conditions 5-7, 9, 13, and 14 are requirements for submission of a report. Any requirement for a report made as a condition to this action is a formal requirement pursuant to CWC section 13267, and failure or refusal to provide, or falsification of such required report is subject to civil liability as described in CWC section 13268.

We anticipate no further action on this request. Should new information come to our attention that indicates a water quality problem with this project, the Water Board may issue Waste Discharge Requirements pursuant to 23 CCR Section 3857.

If you have any question, please contact Brendan Thompson at (510) 622-2506, or via e-mail to BThompson@waterboards.ca.gov.

Sincerely,

Shin-Roei Lee acting for

Bruce H. Wolfe
Executive Officer

cc (via e-mail):

Mr. Bill Orme SWRCB-DWQ
Mr. Hal Durio, Regulatory Branch, USACE
Ms. Jane Hicks, Regulatory Branch, USACE
Ms. Holly Costa, Regulatory Branch, USACE
Mr. Cameron Johnson, Regulatory Branch, USACE
Mr. Dale Bowyer, Water Board
Ms. Melissa Escaron, Fish and Game, Yountville
Mr. Hardeep Takhar, Caltrans
Ms. Jayshree Chauhan, Caltrans
Mr. David Smith, USEPA

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

MAY 14 2009

REPLY TO

Regulatory Division

SUBJECT: File Number SPN-2006-30009 S

Mr. Jeffery Jensen
Division of Biological Sciences and Permits
California Department of Transportation
111 Grand Avenue
PO Box 23660
Oakland, California 94623-0660

Dear Mr. Jensen:

This letter is written in response to your submittal of February 2, 2009, concerning Department of the Army authorization for the Doyle Drive Project. The project is located on Highway 101, south of the Golden Gate Bridge, in the Presidio of San Francisco, San Francisco County, California.

The proposed project would replace Doyle Drive (a segment of Highway 101) with a new roadway facility: the Presidio Parkway. The Presidio Parkway would include a high-viaduct between the Highway 101/Park Presidio Interchange and the San Francisco National Cemetery. Shallow cut-and-cover tunnels would extend from the cemetery to east of Battery Blaney. The facility would then continue towards the Main Post in the Presidio with an open at-grade roadway with a wide, heavily landscaped median. A retaining wall would be constructed along the south side of the facility between the Battery and Main Post tunnels. A landscaped berm would be constructed along the north side of the facility to shield park visitors from the proposed facility. From Building 106 in the Presidio, cut-and-cover tunnels would extend east of Halleck Street. The facility would then rise slightly on a low causeway and then pass over Girard Road. East of Girard Road, the new facility would then return to an existing grade north of the Gorgas warehouses where it would connect to Richardson Avenue.

Constructing the new roadway facility would result in direct impacts to 0.35 acres of waters of the U.S. These permanent impacts would occur as a result of fill from constructing the new viaduct and at-grade roadway.

Based on a review of the information you submitted, your project qualifies for authorization under Department of the Army Nationwide Permit 14 for Linear Transportation Projects (72 Fed. Reg. 11092, March 12, 2007), pursuant to Section 404 of the Clean Water Act (33 U.S.C. Section 1344). See Enclosure 1. All work shall be completed in accordance with the plans and drawings titled "Preferred Alternative Refined Presidio Parkway" Layout sheets L-1

through L-4, dated January 2009, and "Figure 1, Project and Existing Wetland Locations, Doyle Drive Replacement", dated March 23, 2009.

The project must be in compliance with the General Conditions cited in Enclosure 2 for this Nationwide Permit authorization to remain valid. Non-compliance with any condition could result in the suspension, modification or revocation of the authorization for your project, thereby requiring you to obtain an Individual Permit from the Corps. This Nationwide Permit authorization does not obviate the need to obtain other State or local approvals required by law.

This authorization will remain valid for two years from the date of this letter unless the Nationwide Permit is modified, suspended or revoked. If you have commenced work or are under contract to commence work prior to the suspension, or revocation of the Nationwide Permit and the project would not comply with the resulting Nationwide Permit authorization, you have twelve (12) months from that date to complete the project under the present terms and conditions of the Nationwide Permit. Upon completion of the project and all associated mitigation requirements, you shall sign and return the Certification of Compliance, Enclosure 3, verifying that you have complied with the terms and conditions of the permit.

This authorization will not be effective until you have obtained a Section 401 water quality certification from the San Francisco Bay Regional Water Quality Control Board (RWQCB) and concurrence from the S.F. Bay Conservation and Development Commission (BCDC) that your project complies with the Coastal Zone Management Act. You shall submit a copy of the RWQCB 401 water quality certification and the BCDC consistency determination to the Corps prior to the commencement of work.

To ensure compliance with this Nationwide Permit authorization, the following special conditions shall be implemented:

1. A Detailed Final Mitigation Plan, including information on the proposed Tennessee Hollow restoration work, shall be submitted to our office prior to the start of construction. The plan must be reviewed and approved by our office before the start of construction.

2. Compensation for unavoidable impacts to waters of the U.S., including wetlands, within the project area shall be conducted pursuant to the Conceptual Mitigation Plan. Specifically:

    a. You shall revegetate the 0.001 acres of temporarily impacted intermittent stream/emergent wetland at Battery Howe-Wagner.

    b. To mitigate for direct/permanent impacts to 0.02 acres of the wetland at Battery Howe-Wagner, 0.18 acres of W-2, and 0.15 of W-3, you shall restore 0.23 acres of perennial stream/riparian wetland at Middle Dragonfly Creek, Lower Dragonfly Creek, and Quartermaster Reach as shown on "Figure 2-1, Proposed Mitigation Sites in Project Study Area", and listed in "Table 201, Proposed Mitigation Sites",

in the Conceptual Mitigation Plan. You shall also restore 800 feet of Tennessee Hollow that is currently underground in a culvert south of Lover's Lane Bridge and under Morton Street Field as shown on "Figure 4-2, Tennessee Hollow Eastern Tributary", in the Conceptual Mitigation Plan. You shall also enhance areas along Upper Dragonfly Creek, Lower Dragonfly Creek, the wetland at North Fort Scott, the willow scrub wetland at West Crissy bluffs, and the willow scrub wetland at Battery East/Marina Drive as shown on Figure 2-1, in the Conceptual Mitigation Plan.

c. Work on these mitigation areas shall be done concurrently with project construction.

d. The restoration and enhancement areas would be deemed successful when tree and shrub plantings provide at least 80 % total cover and herbaceous species provide 75% total cover on the sites.

e. The mitigation areas shall be monitored for success for 10 years. Monitoring reports shall be submitted annually to our office to determine if mitigation is succeeding. At the end of the ten-year monitoring period, you shall submit a final monitoring report to our office to determine if the above success criteria have been met.

3. Environmentally sensitive areas (ESA) shall be clearly delineated on the construction plans and demarcated in the field with high-visibility fencing prior to commencement of construction activities. ESA fencing shall be properly maintained throughout the duration of the project. The ESA shall be off limits to construction activity and personnel at all times.

4. All project staging and equipment storage shall be limited to the staging areas shown in "Exhibit 2-44, Construction Staging Areas – Preferred Alternative", in the "South Access to the Golden Gate Bridge – Doyle Drive FEIS/FEIR", dated September 2008.

5. No debris, oil, petroleum products or other organic material resulting from construction activities shall be allowed to enter or be placed where it may be washed by rainfall or runoff into areas subject to the jurisdiction of the Corps.

6. In the event of any unanticipated discoveries of potential cultural/historic resources, you shall immediately halt work in the vicinity of the discovery and contact the appropriate regulatory authorities. You shall complete consultation pursuant to 36 CFR 800 to the satisfaction of the SHPO prior to resuming work. The primary Corps point of contact for notification of unanticipated discoveries is Richard Stradford. His phone number is 415-503-6845.

Should you have any questions regarding this matter, please call Andrea Meier of our Regulatory Division at 415-503-6798. Please address all correspondence to the Regulatory Division and refer to the File Number at the head of this letter. If you would like to provide comments on our permit review process, please complete the Customer Survey Form available online at http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

Jane M. Hicks
Chief, Regulatory Division

Enclosures

Copy furnished without enclosures:

US EPA, San Francisco, CA
CA DFG, Napa, CA
CA RWQCB, Oakland, CA
SF BCDC, San Francisco, CA

Enclosure 3

Permittee:

Mr. Jeffery Jensen
Division of Biological Sciences and Permits
California Department of Transportation
111 Grand Avenue
PO Box 23660
Oakland, California 94623-0660

File Number: SPN-2006-30009 S

Certification of Compliance
for
Nationwide Permit

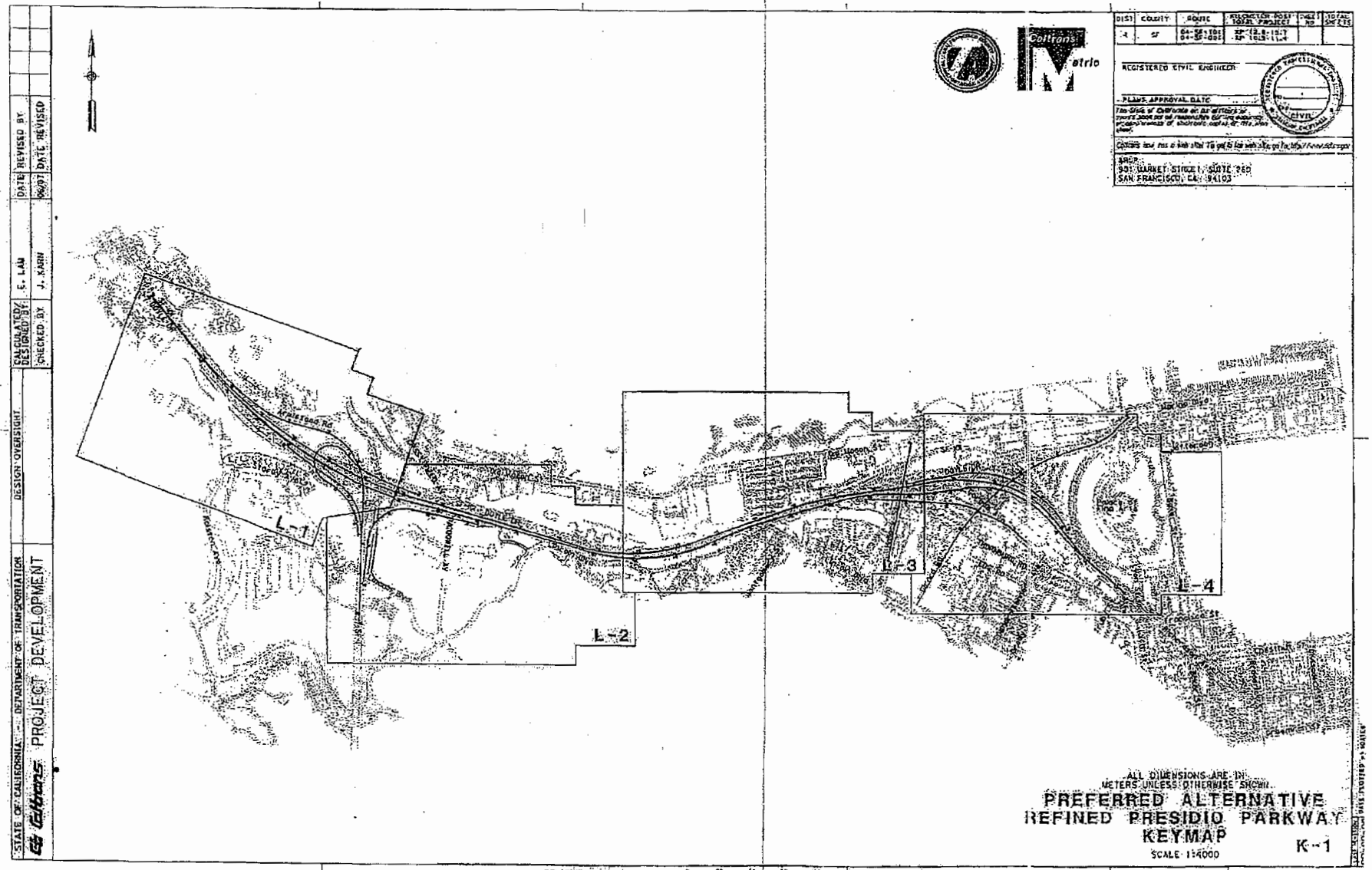
"I hereby certify that the work authorized by the above referenced File Number and all required mitigation have been completed in accordance with the terms and conditions of this Nationwide Permit authorization."

_____ _____

(Permittee) (Date)

Return to:

Andrea Meier
U.S. Army, Corps of Engineers
San Francisco District
Regulatory Division, CESPN-OR-R
1455 Market Street
San Francisco, CA 94103-1398


L-1
L-2
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L-4
Caltrans
Metro
STATE OF CALIFORNIA — DEPARTMENT OF TRANSPORTATION
PROJECT DEVELOPMENT
DESIGN OVERSIGHT
CALCULATED/DESIGNED BY: E. LAU
CHECKED BY: J. KARN
DATE REVISED BY
DATE REVISED
REGISTERED CIVIL ENGINEER
PLANS APPROVAL DATE
CIVIL
ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103
ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN.
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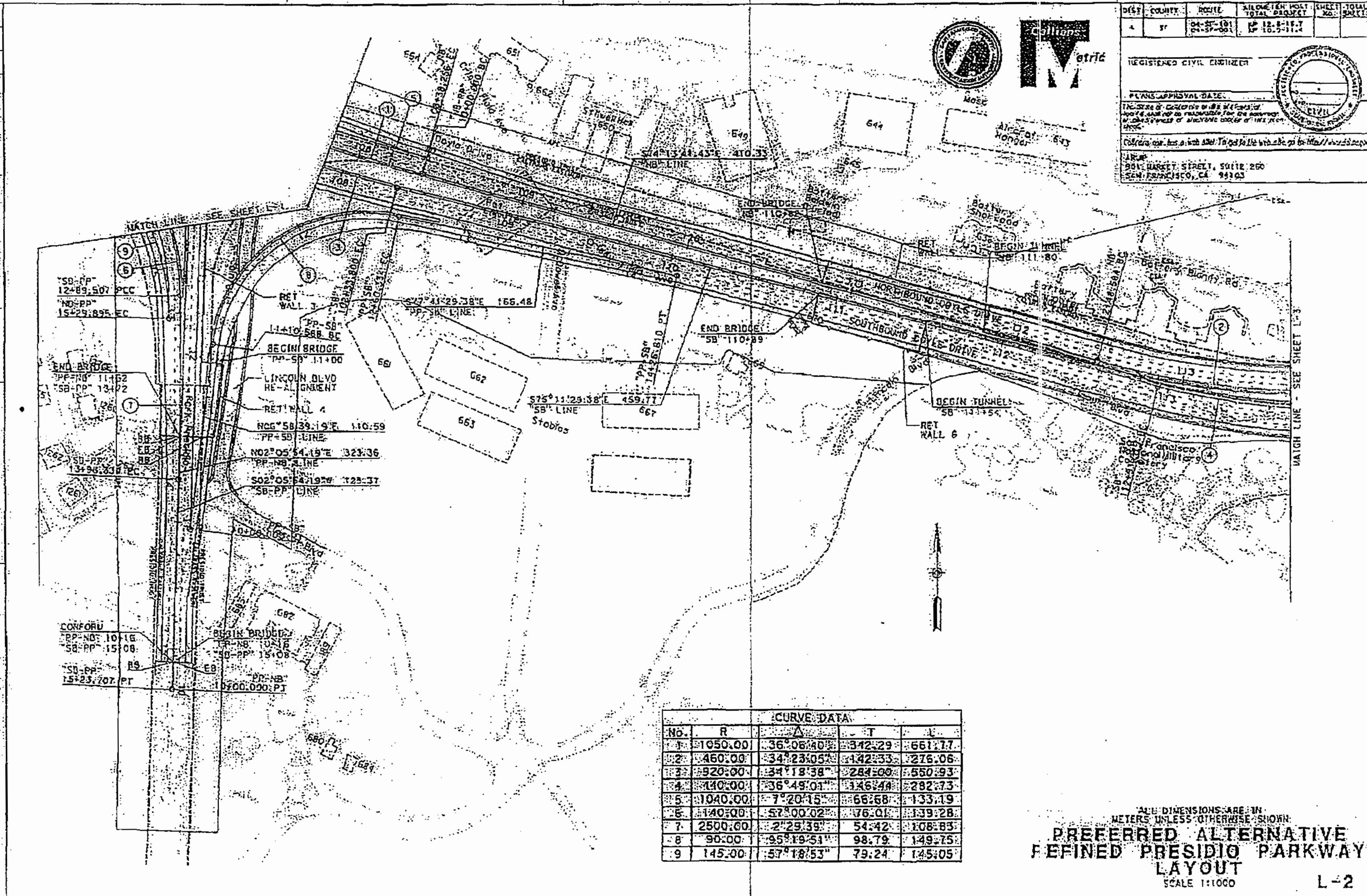

CURVE DATA				
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2	460.00	34°23'05"	142.33	276.06
3	920.00	34°18'38"	284.00	550.93
4	440.00	36°49'01"	146.44	282.73
5	1040.00	7°20'15"	66.68	133.19
6	140.00	57°00'02"	76.01	139.28
7	2500.00	2°29'39"	54.42	108.83
8	90.00	95°19'51"	98.79	149.75
9	145.00	57°18'53"	79.24	145.05

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-2

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No.	TOTAL SHEETS
4	SF	04-SF-101 04-SF-001	KP 12.8-15.7 KP 10.5-11.4		

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103

STATE OF CALIFORNIA -- DEPARTMENT OF TRANSPORTATION

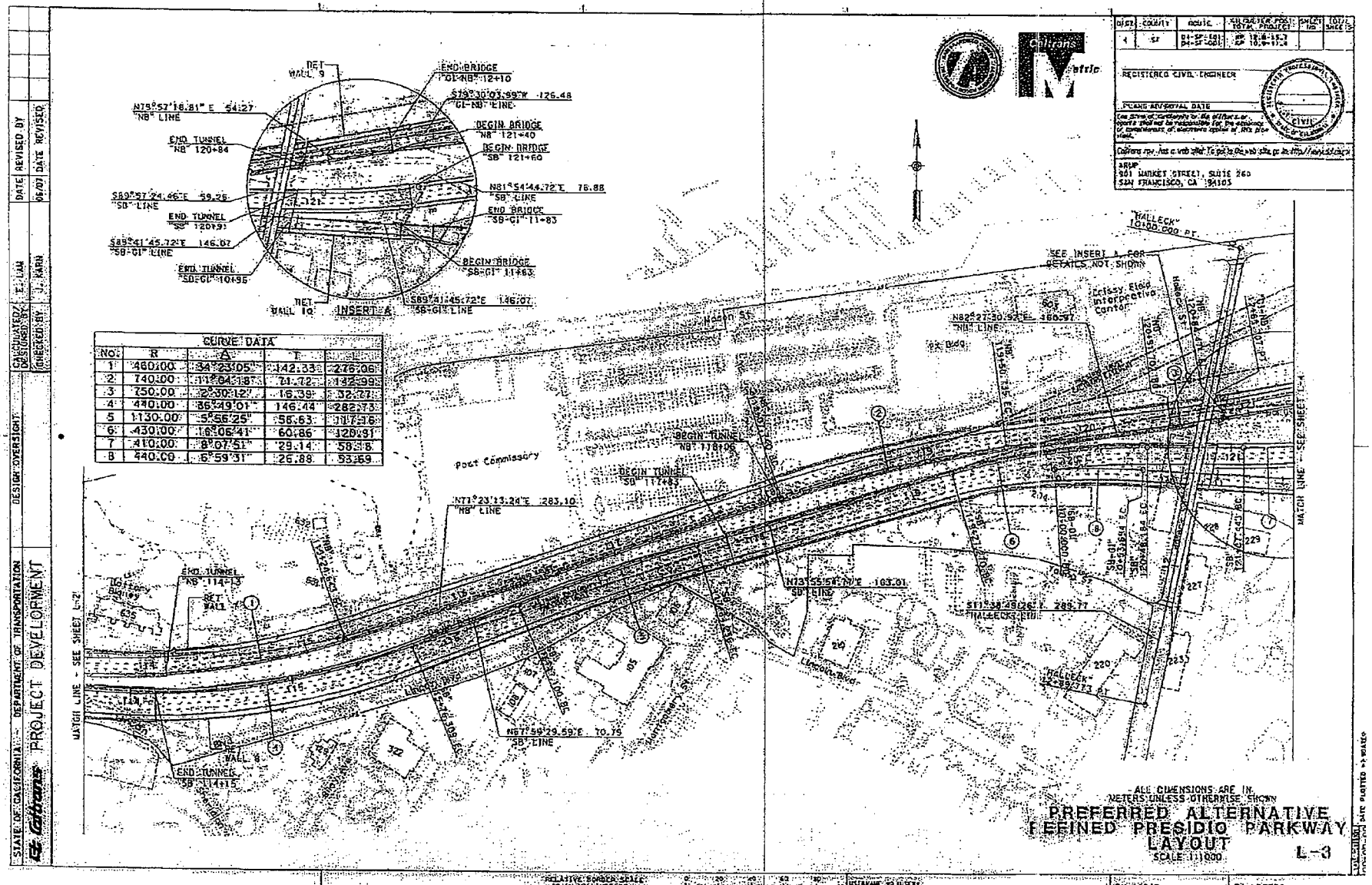
Caltrans PROJECT DEVELOPMENT

DESIGN OVERSIGHT	CALCULATED/DESIGNED BY	E. LAM	DATE	REVISED BY
	CHECKED BY	J. KARN	06/07	DATE REVISED

RELATIVE BORDER SCALE IS IN MILLIMETERS

RU 04242

EA 153700



CURVE DATA				
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2	140.00	117°04'18"	71.72	142.99
3	750.00	2°30'12"	16.39	32.77
4	440.00	36°49'01"	146.44	282.73
5	1130.00	5°56'25"	58.63	117.16
6	430.00	16°06'41"	60.86	120.91
7	410.00	8°07'51"	29.14	58.18
8	440.00	6°59'31"	26.88	53.69

DIST	COUNTY	ROUTE	KILOPOST/POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
4	SF	01-SF-101 04-SF-101	18.4/19.3 10.5/11.2		

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

CIVIL

Caltrans Metric

ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
PROJECT DEVELOPMENT

DESIGN OVERSIGHT	CALCULATED/DESIGNED BY	CHECKED BY	DATE REVISED	BY	DATE REVISED
	E. LAM	J. KARN	05/07		

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-3

RELATIVE BORDER SCALE IS IN MILLIMETERS

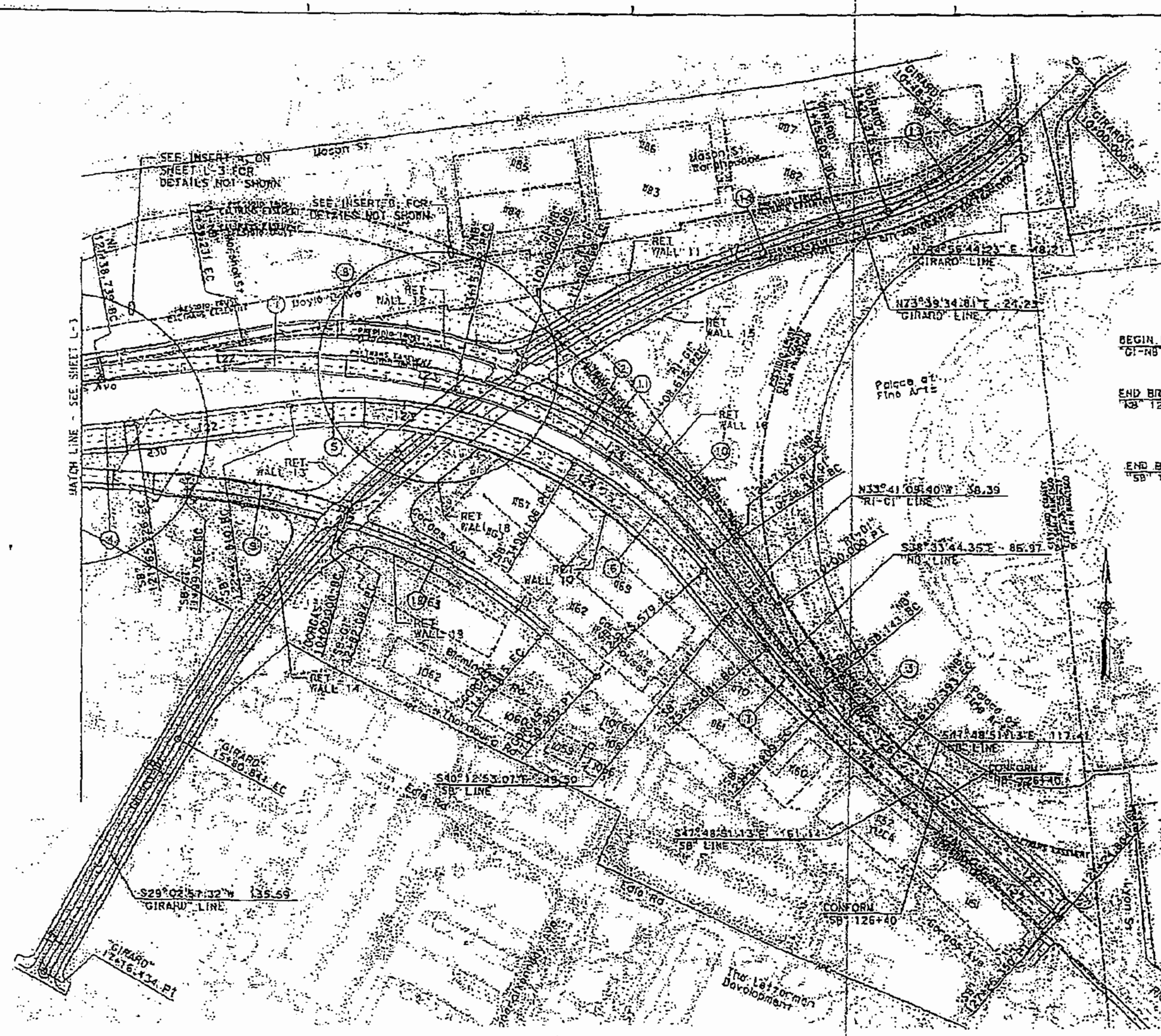
0 20 40 60 80

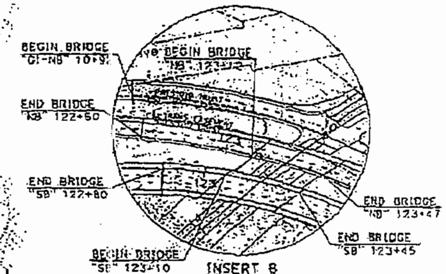
USE FILE AS METRIC

RU 04242

EA 163700

DATE PLOTTED = 05/MAY/07





INSERT B

CURVE DATA.				
No.	R	Δ	T	L
1	440.00	22°59'49"	89.51	176.60
2	232.00	38°29'08"	80.99	155.83
3	305.00	9°15'07"	24.68	49.25
4	410.00	8°07'51"	29.14	58.18
5	220.00	38°26'22"	76.70	147.60
6	252.00	19°26'00"	43.15	85.47
7	295.00	7°35'58"	19.59	39.13
8	240.00	33°14'20"	71.64	139.23
9	303.60	15°32'14"	41.42	82.33
10	200.00	20°07'09"	35.48	70.23
11	300.00	13°41'03"	36.00	71.65
12	260.00	25°53'48"	59.78	117.51

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PREFERRED ALTERNATIVE REFINED PRESIDIO PARKWAY LAYOUT

SCALE 1:1000

L-4

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

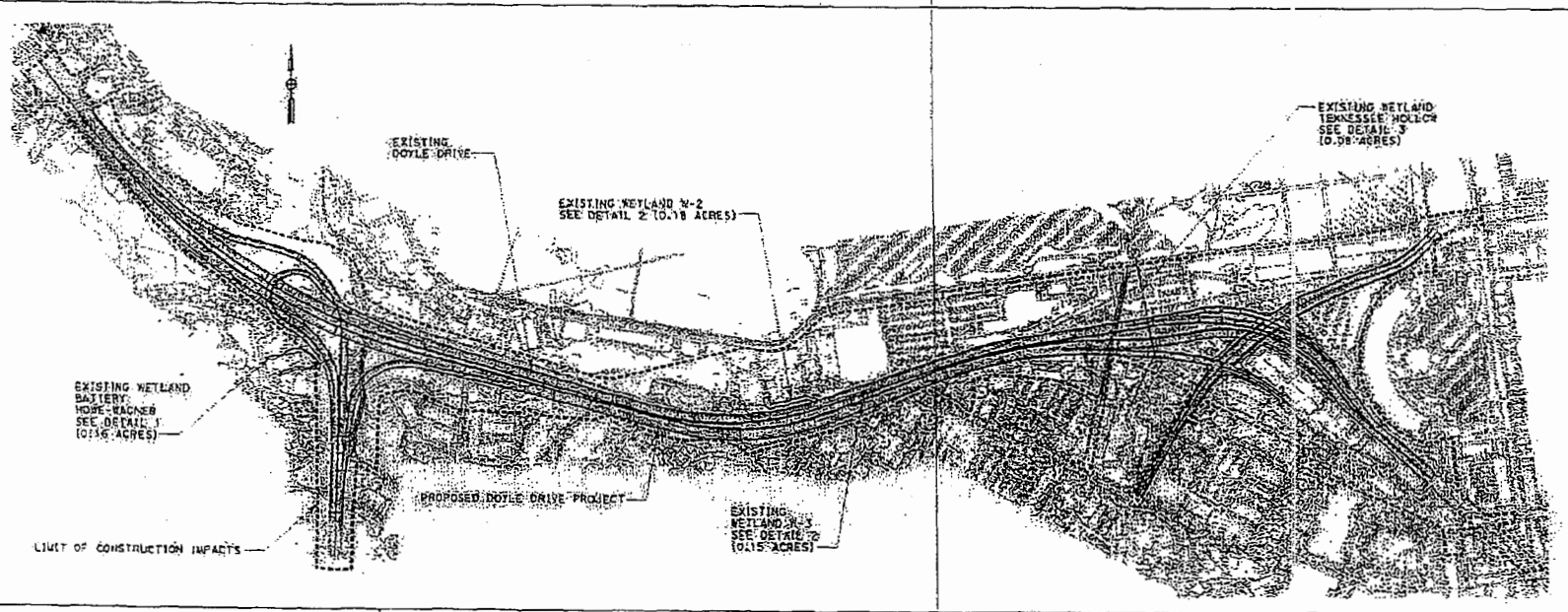
ARUP
901 MARKET STREET, SUITE 260
SAN FRANCISCO, CA 94103

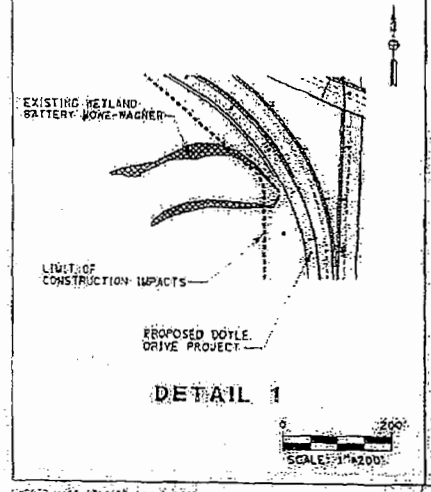
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION | DESIGN OVERSIGHT
Caltrans PROJECT DEVELOPMENT

CALCULATED/DESIGNED BY	E. LAM	DATE	REVISED BY
CHECKED BY	J. KARII	06/07	DATE REVISED

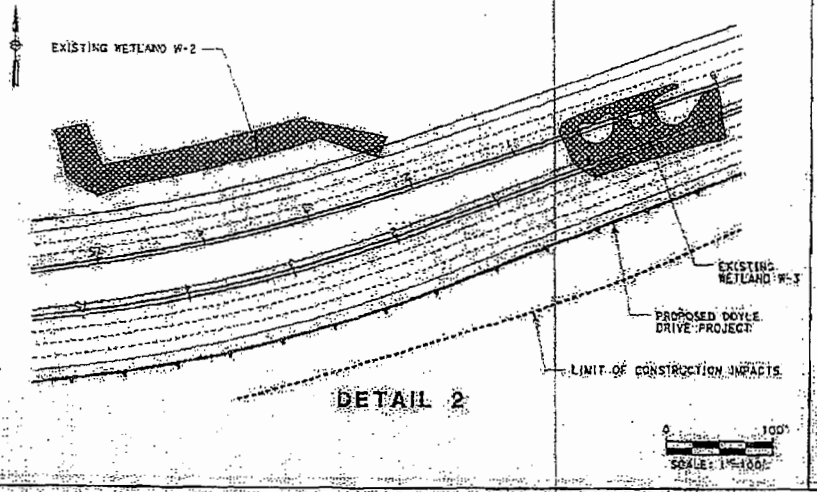
RELATIVE BORDER SCALE IS IN MILLIMETERS 0 20 40 60 80

RU 03242 | EA 163700

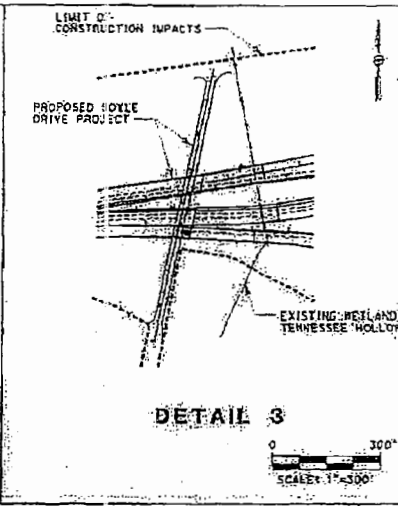




DETAIL 1



DETAIL 2



DETAIL 3

FIGURE 1
PROJECT AND EXISTING WETLAND LOCATIONS

DOYLE DRIVE REPLACEMENT
CONTACT: JOHN WEAVER, PLANNER III
ADDRESS: 111 GRAND AVENUE, OAKLAND, CA 94612

DELINEATION OF WATERS OF THE UNITED STATES, AT THE CITY AND COUNTY OF SAN FRANCISCO, DOYLE DRIVE REPLACEMENT PROJECT, FROM PRESIDIO PARKWAY TO FRANCISCO BOULEVARD EAST, IN THE CITY AND COUNTY OF SAN FRANCISCO, DOYLE DRIVE REPLACEMENT PROJECT, SAN FRANCISCO COUNTY, ROUTE 101, SAN FRANCISCO, CALIFORNIA.

PURPOSE: TO IMPROVE THE SAFETY, STABILITY, AND TRAFFIC CAPACITY OF DOYLE DRIVE, MAINTAINING ACCESS CONSISTENT WITH THE PRESIDIO OF SAN FRANCISCO.

DELINEATOR: YOLANDA MORALES, JENNIFER LOVE (ESA)
DATE OF DELINEATION: JULY 15, 2009
FILE NO.: SFH-101-A(DOYLE)

LAST PLOTTED ** 7/22/2009

Attachment P

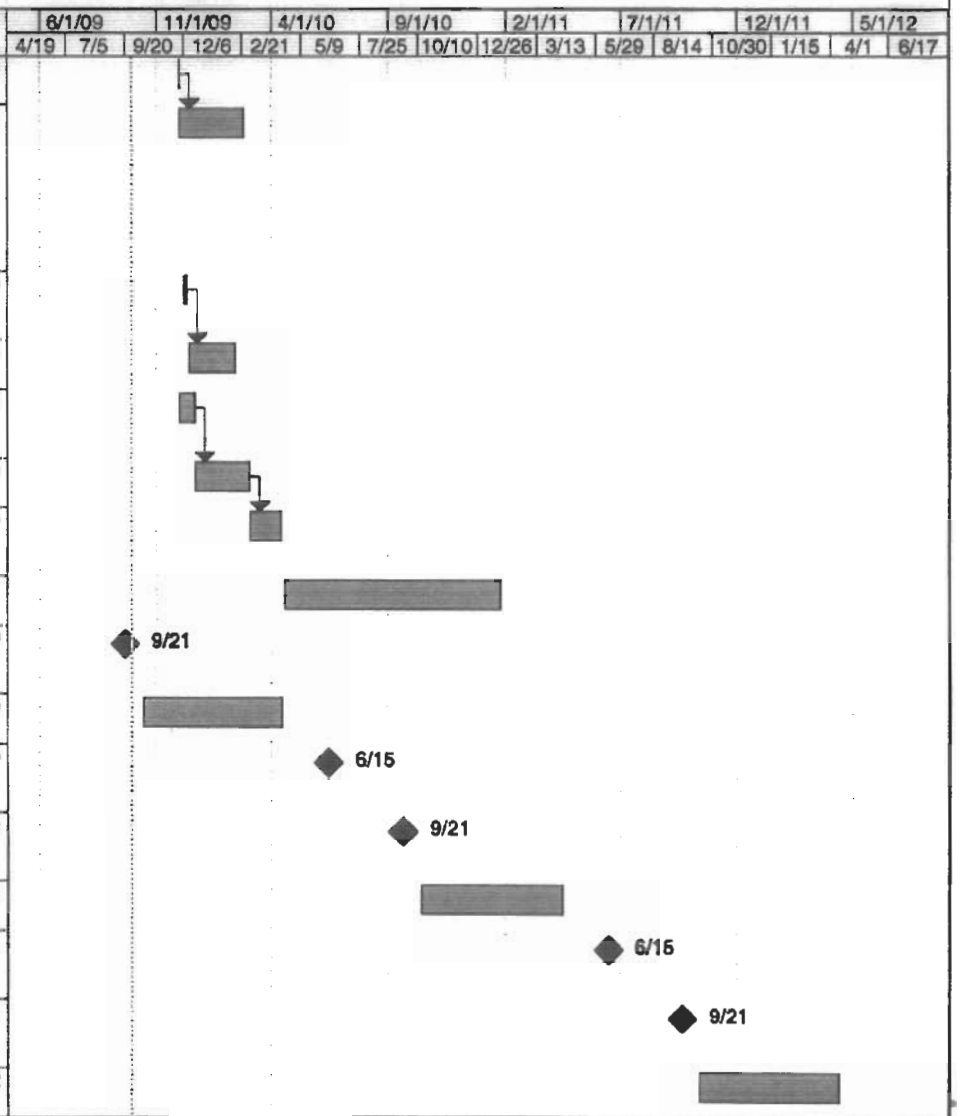
Notice of Completion of Construction / Notice of Termination

INSTRUCTIONS

- **Caltrans Administered Projects:** The Notice of Completion of Construction (NCC) form shown in the following page is a blank form. The completed (NCC) will be provided by Caltrans for inclusion in this attachment.
- **Local Agency / Private Entity Administered Projects:** The Notice of Termination (NOT) will be provided by the Local Agency / Private Entity. The NOT shall be inserted into this attachment.

DOYLE DRIVE PROJECT CONTRACT 04-163744
WATER POLLUTION CONTROL SCHEDULE

ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	1 day	Tue 12/1/09	Tue 12/1/09
2	Begin construction activities for the first 60 days in compliance with Conceptual Storm Water Pollution Prevention Plan (CSWPPP)	60 days	Wed 12/2/09	Tue 2/23/10
3	Contractor to prepare and submit SWPPP	5 days	Mon 12/7/09	Fri 12/11/09
4	Contractor SWPPP Approved	45 days	Mon 12/14/09	Fri 2/12/10
5	Prepare and Submit Dewatering and Discharge Plan (DDP)	15 days	Tue 12/1/09	Mon 12/21/09
6	DDP Approved	52 days	Tue 12/22/09	Wed 3/3/10
7	Dewatering Batch Discharge Permit/SFPUC Permit	30 days	Thu 3/4/10	Wed 4/14/10
8	Dewatering Operations	202 days	Mon 4/19/10	Tue 1/25/11
9	2009 SWPPP Amendment due date	0 days	Mon 9/21/09	Mon 9/21/09
10	2009/2010 Rainy Season	131 days	Thu 10/15/09	Thu 4/15/10
11	2010 Submit Annual Certification of Compliance	0 days	Tue 6/15/10	Tue 6/15/10
12	2010 SWPPP Amendment due date	0 days	Tue 9/21/10	Tue 9/21/10
13	2010/2011 Rainy Season	131 days	Fri 10/15/10	Fri 4/15/11
14	2011 Submit Annual Certification of Compliance	0 days	Wed 6/15/11	Wed 6/15/11
15	2011 SWPPP Amendment due date	0 days	Wed 9/21/11	Wed 9/21/11
16	2011/2012 Rainy Season	131 days	Fri 10/14/11	Fri 4/13/12



Project: Doyle_Contract4_WPC_Sche
Date: Mon 9/28/09

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

ATTACHMENT Q

Attachment R

Sampling Activity Log and Chain-of-Custody Forms

INSTRUCTIONS

- Use this form to log sampling activities.
- Maintain completed chain-of-custody forms in this attachment.

RAIN EVENT GENERAL INFORMATION				
Project Name				
Caltrans Contract N°				
Contractor				
Sampler's Name				
Signature				
Date of Sampling				
Season (Check Applicable)	☐ Rainy		☐ Non-Rainy	
Storm Data	Storm Start Date & Time:		Storm Duration (hrs):	
	Time elapsed since last storm (Circle Applicable Units)	Min. Hr. Days	Approximate Rainfall Amount (mm)	

For rainfall information: http://cdec.water.ca.gov/weather.html or http://www.wrh.noaa.gov/wrhq/nwspage.html

SAMPLE LOG		
Sample Identification	**Sample Location**	**Sample Collection Date and Time**

Specific sample locations descriptions may include: 30m upstream from discharge at eastern boundary, runoff from northern waste storage area, downgradient of inlet 57 at kilometer post 36, etc.

FIELD ANALYSIS		
	Yes No	
Sample Identification	**Test**	**Result**

Attachment S

Pollutant Testing Guidance Table

INSTRUCTIONS

- The following Table will be updated periodically as more information becomes available.

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Asphalt Products (Sections 37, 39, 92, 93, 94, and Special Provisions)	Hot Asphalt	Yes - Rainbow Surface or Brown Suspension	Visually Observable - No Testing Required		
	Asphalt Emulsion				
	Liquid Asphalt (tack coat)				
	Cold Mix				
	Crumb Rubber	Yes – Black, solid material	Visually Observable - No Testing Required		
	Asphalt Concrete (Any Type)	Yes - Rainbow Surface or Brown Suspension	Visually Observable - No Testing Required		
Cleaning Products	Acids	No	**pH** Acidity Anions (acetic acid, phosphoric acid, sulfuric acid, nitric acid, hydrogen chloride)	pH Meter Acidity Test Kit	EPA 150.1 (pH) SM 2310B (Acidity) EPA 300.0 (Anion)
	Bleaches	No	**Residual Chlorine**	Chlorine	SM 4500-CL G (Res. Chlorine)
	Detergents	Yes - Foam	Visually Observable - No Testing Required		
	TSP	No	**Phosphate**	Phosphate	EPA 365.3 (Phosphate)
	Solvents	No	**VOC**	None	EPA 601/602 or EPA 624 (VOC)
			SVOC	None	EPA 625 (SVOC)

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Portland Concrete Cement & Masonry Products (Section 27, 28, 29, 40, 41, 42, 49, 50, 51, 53, 63, 65, 72, 73, 80, 81, 83, 90, and Special Provisions)	Portland Cement (PCC)	Yes - Milky Liquid	Visually Observable - No Testing Required		
	Masonry products	No	**pH**	pH Meter Alkalinity or Acidity Test Kit	EPA 150.1 (pH)
			Alkalinity		SM 2320 (Alkalinity)
	Sealant (Methyl Methacrylate - MMA)	No	**Methyl Methacrylate**	None	EPA 625 (SVOC)
			Cobalt		EPA 200.8 (Metal)
			Zinc		
	Incinerator Bottom Ash Bottom Ash Steel Slag Foundry Sand Fly Ash Municipal Solid Waste	No	**Aluminum** **Calcium** **Vanadium** **Zinc**	Calcium Test	EPA 200.8 (Metal) EPA 200.7 (Calcium)
	Mortar	Yes - Milky Liquid	Visually Observable - No Testing Required		
	Concrete Rinse Water	Yes - Milky Liquid	Visually Observable - No Testing Required		
	Non-Pigmented Curing Compounds	No	Acidity	pH Meter Alkalinity or Acidity Test Kit	SM 2310B (Acidity)
			Alkalinity		SM 2320 (Alkalinity)
			pH		EPA 150.1 (pH)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Landscaping and Other Products (Section 20, 24, and Special Provisions)	Aluminum Sulfate	No	Aluminum	TDS Meter Sulfate	EPA 200.8 (Metal)
			TDS		EPA 160.1 (TDS)
			Sulfate		EPA 300.0 (Sulfate)
	Sulfur-Elemental	No	**Sulfate**	Sulfate	EPA 300.0 (Sulfate)
	Fertilizers-Inorganic [4]	No	**Nitrate**	Nitrate	EPA 300.0 (Nitrate)
			Phosphate	Phosphate	EPA 365.3 (Phosphate)
			Organic Nitrogen	None	EPA 351.3 (TKN)
			Potassium	None	EPA 200.8 (Metal)
	Fertilizers-Organic	No	TOC	Nitrate	EPA 415.1 (TOC)
			Nitrate		EPA 300.0 (Nitrate)
			Organic Nitrogen		EPA 351.3 (TKN)
			COD		EPA 410.4 (COD)
	Natural Earth (Sand, Gravel, and Topsoil)	Yes - Cloudiness and turbidity	Visually Observable - No Testing Required		
	Herbicide	No	**Herbicide**	None	Check lab for specific herbicide or pesticide
	Pesticide		**Pesticide**		
	Lime		Alkalinity	pH Meter Alkalinity or Acidity Test Kit	SM 2320 (Alkalinity)
			pH		EPA 150.1 (pH)

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Painting Products (Section 12-3.08, 20-2.32, 50-1.05, 59, 91, and Special Provisions)	Paint	Yes	Visually Observable - No Testing Required		
	Paint Strippers	No	**VOC**	None	EPA 601/602 or EPA 624 (VOC)
			SVOC	None	EPA 625 (SVOC)
	Resins	No	**COD**	None	EPA 410.4 (COD)
			SVOC		EPA 625 (SVOC)
	Sealants	No	**COD**	None	EPA 410.4 (COD)
	Solvents	No	**COD**	None	EPA 410.4 (COD)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)
	Lacquers, Varnish, Enamels, and Turpentine	No	**COD**	None	EPA 410.4 (COD)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)
	Thinners	No	VOC	None	EPA 601/602 or EPA 624 (VOC)
			COD		EPA 410.4 (COD)
Portable Toilet Waste Products	Portable Toilet Waste	Yes	Visually Observable - No Testing Required		

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Contaminated Soil [5]	Aerially Deposited Lead[3]	No	**Lead**	None	EPA 200.8 (Metal)
	Petroleum	Yes – Rainbow Surface Sheen and Odor	Visually Observable - No Testing Required		
	Mining or Industrial Waste, etc.	No	**Contaminant Specific**	Contaminant Specific – Check with laboratory	Contaminant Specific – Check with laboratory
Line Flushing Products	Chlorinated Water	No	**Total chlorine**	Chlorine	SM 4500-CL G (Res. Chlorine)
Adhesives	Adhesives	No	COD	None	EPA 410.4 (COD)
			Phenols	Phenol	EPA 420.1 (Phenol)
			SVOC	None	EPA 625 (SVOC)
Dust Palliative Products (Section 18)	Salts (Magnesium Chloride, Calcium Chloride, and Natural Brines)	No	Chloride	Chloride	EPA 300.0 (Chloride)
			TDS	TDS Meter	EPA 160.1 (TDS)
			Cations (Sodium, Magnesium, Calcium)	None	EPA 200.7 (Cations)
Vehicle	Antifreeze and Other Vehicle Fluids	Yes - Colored Liquid	Visually Observable - No Testing Required		
	Batteries	No	Sulfuric Acid	None	EPA 300.0 (Sulfate)
			Lead	None	EPA 200.8 (Metal)
			pH	pH Meter Alkalinity or Acidity Test Kit	EPA 150.1 (pH)
	Fuels, Oils, Lubricants	Yes - Rainbow Surface Sheen and Odor	Visually Observable - No Testing Required		

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Soil Amendment/Stabilization Products	Polymer/Copolymer [6, 7]	No	**Organic Nitrogen**	None	EPA 351.3 (TKN)
			BOD	None	EPA 405.1 (BOD)
			COD	None	EPA 410.4 (COD)
			DOC	None	EPA 415.1 (DOC)
			Nitrate	Nitrate	EPA 300.0 (Nitrate)
			Sulfate	Sulfate	EPA 300.0 (Sulfate)
			Nickel	None	EPA 200.8 (Metal)
	Straw/Mulch	Yes - Solids	Visually Observable - No Testing Required		
	Lignin Sulfonate	No	Alkalinity	Alkalinity	SM 2320 (Alkalinity)
			TDS	TDS Meter	EPA 160.1 (TDS)
	Psyllium	No	COD	None	EPA 410.4 (COD)
			TOC		EPA 415.1 (TOC)
	Guar/Plant Gums	No	COD	None	EPA 410.4 (COD)
			TOC		EPA 415.1 (TOC)
			Nickel		EPA 200.8 (Metal)
	Gypsum	No	pH	pH Meter Alkalinity or Acidity Test Kit	EPA 150.1 (pH)
			Calcium	Calcium	EPA 200.7 (Calcium)
			Sulfate	Sulfate	EPA 300.0 (Sulfate)
			Aluminum	None	EPA 200.8 (Metal)
			Barium		
			Manganese		
			Vanadium		

Attachment S
Pollutant Testing Guidance Table [1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators [2]	Suggested Analyses Field [3]	Laboratory
Treated Wood Products (Section 58, 80-3.01B(2), and Special Provisions)	Ammoniacal-Copper-Zinc-Arsenate (ACZA) Copper-Chromium-Arsenic (CCA) Ammoniacal-Copper-Arsenate (ACA) Copper Naphthenate	No	Arsenic Total Chromium **Copper** Zinc	Total Chromium	EPA 200.8 (Metal)
	Creosote	Yes - Rainbow Surface or Brown Suspension	Visually Observable - No Testing Required		

Notes:

1. 1 If specific pollutant is known, analyze only for that specific pollutant. See MSDS to verify.
2. For each construction material, test for one of the pollutant indicators. Bolded pollutant indicates lowest analysis cost or best indicator. However, the composition of the specific construction material, if known, is the first criterion for selecting which analysis to use.
3. See www.hach.com, www.lamotte.com, www.ysi.com and www.chemetrics.com for some of the test kits
4. If the type of inorganic fertilizer is unknown, analyze for all pollutant indicators listed.
5. Only if special handling requirements are required in the Standard Special Provisions for aerially deposited lead (ADL)
6. If used with a dye or fiber matrix, it is considered visually observable and no testing is required.
7. Based upon research conducted by Caltrans, the following copolymers/polymers do not discharge pollutants and water quality sampling and analysis is **not** required: Super Tak™, M-Binder™, Fish Stik™, Pro40dc™, Fisch-Bond™, Soil Master WR™, and EarthGuard™.

Acronyms:

BOD – Biochemical Oxygen Demand
COD – Chemical Oxygen Demand
DOC – Dissolved Organic Carbon
EPA – Environmental Protection Agency
HACH – Worldwide company that provides advanced analytical systems and technical support for water quality testing.
SM – Standard Method
SVOC – Semi-Volatile Organic Compounds
TDS – Total Dissolved Solids
TKN – Total Kjeldahl Nitrogen
TOC – Total Organic Carbon
TSP – Tri-Sodium Phosphate
VOC - Volatile Organic Compounds

References:

Construction Storm Water Sampling and Analysis Guidance Document, California Stormwater Quality Task Force, October 2001.
Environmental Impact of Construction and Repair Materials on Surface and Ground Waters, Report 448, National Cooperative Highway Research Program, 2001
Soil Stabilization for Temporary Slopes, Environmental Programs, California Department of Transportation, October 1, 1999.
Statewide Storm Water Management Plan, Division of Environmental Analysis, California Department of Transportation, April 2002.
Statewide Storm Water Quality Practice Guidelines, Environmental Program, California Department of Transportation, August 2000.
Soil Stabilization for Temporary Slopes and District 7 Erosion Control Pilot Study, June 2000.
Stormwater Monitoring Protocols, Guidance Manual, California Department of Transportation, May 2000.

Attachment T

Sampling Data Reporting Form

RAIN EVENT GENERAL INFORMATION				
Project Name				
Caltrans Contract N°				
Contractor				
Sampler's Name				
Signature				
Date of Sampling				
Season (Check Applicable)	☐ Rainy		☐ Non-Rainy	
Storm Data	Storm Start Date & Time:		Storm Duration (hrs):	
	Time elapsed since last storm (Circle Applicable Units)	Min. Hr. Days	Approximate Rainfall Amount (mm)	

SAMPLE LOG		
Sample Identification	Sample Location	Sample Collection Date and Time

Specific sample locations descriptions may include: 30m upstream from discharge at eastern boundary, runoff from northern waste storage area, downgradient of inlet 57 at kilometer post 36, etc.

FIELD ANALYSIS		
	Yes No	
Sample Identification	Test	Result

"I certify under a penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I

am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Contractor's Signature	Date
Contractor's Name and Title	Contractor's Telephone Number

Attachment U

Discharge Reporting Log

Project Name: _____

Caltrans Contract Number: _____

Date	Material(s) Discharged	Estimated Quantity	Observed By

Underground Classification No. C003-075-10T

STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT
2211 Park Towne Circle, Suite 2
Sacramento, California 95825

Telephone (916) 574-2540
FAX (916) 574-2542

July 20, 2009

Department of Transportation
111 Grand Avenue
Oakland, California 94612

Attention: Matthew Gaffney

Subject: Underground Classification No. C003-075-10T
Highway 101 (Doyle Drive) Sign Foundations

Mr. Gaffney:

The information provided to this office relative to the above project has been reviewed. On the basis of this analysis, an Underground Classification of "Potentially Gassy with Special Conditions" has been assigned to the tunnel identified on your submittal. Please retain the original Classification for your records and deliver a true and correct copy of the Classification to the tunnel contractor for posting at the job site.

When the contractor who will be performing the work is selected, please advise them to notify this office to schedule the mandated Prejob Conference with the Division prior to commencing any activity associated with construction or rehabilitation of the tunnel.

Please be informed that whenever an employee enters any bore or shaft being constructed under 30 inches in diameter, the Mining and Tunneling Unit then has immediate jurisdiction over that job. Please contact the Mining and Tunneling Unit prior to entering such spaces.

If you have any questions on this subject, please contact this office at your earliest convenience.

Sincerely,

John R. Leahy
Senior Engineer

cc: Richard Brockman
File

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C003-075-10T

DEPARTMENT OF TRANSPORTATION
(NAME OF TUNNEL OR MINE AND COMPANY NAME)

of 111 Grand Avenue, Oakland, California 94612
(MAILING ADDRESS)

at HIGHWAY 101 (DOYLE DRIVE) SIGN FOUNDATIONS
(LOCATION)

has been classified as *** POTENTIALLY GASSY with Special Conditions***
(CLASSIFICATION)

as required by the California Labor Code Section 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

SPECIAL CONDITIONS

1. A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.
2. Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.
3. The Division shall be notified immediately if any **Flammable Gas** or **Petroleum Vapor** exceeds 5% of the Lower Explosive Limit.
4. All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.

The thirty-four 60-inch diameter by 30 feet deep drilled shafts (CIDH) located near the south access to the Golden Gate Bridge near Doyle Drive, San Francisco Presidio, San Francisco County.

This classification shall be conspicuously posted at the place of employment.

Date July 20, 2009

John R Leahy
(SENIOR ENGINEER)

John R. Leahy

03 77089

Underground Classification No. C004-075-10T

STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT
2211 Park Towne Circle, Suite 2
Sacramento, California 95825

Telephone (916) 574-2540
FAX (916) 574-2542

July 20, 2009

Department of Transportation
111 Grand Avenue
Oakland, California 94612

Attention: Matthew Gaffney

Subject: Underground Classification No. C004-075-10T
Highway 101 (Doyle Drive) Battery Tunnels

Mr. Gaffney:

The information provided to this office relative to the above project has been reviewed. On the basis of this analysis, an Underground Classification of "Potentially Gassy with Special Conditions" has been assigned to the tunnel identified on your submittal. Please retain the original Classification for your records and deliver a true and correct copy of the Classification to the tunnel contractor for posting at the job site.

When the contractor who will be performing the work is selected, please advise them to notify this office to schedule the mandated Prejob Conference with the Division prior to commencing any activity associated with construction or rehabilitation of the tunnel.

Please be informed that whenever an employee enters any bore or shaft being constructed under 30 inches in diameter, the Mining and Tunneling Unit then has immediate jurisdiction over that job. Please contact the Mining and Tunneling Unit prior to entering such spaces.

If you have any questions on this subject, please contact this office at your earliest convenience.

Sincerely,

John R. Leahy
Senior Engineer

cc: Richard Brockman
File

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C004-075-10T

DEPARTMENT OF TRANSPORTATION

(NAME OF TUNNEL OR MINE AND COMPANY NAME)

of 111 Grand Avenue, Oakland, California 94612

(MAILING ADDRESS)

at HIGHWAY 101 (DOYLE DRIVE) BATTERY TUNNELS

(LOCATION)

has been classified as *** POTENTIALLY GASSY with Special Conditions***

(CLASSIFICATION)

as required by the California Labor Code Section 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

SPECIAL CONDITIONS

1. A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.
2. Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.
3. The Division shall be notified immediately if any **Flammable Gas** or **Petroleum Vapor** exceeds 5% of the Lower Explosive Limit.
4. All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.

The twin 65 feet wide by 27 feet high by 860 feet long tunnels located near the south access to the Golden Gate Bridge on Doyle Drive near Crissy Field Avenue, San Francisco Presidio, San Francisco County.

This classification shall be conspicuously posted at the place of employment.

Date July 20, 2009

John R Leahy

(SENIOR ENGINEER)

John R. Leahy

03 77089

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Owner Controlled Insurance Program (OCIP)

Updated 08/19/09

OCIP MANUAL

Prebid Version

OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

OCIP Manual

California Department of Transportation
Division of Construction, MS 44
Office of Risk Management
1120 N Street
Sacramento, CA 95814
Phone 916.654.4347 • Fax 916.654.5990

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Section 1

Overview

Welcome to the California Department of Transportation Owner Controlled Insurance Program.

The California Department of Transportation (Caltrans) has arranged insurance for certain construction projects under an Owner Controlled Insurance Program (OCIP). An OCIP is a consolidated insurance program that insures Caltrans, Construction Managers, the Contractor, eligible and enrolled subcontractors and other designated parties for Work performed at the Project Site.

The OCIP requirements do not create any contractual relationship between the subcontractors and the Department. The Contractor shall be responsible for compliance with all OCIP requirements for itself and eligible subcontractors of all tiers. Certain Contractors and Subcontractors are excluded from this OCIP. These parties are identified in the definitions section of this manual and in Section 4.

Coverage under the OCIP includes workers' compensation, general liability, excess liability, and contractor's pollution liability. This coverage shall be primary insurance for all construction activities performed at the job site. At its sole discretion, Caltrans may provide other insurance as appropriate.

See Section 8 of this manual for samples of forms that will assist you in identifying your insurance cost. The OCIP Administrator (see p. 3) can assist in determining insurance costs.

Caltrans will pay the insurance premiums for the OCIP coverages described in this manual. We recommend that you consult with your insurance representative to determine what modifications should be made to your insurance program due to OCIP coverage for on-site construction activities.

Note

Insurance coverages and limits provided under the OCIP are limited in scope and are specific to this project only. Your insurance representative should review this information. Any additional coverage you may wish to purchase will be at your option and expense.

About This Manual

The manual is designed to identify, define and assign responsibilities for the OCIP.

What This Manual Does

This Manual:

- Generally describes the Caltrans OCIP
- Identifies responsibilities of the various parties involved in the project
- Provides a basic description of the OCIP operation
- Describes audit and administrative procedures
- Provides answers to basic questions about the OCIP
- Will be updated as necessary

What this Manual Does Not Do

This Manual does not:

- Provide coverage interpretations
- Provide complete information about coverages
- Provide answers to specific claims questions

Specific questions about the OCIP, its administration or the coverages provided should be referred to the appropriate party identified in the Project Directory section immediately following this introduction. A "Frequently Asked Questions" (FAQ) section of this manual (Section 9) includes responses to various common questions.

Disclaimer

The information in this manual is intended to outline the OCIP Program. If conflict exists between this manual and the insurance policies or Contracts between Caltrans and Contractor, the policies or contracts will govern.

Key Information

This manual includes several important sections that provide quick reference information for contractors and subcontractors. Among these are:

- Project Directory: (p. 3) a listing of key contact people who can provide further information
- Definitions: (beginning on p. 4) a list of words used in the manual and their meanings
- Forms: (beginning on p. 21) copies of OCIP forms and instructions for their use

Section 2

OCIP Project Directory

The following list includes key risk management and insurance personnel involved in the project.

Project Management

Caltrans District X
Street
Local town, CA 90000

Construction Manager – ..... xxx xxx-xxxx
Senior Resident Engineer ..... xxx xxx-xxxx

Caltrans Risk Management Administration

California Department of Transportation
1120 N Street
Sacramento, CA 95814

OCIP Manager – Kha Hoang 916 654-4347

OCIP Administration

Kaercher/Campbell & Associates Insurance Brokerage, LLC
1840 Century Park East, Suite 1100
Los Angeles, CA 90067

OCIP Program Manager – ..... xxx xxx-xxxx
Safety Manager – ..... xxx xxx-xxxx

Insurers

XYZ Insurance Company, Inc.
ABC Casualty Company

Section 3

Project Definitions

The following definitions apply to this project and to the descriptions of the OCIP used in this manual.

Approved Additional Sites:	Storage yards or staging areas not at the site that are used solely in connection with performing work at the Project Site, approved by Caltrans and the insurer and scheduled on the insurance policies.
Caltrans	The California Department of Transportation
Certificate of Insurance:	A document providing evidence of the existence of coverage for a particular insurance policy or policies.
Confirmation Letter:	A letter issued by the OCIP administrator that confirms acceptance of the applicant into the Owner's OCIP.
Contract:	A written agreement between Caltrans and the Contractor for specific work. An agreement between a Contractor and any tier of subcontractor.
Contractor:	The person, firm, joint venture, corporation or other party that has a Contract with Caltrans to perform work at the Project Site.
Contractor deductible assessment:	The amount the Contractor or Subcontractor is responsible for paying as its contribution for settlement of an insured loss that is chargeable to the Contractor or subcontractor primarily responsible for causing any loss as determined by the OCIP insurance company and Caltrans.
Employer:	Any individual, firm, or corporation that provides direct construction labor for work performed at the Project Site.
Enrolled Parties:	Eligible Contractors and Subcontractors that have submitted all necessary enrollment forms and have been accepted into the OCIP as evidenced by a Confirmation Letter or Certificate of Insurance.
Excluded parties:	"Excluded Parties" are: (a) Architects, surveyors, engineers, and soil testing en-

gineers, and their consultants;
(b) Hazardous materials remediation, removal and/or transport companies and their consultants;
(c) Vendors, suppliers, fabricators, material dealers, truckers, haulers, drivers and others who merely transport, pickup, deliver, or carry materials, personnel, parts or equipment or any other items or persons to or from the Project site;
(d) Contractors and each of their respective Subcontractors who do not perform any actual labor on the Project site, during the term of the Contract;
(e) Persons or entities who are not Enrolled Parties;
(f) Any other persons or entities not specifically identified or who, whether or not they qualify as Enrolled Parties, are expressly excluded by Caltrans.

Insured: Caltrans, Enrolled Contractors and Subcontractors, the OCIP Administrator and any other party so named in the insurance policies while performing construction activities at the job site.

Insurer: The insurance companies named on a policy or certificate of insurance that provide coverage for the OCIP.

OCIP: Owner Controlled Insurance Program – A coordinated insurance program providing certain insurance coverages as generally described in this manual and as defined in the insurance policies covering activities at the Project site.

OCIP Administrator: Contractor hired by Caltrans to administer the OCIP by performing activities related to enrolling and insuring participants in the program and providing related administrative services.

On-Site Activities: Those activities "at or emanating from" the project site

Project Site: "Project Site" shall mean those areas designated in writing by Caltrans for performance of the Work.

Subcontractor: Those persons, firms, joint ventures, corporations or other parties that enter into a Contract with a Contractor to perform Work relating to the Project.

Work: Operations as fully described in the Contract, performed at or emanating directly from the Project Site. Also, the entire completed construction or the various separately identifiable parts required to be furnished under the Contract documents.

Section 4

OCIP Insurance Coverage

This chapter provides a brief description of OCIP Coverages. Please refer to the actual policies for details of coverage, exclusions and limitations.

Covered Parties

Parties covered as named insureds include Caltrans, Enrolled Contractors and Subcontractors. Other parties may be included as additional insureds at Caltrans discretion and subject to insurer approval.

Parties Not Covered

Parties ineligible for coverage include those contractors or subcontractors involved *solely* in surveying, soil testing, loading, transporting and unloading materials, personnel, parts or equipment or any other items to, from or within the Site and suppliers and subcontractors performing hazardous waste remediation work.

Evidence of Coverage

Each Enrolled Contractor and Subcontractor will be issued an individual workers' compensation policy. The OCIP Administrator will provide a Certificate of Insurance or copy of the policy evidencing general liability and excess liability to each Enrolled Contractor and Subcontractor, each of whom will be a named insured on the policies. Other documentation including forms, posting notices, etc., will be furnished to each Enrolled Contractor and Subcontractor. Complete copies of policies will be furnished to an authorized representative of each Enrolled Contractor and Subcontractor on request.

Description of OCIP Coverages

The following sections describe the policies that Caltrans has arranged for this project.

Each Enrolled Contractor and Subcontractor will be issued a separate workers' compensation policy

Workers Compensation and Employers Liability:

Annual Limits Per Insured

Part One - Workers' Compensation:	Statutory Limit
Part Two - Employer's Liability:	
Bodily Injury by Accident, each Accident:	$1,000,000
Bodily Injury by Disease, each employee	1,000,000
Bodily Injury by Disease, policy limit:	1,000,000

- Other States Endorsement
- Waiver of Subrogation
- Alternate Employer Endorsement
- Voluntary Compensation

A single policy will be issued for all insureds for all liability and property coverage. Enrolled Contractor and Subcontractor will receive certificates or copies of the policy.

Commercial General Liability

Limits of Liability Shared by All Insureds

General Aggregate	$4,000,000
Products/Completed Operations Aggregate	$4,000,000
Personal/Advertising Injury Aggregate	$2,000,000
Each Occurrence Limit	$2,000,000
Fire Damage Legal Liability (any one fire)	$1,000,000
Medical Expense Limit (any one person)	$5,000

GENERAL LIABILITY DEDUCTIBLE ASSESSMENT

$ 25,000 maximum per occurrence caused by contractor or its subcontractor of any tier subject to adjustment to equal contractor's corporate general liability policy (non-OCIP) deductible with a minimum of $5,000 or the actual amount of loss, whichever is less.

- Broad named insured
- Amend Bodily injury definition
- Delete 50' railroad limitation
- Delete Personal Injury/Advertising Injury contractual liability exclusion
- Fellow employee coverage – supervisory personnel only
- Annual Reinstatement of Aggregates (except Products/Completed Operations)
- Ten (10) Year Products & Completed Operations Extension (single aggregate)

Excess Liability

Limits of Liability Shared by All Insureds

Each Occurrence Limit	$200,000,000
Annual General Aggregate Limit	$200,000,000

- "Pay on behalf" wording
- Annual reinstatement of limits
- "Contractors Limitation" endorsements deleted
- Underlying Coverages: Employer's Liability; Primary Commercial General Liability
- Ten (10) Year Completed Operations Extension beyond Final Acceptance of project
- Excludes: Real & Personal Property in the care, custody or control of the insured; Asbestos; Discrimination & Wrongful Termination; ERISA; Owned & Nonowned Aircraft, Watercraft, and Automobile Liability; Nuclear Broad Form Liability

Contractor Pollution Liability

Limits of Liability Shared by All Insureds

Each Occurrence and Aggregate Limit $25,000,000
Coverage extends to hazardous materials transport and treatment / disposal facilities.

Note

The descriptions above provide a summary of coverages only. Contractors should refer to the policies for actual terms and conditions.

Note

Contractors are advised to arrange their own insurance for contractor-owned equipment and materials not intended for inclusion in the project. The OCIP will not cover Contractor property.

OCIP Termination or Modification

Caltrans reserves the right to terminate or modify the OCIP or any portion thereof. If Caltrans exercises this right, contractors will be provided notice as required by the terms of their individual contracts. At its option, Caltrans may procure alternate coverage or may require the Contractors to procure and maintain alternate insurance coverage.

Section 5

Insurance Required From Contractors

Contractors and subcontractors are required to maintain coverage to protect against losses that occur away from the Site or that are otherwise not covered under the OCIP.

Contractors and Subcontractors are required to maintain insurance coverage that protects the Owner from liabilities arising from the contractor's and subcontractor's operations performed away from the Project site, for types of coverage not provided by the OCIP, and for operations performed in connection with this Contract by excluded parties.

See Section 8 for sample certificate of insurance forms.

Verification of insurance may be submitted in the form of a Certificate of Insurance on a standard ACORD Form 25. A sample of an acceptable Certificate of Insurance is provided in Section 8. Please note requirements for thirty- (30) days notice of cancellation, waiver of subrogation and additional insured status.

Contractors are responsible for monitoring their Subcontractors and Excluded Parties' Certificates. Caltrans reserves the right to disapprove use of Subcontractors unable to meet the insurance requirements. Certificates evidencing compliance shall be available to Caltrans, or the OCIP Administrator upon request.

Note

Prior to mobilization and within three (3) days of any renewal, change or replacement of coverage, Contractors and Subcontractors shall submit to Caltrans a Certificate of Insurance evidencing the coverage and limits as specified in this section. The Certificate shall evidence a 30-day notice of cancellation provision

The limits of liability shown for the insurance required of the Contractor and Subcontractors are minimum limits only and are not intended to restrict the liability imposed on the Contractor and Subcontractors for Work performed under their Contract.

Contractor-Provided Coverages

All Contractors shall provide evidence of automobile liability. The OCIP does not cover automobile liability.

Automobile Liability

Covering all owned, hired and non-owned automobiles, trucks and trailers with coverage not less than that of the commercial Business Auto Policy with limits not less than **$1,000,000 Combined Single Limit** each accident for Bodily Injury and Property Damage. Coverage shall apply both on and away from the Project Site. All subcontractors shall be required to maintain limits of not less than **$1,000,000 Combined Single Limit.**

Eligible contractors shall provide evidence of workers' compensation insurance for off-site activities, including design work.

Ineligible contractors shall provide evidence of workers' compensation applicable to this project.

Workers' Compensation and Employer's Liability

	Limits of Liability
Part One - Workers' Compensation:	Statutory Limit
Part Two - Employer's Liability:	
	Limit
Bodily Injury by Accident, each Accident:	$1,000,000
Bodily Injury by Disease, each employee	1,000,000
Bodily Injury by Disease, policy limit:	1,000,000

Eligible contractors shall provide evidence of general liability insurance for off-site activities.

Ineligible contractors shall provide evidence of general liability insurance applicable to this project and must add Caltrans and other parties as additional insureds to the policy.

Commercial General Liability/Umbrella Liability

Total Limits of Liability	
	Limit
General Aggregate	$4,000,000
Products/Completed Operations Aggregate	$4,000,000
Personal/Advertising Injury Aggregate	$4,000,000
Each Occurrence Limit	$3,000,000

Coverage shall be on an Occurrence form and apply to bodily injury and property damage for operations (including explosion, collapse and underground coverage), independent contractors, products and completed operations. Limits can be provided by a combination of a primary Commercial General Liability policy and Excess or Umbrella Liability policy.

Protection & Indemnity (P&I)

Should the contractor's work require the use of watercraft on coastal waters, the Contractor shall obtain and maintain, or require its subcontractors utilizing watercraft vessels to perform such activities, to obtain and maintain, at all times during the term of this contract, protection and indemnity insurance with limits to be approved by the Department.

Aircraft Liability

Should the contractor's work require the use of aircraft of any kind, the contractor shall obtain and maintain, or require its subcontractors utilizing aircraft to perform such activities, to obtain and maintain, at all times during the term of this contract, aircraft liability insurance with limits to be approved by the Department.

Caltrans does not provide professional liability insurance for contractors or subcontractors.

Professional Liability

All professional service firms must provide professional liability insurance appropriate to their profession. Architects and engineering firms and contractors doing any design work must provide insurance covering liability arising out of design errors and omissions with a limit of not less than $2,000,000 per claim and aggregate with a maximum of $100,000 self insured retention.

The OCIP does not provide insurance for contractors or subcontractors tools or equipment.

Contractor's Tools and Equipment Floater

Whatever coverage the Contractor may deem necessary for protection against loss of owned, rented, or borrowed capital equipment and tools, including any tools owned by mechanics, and any tools, equipment, scaffolding, staging, trailers, cranes, towers, and forms owned, rented, or borrowed by it or it's subcontractors, must be provided by the Contractor. The Department will have no liability with respect to such equipment and tools. Failure of the Contractor to secure such insurance or to maintain adequate levels of coverage does not obligate the Department or its agents and employees for any losses on owned, rented, or borrowed equipment. Any policies maintained by the Contractor on their owned or rented equipment and materials shall contain a provision requiring the insurance companies to waive their rights of subrogation against the Department.

Note: Waivers Required/Caltrans as Additional Insured

Contractor shall waive its rights of recovery` in favor of Caltrans and other designated parties. General Liability, Excess Liability, and Aircraft Liability Policies shall name the State of California, the California Department of Transportation, the United States, the Presidio Trust, the National Park Service, and their officers, directors, agents, subsidiaries, parents, and employees as additional insureds out of or connected with work performed by or on behalf of the contractor. The endorsement must be separately attached to the certificate of insurance, list the project number, and list the entities referenced above as additional insureds. Coverage shall state that coverage is primary and non-contributory.

Section 6

Contractor Responsibilities

Throughout the course of the Project, Contractors will be responsible for reporting and maintenance of certain records as outlined in this section.

The Contractor is required to cooperate with Caltrans and its OCIP Administrator in all aspects of OCIP operation and administration. Responsibilities of the Contractor include:

- Enrolling in the OCIP
- Including OCIP provisions in all subcontracts as appropriate
- Providing each Subcontractor with a copy of the OCIP manual
- Requiring that all eligible Subcontractors who will perform Work at the Job Site are enrolled in the OCIP prior to working on the site
- Providing timely evidence of insurance to the Engineer
- Notifying the Engineer of all subcontracts awarded
- Maintaining and reporting monthly payroll records
- Complying with the OCIP Administrator's requests for information
- Complying with insurance, claim and safety procedures
- Paying deductible assessments promptly as required
- Notifying the Engineer immediately of any insurance cancellation or non renewal (contractor-required insurance)
- Cooperating with OCIP insurance policy requirements, including but not limited to physical audit of payroll records by the insurance company or its representatives.

Enrollment

See Section 8 for sample OCIP enrollment forms.

Each Contractor shall provide details about its subcontractors as necessary to enroll them in the OCIP.

Forms To Be Submitted

The Contractor shall submit the following forms as specified:

CT OCIP Form 1, "OCIP Enrollment Form:" CT OCIP Form 1 shall be completed and submitted to the OCIP Administrator for the Contractor and each eligible subcontractor of every tier by the following deadlines:

Prime Contractors:	During OCIP Enrollment and prior to starting work
Listed Subcontractors:	During OCIP Enrollment and prior to starting work
Non-Listed and Lower-Tiered Subcontractors:	During OCIP Enrollment and prior to starting work

OCIP coverage will not be in effect for the Contractor or Subcontractors until CT OCIP Form 1 has been received and approved by the OCIP Administrator.

CT OCIP Form 2, "Monthly Payroll Reporting Form:" The Contractor and enrolled subcontractors of all tiers shall complete and submit to the OCIP Administrator CT OCIP Form 2 for the prior month's work by the 15th day of the subsequent month. This form shall be submitted monthly until CT OCIP Form 3, "Contractor's Notice of Work Termination Form," is submitted, even if there was no on-site work performed. CT OCIP Form 2 is in addition to any payroll records required by Section 7-1.01A(3), "Payroll Records," of the Standard Specifications.

CT OCIP Form 3, "Contractor's Notice of Work Termination:" The Contractor and subcontractors of all tiers shall complete and submit this form to the OCIP Administrator upon completion of its work by the 5th work day after the last day of the month including punch list items under the contract. The Contractor is responsible to make sure subcontractors of all tiers complete this form.

All Eligible Parties performing Work at the Job Site are required to enroll in the OCIP. Each Eligible Party (Contractor/Subcontractor) initiates the enrollment process by submitting CT OCIP Form 1 to the OCIP Administrator. Each Contractor shall also provide details (contact and related project information) about its Subcontractors as necessary for OCIP enrollment and require that each of its Subcontractors as an Eligible Party complete and submit CT OCIP Form 1 to the OCIP Administrator prior to beginning work on the Job Site.

Direct questions about the enrollment process and completion submission of enrollment documents to the OCIP Administrator. See Section 2 for information on contacting the OCIP Administrator.

When a Contractor or Subcontractor is accepted into the OCIP, they will receive a Certificate of Insurance and a Confirmation Letter acknowledging that they have been enrolled into the OCIP.

Note: Enrollment Not Automatic

Enrollment into the OCIP is required, but not automatic. Eligible contractors and all eligible subcontractors MUST complete the enrollment forms and participate in the enrollment process for OCIP coverages to apply. No contractor or subcontractors will be allowed on the job site until enrollment is complete. The OCIP Administrator will arrange enrollment meetings with each eligible contractor and subcontractor.

Deductible Assessment

Caltrans requires Enrolled Contractors to pay an amount not to exceed $25,000 for a General Liability or Pollution Liability loss chargeable to the Contractor or subcontractor primarily responsible for causing any loss as determined by the OCIP insurance company. The OCIP Administrator will notify the responsible contractor or subcontractor of such claims and will consider information from the contractor for claims investigation, but the OCIP insurer will make the final determination of liability and payment. This "Deductible Assessment" is not covered by the OCIP and shall remain uninsured.

The Department will withhold from the Contractor's progress payment the amount of the General Liability Deductible Assessment as determined by claim cost estimates established by the respective OCIP Insurance Company. The amount of the assessment will be based on the actual loss but will be adjusted to equal the contractor's non-OCIP (corporate general liability policy) insurance deductible with a maximum of $25,000 and a minimum of $5,000 or the actual loss, whichever is less.

The deductible assessment applies to contractor pollution liability claims. The amount of the deductible assessment will be determined by the deductible on the Contractor or subcontractor's pollution liability policy subject to a minimum assessment of $5,000 or actual loss, whichever is less. In the event that the Contractor or subcontractor does not have a contractor's pollution liability policy, the Contractor's or subcontractor's general liability policy deductible will be used to determine the assessment subject to the minimums described above.

The deductible assessment does not apply to workers' compensation claims for Contractor's own employee.

Due to the potential development of claims costs in the course of handling any OCIP claim, the amount of the Liability Obligation withheld might be in excess of the actual claim costs. In that case the difference between the actual claims costs and the Liability Deductible Assessment amount withheld may not be released until such time the OCIP Insurance Company has confirmed closure of the claim file.

Assignment of Return Premiums

Caltrans will pay for the cost of the OCIP insurance coverages. Caltrans will be the sole recipient of any return OCIP premiums or dividends. All Enrolled Contractors and Subcontractors shall assign to Caltrans all adjustments, refunds, premium discounts, dividends, credits or any other monies due from the OCIP insurers. Contractors shall assure that each Enrolled Subcontractor shall execute such an assignment.

Payroll Reports

Each Contractor and Subcontractor of every tier must submit by the 15th of the following month, payroll reports identifying man-hours and payroll for all work performed at the Project Site during the previous month. The monthly man-hour and payroll reports should include supervisory and clerical personnel on-site and shall certify all Work performed at or emanating directly from the Project Site. This information will be used to provide the insurance company with information required to determine Caltrans' premium. This report is required even if no work was performed by the contractor in the prior month unless the contractor has completed a CT OCIP Form 3, "Contractors' Notice of Work Termination."

Note: Separate Reports Required

A separate Monthly Payroll Report is required for each enrolled contractor. This report is *not* a certified payroll form. See Section 8.

Insurance Company Payroll Audit

Each Enrolled Contractor and Subcontractor is required to maintain payroll records for the Project Site in accordance with the Basic Manual of Rules, Classifications, and Experience Rating Plan for Workers' Compensation and Employer's Liability Insurance. Such records shall allocate the payroll by Workers' Compensation classification(s) and shall exclude the excess or premium paid for overtime (i.e., only the straight time rate shall apply to overtime hours worked). Furthermore, such records shall limit the payroll for Executive Officers and Partners/Sole Proprietors to the limitations as stated in the state manual rules.

It is important that you properly classify payrolls, as these will be reported to the rating bureau for promulgation of future Experience Modifiers for your firm. All Enrolled Contractors and Subcontractors shall make available their books, vouchers, contracts, documents, and records, of any and all kinds, to the auditors of the OCIP insurance carriers or Caltrans' representatives at any reasonable time during the policy period, any extension, or during a final audit period as required by the insurance policies.

Note

Failure to submit the payroll reports as required may result in the withholding of payments until required documentation is received.

Completion of Work

When an Enrolled Contractor or Subcontractor has completed its Work, that party shall complete the CT OCIP Form 3, "Contractor's Notice of Work Termination," and submit it to the OCIP Administrator. Final Payment will not be released by the Owner until all necessary forms have been submitted to the OCIP Administrator.

Claims Reporting

A claims kit will be provided to all contractors. It will include details about claim reporting and is intended for use at the job site.

Each Contractor and Subcontractor shall follow claims procedures established by the OCIP Administrator. Contractors and Subcontractors agree to assist and cooperate in every manner possible with the adjustment of all claims and demands. Refer to Section 7 of this Manual.

Safety Procedures

The Contractor shall ensure that its employees and the general public will be provided a clean, safe environment free of hazards during construction activities. The ultimate responsibility for providing a safe place to work rests with the Contractor. The Contractor shall develop its own written Site-Specific Safety Program (SSSP). At minimum, the SSSP shall conform to the requirements addressed in the CA Code of Regulations if applicable, and any other pertinent safety regulations. This includes, but is not limited to; all applicable local, state, and federal Safety Standards and Codes.

The Contractor shall allocate a full-time, 100% project dedicated, on-site Safety Quality Control Manager (SQCM) for the duration of this contract. This SQCM must be a competent and qualified person, as defined by Cal OSHA, shall provide oversight on the project. SQCM shall have knowledge in the area of safety procedures for all types of work being performed on this contract. SQCM shall be up to date on Caltrans, Cal OSHA, OSHA and other safety agency requirements. SQCM shall continuously review the construction work plan and actual work, and submit daily status reports to the Engineer through the contractor's onsite construction manager on all activities underway to document safety conditions, and if necessary measures being taken to improve safety. This provision does not relieve the Contractor of his responsibility to comply with all safety requirements of the contract.

At a minimum, daily status reports shall include:

1. Documentation of daily work activity.

2. Documentation of safety related field activities.

3. Documentation of safety deficiencies and corrective actions taken.

4. Documentation of meetings, conversations, and other communications related to safety issues.

All reports shall include name of individual preparing report, date, and weather conditions.

The Contractor shall provide resumes/qualifications for SQCM for review and approval by the Engineer. Contractor shall terminate and/or replace the SQCM upon 2 weeks written notice from the Engineer. The Contractor may terminate and/or replace the SQCM upon 2 weeks written notice to the Engineer.

Without diminishing the Contractor's responsibility for safety, the Department through the OCIP may provide technical safety services to assist the Engineer in monitoring the safety, health, and environmental performance of the Contractor and its subcontractors of all tiers. The Contractor and its subcontractors of all tiers shall be monitored for effectiveness and application of their respective safety programs at the job site.

The Contractor and its subcontractors of all tiers shall adhere to a 100 percent drug and alcohol-free program. At a minimum pre-employment, probable cause, and post-accident testing is required.

Contractor employees must wear approved Class B hard hats on the job site.

Fall protection is required for work at or above six feet.

The Contractor or subcontractors shall ensure that employees of the Contractor and subcontractors of all tiers attend a safety orientation program and that new hires and personnel transferred to the project receive this orientation prior to starting work. This orientation shall be designed to communicate all project-specific safety policies, procedures, and expectations of the Department in regard to the construction of the project.

The Contractor shall perform a daily self-inspection of the site and shall document such inspections at least weekly.

The Contractor or subcontractors shall hold weekly crew-level toolbox safety meetings. These meetings shall be documented as to content and attendance.

The Contractor shall hold weekly subcontractor safety coordination meetings documented as to content and attendance.

The Contractor and subcontractors are responsible to assure that any accident receives prompt response including investigation, analysis and reporting, and that any injuries receive prompt care and treatment.

Off-Site Locations

The Contractor is responsible for applying for approval to have off-site locations covered. The Contractor shall notify the OCIP Program Administrator of the need and shall request approval of the site. The request should include the location, address, description of the site and the type of use it will be put to and the duration of the work to be preformed at the site. The off-site location must be 100% dedicated to the project.

Close Out And Audit Procedures

When a Contractor and/or an associated Subcontractor has completed its Work at the Project and will no longer have on-site workers, the Contractor shall notify the Owner by submitting the CT OCIP Form 3, "Contractor's Notice of Work Termination," for the final reporting and audit of payroll and man-hours. A copy of CT OCIP Form 3 with instructions on the proper method for completion is in Section 8. Any deductible assessment for which the Contractor or Subcontractors are responsible for, must be satisfied prior to close-out.

Section 7

Claim Procedures

This section describes basic procedures for reporting various types of claims: workers' compensation, liability, and damage to the project.

General Procedures

Catastrophic or Traumatic Injuries – Call emergency by dialing 911 and provide the operator with any information requested.

Make no statements to the media. Refer all questions from the media to the Department's Engineer.

It is the responsibility of all Enrolled Contractors to report immediately all occupational-related illnesses and injuries, liability claims or property damage to the Department's Engineer. All Contractors/Subcontractors and others involved in the OCIP shall instruct employees and other personnel to report in writing to the Department's Engineer within 24 hours of any Accident or Occurrence of any type that might lead to a loss.

Department's Engineer

Immediately call the Department's Construction Safety Representative at (TBD) in the event of the following:

- Fatality
- Any injury
- An ambulance is called
- Injury to head or neck
- Unconscious employee
- Possible blindness
- Amputation of limbs
- Heart attack or stroke
- Hospitalization
- Possible injury to back or spinal cord
- Property damage estimated over $1,000
- Actual or alleged injury to a member of the general public
- Damage to property owned by the general public regardless of the estimated amount of damages

Workers' Compensation Claims

A claims kit will be provided to all contractors. It will include details about claim reporting and is intended for use at the job site.

The main responsibility for any Contractor is first to see that any injured worker receives immediate medical care. Next, you should notify the OCIP administrator immediately in the event of a serious injury or accident.

An Employer's First Report of Injury (form 5020) must be completed and submitted to the OCIP Administrator, along with the DWC-1 (Employee's Claim) and the Supervisor's Report of Injury form.

The OCIP administrator will provide claims kits to all Enrolled Contractors and Subcontractors. These kits will include all claim forms that are needed. Additional kits or claim forms can be obtained from the OCIP administrator or the Insurer's Claims Coordinator.

Caltrans' insurer will arrange with preferred medical providers for treatment of all minor or non-life-threatening injuries. A list of these providers will be provided for insertion at the end of this manual.

Enrolled Contractors and Subcontractors must designate a representative at the site to take injured employees to the medical center, and to report the claim. This individual should remain with the injured employee at the center while he/she is being treated. The treating physician should provide a written description of whether or not the injured employee can return to work, a list of restrictions if any, and the estimated length of time he/she will stay on modified duty.

Caltrans' insurer will arrange with the local 911 emergency ambulance services for response to any serious traumatic life threatening injuries and will provide information for insertion in this manual and in the claims kit.

Liability Claims

Accidents resulting in damage to property of others (other than the Work itself), or personal injury or death to a member of the public, must be reported immediately to the OCIP Administrator. A General Liability Loss Notice (Accord Form 3) shall be completed and delivered within 24 hours to the OCIP Administrator.

Contractors and Subcontractors shall not voluntarily admit liability and shall cooperate with Caltrans or insurer representatives in the accident investigation.

The Contractor shall be responsible for up to the first $25,000 of any damages/injuries caused by the Contractor or its Subcontractors to third parties. Please refer to Section 4, page 7 for a description of the operation of the contractor's deductible assessment.

Property Claims

Report any damages to your Work or the Work of any other Contractor/Subcontractor to the OCIP Administrator. In addition, complete the Property Loss Notice (ACORD Form 1) and submit it to the OCIP Administrator.

Contractor will be responsible for up to the first $25,000 of insured damage to Contractor's Work or the Work of any other Contractor caused by Contractor or Subcontractors of any tier.

No coverage is provided for contractors' tools and equipment under the OCIP. It is the sole responsibility of each Contractor and Subcontractor to report damage to the project and to their tools and equipment to their own insurers.

Automobile Claims

No coverage is provided for automobile accidents under the OCIP. It is the sole responsibility of each Contractor and Subcontractor to report accidents involving their automobiles to their own insurers.

HOWEVER, all accidents occurring in or around the job site must be reported to the OCIP Administrator. These accidents will be investigated with regard to any liability arising out of the Project construction activities that could result in future claims (i.e. due to the conditions of the roads, etc.) Each Contractor and Subcontractor shall cooperate in the investigation of all automobile accidents.

Pollution Claims

Contractors should **immediately** notify the OCIP administrator of any known or suspected pollution incidents.

Section 8

Forms & Exhibits

This section contains the forms needed for reporting claims, reporting payroll and other administration of the OCIP.

Note

For assistance in completing these forms, please contact:
Kaercher Campbell & Associates Insurance Brokerage
1840 Century Park East, Suite 1100
Los Angeles, CA 90067
Fax 310 551-6888

This section contains the following forms:

CT OCIP Form 1, "OCIP Enrollment Form."

CT OCIP Form 2, "Monthly Payroll Reporting Form."

CT OCIP Form 3, "Contractor's Notice of Work Termination Form

Exhibit 1	Sample Certificate of Insurance
Exhibit 2	Accident Investigation Report
Form 5020	State of California Employers Report of Occupational Injury or Illness
	State of California Employee's Claim for Worker's Compensation Benefits
	General Liability Loss Notice – TBD
Exhibit 3	Detailed Summary of OCIP Coverages and Limits

Contract No. _____

OCIP ENROLLMENT FORM

CT OCIP FORM 1

CONTRACTOR INFORMATION:

Contractor/Subcontractor: _____ Indv: _____ Ptshp:_____ Corp: _____ J/V: _____
Address: _____ **FEIN:** _____
Office Contact: _____ Phone: _____ Fax: _____
Email Address: _____
Site Contact: _____ Phone: _____ Fax: _____
Safety Contact: _____ Phone: _____ Fax: _____
Insurance Contact: _____ Phone: _____ Fax: _____
Payroll Contact: _____ Phone: _____ Fax: _____
Address (if different): _____

CONTRACT INFORMATION: Contract Value: $_____ Contract/JOB#: _____

Job Name/Description: _____ DBE/DVBE: _____
Prime Contractor: _____ Subcontractor: _____
Start Date: _____ Est. Completion Date: _____ % Self Performed _____ Est. Man-hours _____
% Subcontracted _____ Est. # of Subcontractors _____ Est. Sub'd Man-hours _____

CURRENT INSURANCE INFORMATION:

REQUIRED INSURANCE COVERAGES AND LIMITS ARE SHOWN IN THE CONTRACT DOCUMENTS AND THE OCIP INSURANCE MANUAL. Contractor's Insurance Broker or Agent:
Company Name: _____ Contact: _____
City: _____ Phone: (_____) _____

WORKERS' COMPENSATION INSURANCE INFORMATION: Please use policy that was in effect at time of bid award
Current WC Ins. Co: _____ Policy No.: _____ Policy Period: _____
Experience Modifier: _____ Rate Date: _____ Deductible: _____ Retention: _____

A. Workers' Compensation (Project Site Payroll Only)
Attach copy of declaration page and rate sheets for WC Policy

W.C. Class Description	W.C. Class Code	W.C. Rate per $100 Payroll	Estimated Payroll *	Premium
1.				
2.				
3.				
		Subtotal	$	$
* It is extremely important to accurately estimate payrolls anticipated for this contract. Payroll should be raw wages without burden, fringes, or overtime premium: but should include sick, vacation, holiday pay and imputed income. **Attach a copy of your current Workers' Compensation policy declaration page and rating sheets**			Increased Limits Factor:_____ Experience Modifier:_____ Discounts:_____ Surcharges/Assessments:_____	$ $ $ $
* Deductible and Self-Insured Retention Credits shall be identified but not allowed. Since these types of programs require loss funding, the credits or the loss pick must be identified but not allowed in calculating the total workers' compensation premium. Composite Rates must have rating sheets. Corporate Allocations must include the actual insurance company rating. Provide additional documentation for all such credits.			Deductible Credit * OR Self Insured Retention Credit *	*Deductible or self-Insured retention credits shall be identified but not allowed.
			Total Workers' Compensation Premium	**A $**

CT OCIP FORM 1

OCIP ENROLLMENT FORM

GENERAL LIABILITY (GL) INFORMATION:

Current GL Ins. Co: _____ Policy No.: _____ Policy Period: _____

Current GL rate is based on: Payroll or Receipts per $100 $1,000 or Receipts or Flat Premium

Deductible: _____ Retention: _____

A. Worker's Compensation	**(Total from page 1 "A")**			**A. $**
B. General Liability (Project Site Payroll/Receipts Only) Attach copy of Declaration page and Rating Sheets for GL Policy				
GL Classification	**GL Code**	**GL Rate as shown above**	**Estimated Payroll*/Receipts***	**Premium**
1.				$
2.				$
3.				$
4. Subcontractors	91585			$
5.				
* Deductible and Self-Insured Retention Credits shall be identified but not allowed. Since these types of programs require loss funding, the credits or the loss pick must be identified but not allowed in calculating the total general liability premium. Composite Rates must have rating sheets. Corporate Allocations must include the actual rating insurance company rating. Provide additional documentation for all such credits.		*Deductible or self-insured retention credits shall be identified but not allowed.	**Total GL Premium**	**B. $**
*It is extremely important to accurately estimate payrolls/receipts.				
C. Umbrella Excess Liability: Ins. Co.: _____ **Policy Period:** _____ **Rate:** _____ **per $** _____ **Payroll / Receipts** ***Attach copy of declaration page and rating sheets for Umbrella/Excess policy**				**C. $**
D. Estimated Subcontractor Premiums (Attach Cost Identification Sheet for Each Subcontractor or calculate 4% of Subcontract value for each subcontractor's estimated insurance cost) ***CONTRACTOR MUST ENSURE ALL SUBCONTRACTORS COMPLETE "CT OCIP FORM 1"**				**D. $**
E. TOTAL PREMIUMS (A + B + C + D)				**E. $**

Contractor should notify its own insurance carrier to exclude all work done under this contract from your current insurance program.

AGREEMENT

The Department, or their Agent, is granted permission by Contractor to inspect the insurance and payroll records used in determining the above credit and to release all relevant information for review DEPARTMENT or their Agents. At completion of the Work, Agent shall audit the payroll records of Contractor for final audited insurance premiums in accordance with the insurance premium audit provisions of the OCIP. Any and all returns of premiums, dividends, discounts or other adjustments to any OCIP policy is assigned, transferred and set over absolutely to DEPARTMENT. This assignment is valid for insurance policies whose premiums have been paid by DEPARTMENT on behalf of such Contractor.

Signed _____ Title _____ Date _____

Please submit this form to the Engineer

CT OCIP FORM 2

CALTRANS
OWNER CONTROLLED INSURANCE PROGRAM

MONTHLY PAYROLL REPORTING FORM

(Report job site payroll separately by each contract)

Contractor/Subcontractor: _____ Contract Location Code: _____

Address: _____ Department: _____ State: _____ Zip: _____
Phone: _____ Fax: _____
Prime Contractor: _____ Subcontractor: _____

Please indicate Job Site Payroll and forward with pay application. Please retain a copy for your files.

MONTH ENDING: _____ **Contract/Job #:** _____

IS THIS IS YOUR FIRST PAYROLL REPORT? IF SO, PLEASE SHOW START DATE: _____
Is this is your final payroll report? If so, please show completed date: _____

WORKERS' COMPENSATION (WC)			
WC Classification Description	**Man-Hours**	**WC Code**	**Actual Payroll**
1.			
2.			
3.			
Total			
GENERAL LIABILITY (GL)			
GL Classification Description		**GL Code**	**Receipts/Other**
1.			
2.			
3.			
Total			
If GL premium is based on Receipts, please show total monthly Receipts: $_____			

- It is extremely important to accurately estimate payrolls anticipated for this contract. Payroll should be raw wages **without** burden, fringes, or overtime premium but should include sick, vacation, holiday pay and imputed income.
- Earnings for overtime should be included only at straight hourly rates. Overtime **hours** should be shown but do not include the extra wages paid for Overtime hours.
- Overtime means those hours in excess of 8 hours worked each day, 40 hours in any week or on Saturdays, Sundays, or holidays, but only when there is an increase in the hourly rate to work such hours.
- If GL is based on payroll -- only show the classification description and codes, man-hours and payroll are already shown under WC.

The above is a true and complete statement of the entire remuneration of services rendered by employees of the company shown above.

Signature: _____ Title: _____ Date: _____

Please submit this form to the Engineer

CT OCIP FORM 3

Contractor's Notice of Work Termination

Note: Every enrolled Contractor and subcontractor of all tiers must complete this form.

Submit this form to: The Engineer
Fax:
Tel:

Contract Location Code:_____
Contract/Job #:_____

Please be advised _____ **is scheduled to complete work for:**
(Your company's name)

Job Name/Description: _____
Contractor _____ Subcontractor: _____

Actual Start Date:_____ **Actual Completion Date:** _____
Original Contract Value: _____ **Final Contract Value:**_____
Final Total Payroll value:_____

Please provide accurate final values in order for Willis to calculate your final OCIP deduct. Delays in providing this form and accurate information to Willis will delay close out of your contract and release of any retention.

We used the following subcontractors who will also complete their work on the date shown above:

Subcontractor	Final Contract Value
_____	$ _____
_____	$ _____
_____	$ _____

PLEASE SELECT ONE OF THE FOLLOWING:

_____ This is our only contract on this Contract
_____ We are still working under the following contracts on this Contract

Contractor	Job Name/Description	Subcontractor

Form completed by:
By _____ Title _____

Final insurance audits may be made under the applicable policies. Please show who in your office (or another location if applicable) is responsible for this information:

Name: _____ Phone: _____ Fax: _____

Address: _____ City: _____ State: _____ Zip:_____

Exhibit 1 – Sample Certificate of Insurance from **Enrolled** Contractors

ACORD© **CERTIFICATE OF INSURANCE**	**ISSUE DATE: CURRENT DATE**
PRODUCER Insurance Agent's Name and Address	THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW
TELEPHONE #	**COMPANIES AFFORDING COVERAGE**
INSURED	COMPANY A LETTER — INSURANCE CARRIER
Contractor or Subcontractor's Name and Address	COMPANY B LETTER — INSURANCE CARRIER
Sample Certificate from Enrolled Contractor or Subcontractor	COMPANY C LETTER
Required Insurance	COMPANY D LETTER

COVERAGES

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN. THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NO.	POLICY EFF. DATE MM/DD/YY	POLICY EXP. DATE MM/DD/YY	ALL LIMITS	
A	GENERAL LIABILITY ☒ COMMERCIAL GEN. LIABILITY ☐ CLAIMS MADE ☒ OCCUR. ☐ OWNER'S & CONTRACTOR'S PROT. ☐ _____	Policy Number			GENERAL AGGREGATE PRODUCTS-COMP/OPS AGGREGATE PERSONAL & ADVERTISING INJURY EACH OCCURRENCE FIRE DAMAGE (Any one fire) MEDICAL EXPENSE (Any one person)	$2,000,000 $2,000,000 $1,000,000 $1,000,000
A	AUTOMOBILE LIABILITY ☒ ANY AUTO ☐ ALL OWNED AUTOS ☐ SCHEDULED AUTOS ☐ HIRED AUTOS ☐ NON-OWNED AUTOS	Policy Number			COMBINED SINGLE LIMIT BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE	$1,000,000
A	EXCESS LIABILITY ☒ UMBRELLA ☐ OTHER THAN UMBRELLA FORM	Policy Number			EACH OCCURRENCE AGGREGATE	
B	WORKERS' COMPENSATION AND EMPLOYER'S LIABILITY	Policy Number			STATUTORY LIMITS ☒ (Each accident) (Disease-policy limit) (Disease-each employee)	 $1,000,000 $1,000,000
	OTHER:	Policy Number				

DESCRIPTION OF OPERATIONS/LOCATIONS: Department of Transportation, Consultants, Construction Managers and their consultants, the OCIP Administrator, their respective officers, agents, and employees, and Certificate Holders are Additional Insureds on a Primary and Non-contributing basis for General Liability, Automobile and Umbrella coverage. Waiver of Subrogation is included for General Liability and Workers' Compensation. **General Liability and Workers' Compensation apply only to off-site operations.**

CERTIFICATE HOLDER	**CANCELLATION**
California Department of Transportation c/o OCIP Administrator Main St Somewhere, CA 92614 (NOTE: Subcontractors should send certificates to their prime contractor)	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ENDEAVOR TO MAIL 60 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES. **AUTHORIZED REPRESENTATIVE** By:

ACORD 25-S (3/93) **© ACORD CORPORATION 1993**

Exhibit 1 – Sample Certificate of Insurance from **Excluded** Parties

ACORD© **CERTIFICATE OF INSURANCE**	**ISSUE DATE: CURRENT DATE**
PRODUCER Insurance Agent's Name and Address	THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW
TELEPHONE #	**COMPANIES AFFORDING COVERAGE**
INSURED	COMPANY A LETTER — INSURANCE CARRIER
Name and Address	COMPANY B LETTER — INSURANCE CARRIER
Sample Certificate from Excluded Parties	COMPANY C LETTER
Required Insurance	COMPANY D LETTER

COVERAGES

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN. THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NO.	POLICY EFF. DATE MM/DD/YY	POLICY EXP. DATE MM/DD/YY	ALL LIMITS	
A	GENERAL LIABILITY ☒ COMMERCIAL GEN. LIABILITY ☐ CLAIMS MADE ☒ OCCUR. ☐ OWNER'S & CONTRACTOR'S PROT. ☐_____ _____	Policy Number			GENERAL AGGREGATE PRODUCTS-COMP/OPS AGGREGATE PERSONAL & ADVERTISING INJURY EACH OCCURRENCE FIRE DAMAGE (Any one fire) MEDICAL EXPENSE (Any one person)	$2,000,000 $2,000,000 $1,000,000 $1,000,000 $ $
A	AUTOMOBILE LIABILITY ☒ ANY AUTO ☐ ALL OWNED AUTOS ☐ SCHEDULED AUTOS ☒ HIRED AUTOS ☒ NON-OWNED AUTOS	Policy Number			COMBINED SINGLE LIMIT BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE	$1,000,000
A	EXCESS LIABILITY ☒ UMBRELLA ☐ OTHER THAN UMBRELLA FORM	Policy Number			EACH OCCURRENCE AGGREGATE	$2,000,000
B	WORKERS' COMPENSATION AND EMPLOYER'S LIABILITY	Policy Number			STATUTORY LIMITS ☒ (Each accident) (Disease-policy limit) (Disease-each employee)	 $1,000,000 $1,000,000 $1,000,000
	OTHER:	Policy Number				

DESCRIPTION OF OPERATIONS/LOCATIONS: Department of Tranportation, Consultants, Construction Managers and their consultants, the OCIP Administrator, their respective officers, agents, and employees and Certificate Holders are Additional Insureds on a Primary and Non-contributing basis for General Liability, Automobile and Umbrella coverage. Waiver of Subrogation is included for General Liability and Workers' Compensation. **ALL COVERAGES APPLY ON-SITE AND OFF-SITE.**

CERTIFICATE HOLDER	**CANCELLATION**
Prime Contractor Prime Contractor Name and Address	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ENDEAVOR TO MAIL **60** DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.
	AUTHORIZED REPRESENTATIVE **By:**

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Exhibit 2 - Accident Investigation Report

This form must be completed for all injuries and damage to property, including employee injury and injury and/or damage to the property of a third party, and must be submitted to:

- Department's Engineer, and
- The OCIP Administrator

Caltrans Owner Controlled Insurance Program
Accident Investigation Report

Date of Accident: _____ Time of Accident: _____ Company: _____

Date of Investigation: _____ Contractor Job Number/Name: _____

Department Contract Name: _____ Department Contract No.: _____

Location of Accident: _____

Did injury result? Yes/No _____ If yes, provide Employee Names and Employer(s):

_____

S.S. No.: _____ Skill: _____ Yrs. in this Skill: _____

Yrs. With Company: _____

Describe Type of Injury: _____

Was property damaged? Yes/No _____ Describe damage/owner: _____

_____

Is damaged property secured/maintained? Yes/No _____ Person Maintaining _____

Names of Witnesses/Co-Workers (With Social Security No.): _____

_____

Weather/Wind Conditions: _____

List/Describe all personal protective equipment (PPE) in use by person exposed or injured: _____

_____

If Chemicals Involved:

Name(s) of Chemical(s) of Encountered: _____

_____

Form of Chemicals (Solid, Liquid, Gas, Vapor, Dust, Mist Fume): _____

Describe Radiological Materials (if any): _____

Volume or Quantity Released: _____

Description of Accident: _____

_____

_____

Contributing Factors:

_____

What corrective actions are being taken to prevent recurrence? Also list the person responsible for implementing and the target completion date for each item.

Was a Safe Plan of Action developed for the task being performed? Yes/No _____ If yes, attach a copy.

Was a permit(s) issued? Yes/No _____ If yes, attach a copy of the in effect at time of the accident.

Indirect Cause of accident: **Lack of**: _____

_____

Basic cause of accident: **Failure to:** Plan____ , Direct____, Organize____ , Control ____ (*explain)

_____

INVESTIGATION TEAM: Report by: _____ **Date:** _____

Injured Involved:	Name	Signature
Supervisor:	Name	Signature
Site Manager:	Name	Signature
Health and Safety Representative:	Name	Signature
Name (Others)	Title	Signature
Name (Others)	Title	Signature

Project Representative(s) Contacted: _____

* Attach additional sheets and supplemental data & information as necessary.

** Distribution: Original filed on-site at Department's Engineer 's office

State of California
EMPLOYER'S REPORT OF OCCUPATIONAL INJURY OR ILLNESS

Please complete in triplicate (type if possible) Mail two copies to:

OSHA CASE NO.

FATALITY ☐

Any person who makes or causes to be made any knowingly false or fraudulent material statement or material representation for the purpose of obtaining or denying workers compensation benefits or payments is guilty of a felony.

California law requires employers to report within **five days** of knowledge every occupational injury or illness which results in lost time beyond the date of the incident **OR** requires medical treatment beyond first aid. If an employee subsequently dies as a result of a previously reported injury or illness, the employer must file within **five days** of knowledge an amended report indicating death. In addition, every serious injury, illness, or death must be **reported immediately** by telephone or telegraph to the nearest office of the California Division of Occupational Safety and Health.

EMPLOYER

1. FIRM NAME
1a. Policy Number
2. MAILING ADDRESS: (Number, Street, Department, Zip)
2a. Phone Number
3. LOCATION if different from Mailing Address (Number, Street, Department and Zip)
3a. Location Code
4. NATURE OF BUSINESS; e.g.. Painting contractor, wholesale grocer, sawmill, hotel, etc.
5. State unemployment insurance acct.no
6. TYPE OF EMPLOYER: ☐ Private ☐ State ☐ County ☐ Department ☐ School District ☐ Other Gov't, Specify:

INJURY OR ILLNESS

7. DATE OF INJURY / ONSET OF ILLNESS (mm/dd/yy)
8. TIME INJURY/ILLNESS OCCURRED _____AM _____PM
9. TIME EMPLOYEE BEGAN WORK _____AM _____PM
10. IF EMPLOYEE DIED, DATE OF DEATH (mm/dd/yy)
11. UNABLE TO WORK FOR AT LEAST ONE FULL DAY AFTER DATE OF INJURY? ☐ Yes ☐ No
12. DATE LAST WORKED (mm/dd/yy)
13. DATE RETURNED TO WORK(mm/dd/yy)
14. IF STILL OFF WORK, CHECK THIS BOX: ☐
15. PAID FULL DAYS WAGES FOR DATE OF INJURY OR LAST DAY WORKED? ☐ Yes ☐ No
16. SALARY BEING CONTINUED? ☐ Yes ☐ No
17. DATE OF EMPLOYER'S KNOWLEDGE/ NOTICE OF INJURY/ILLNESS (mm/dd/yy)
18. DATE EMPLOYEE WAS PROVIDED CLAIM FORM (mm/dd/yy)
19. SPECIFIC INJURY/ILLNESS AND PART OF BODY AFFECTED, MEDICAL DIAGNOSIS if available, e.g.. Second degree burns on right arm, tendonitis on left elbow, lead poisoning
20. LOCATION WHERE EVENT OR EXPOSURE OCCURRED (Number, Street, Department, Zip) ☐ Yes ☐ No
20a. COUNTY
21. ON EMPLOYER'S PREMISES?
22. DEPARTMENT WHERE EVENT OR EXPOSURE OCCURRED, e.g. Shipping department, machine shop ☐ Yes ☐ No
23. Other Workers injured or ill in this event?
24. EQUIPMENT, MATERIALS AND CHEMICALS THE EMPLOYEE WAS USING WHEN EVENT OR EXPOSURE OCCURRED, e.g. Acetylene, welding torch, farm tractor, scaffold
25. SPECIFIC ACTIVITY THE EMPLOYEE WAS PERFORMING WHEN EVENT OR EXPOSURE OCCURRED, e.g. Welding seams of metal forms, loading boxes onto truck.
26. HOW INJURY/ILLNESS OCCURRED. DESCRIBE SEQUENCE OF EVENTS. SPECIFY OBJECT OR EXPOSURE WHICH DIRECTLY PRODUCED THE INJURY/ILLNESS, e.g. Worker stepped back to inspect work and slipped on scrap material. As he fell, he brushed against fresh weld, and burned right hand. USE SEPARATE SHEET IF NECESSARY ☐ Yes ☐ No
27. Name and address of physician (number, street, city, zip)
27a. Phone Number
28. Hospitalized as an inpatient overnight? ☐ Yes ☐ No If yes then, name and address of hospital (number, street, city, zip)
28a. Phone Number
29. Employee treated in emergency room?

ATTENTION This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes. See CCR Title 8 14300.29 (b)(6)-(10) & 14300.35(b)(2)(E)2.
Note: Shaded boxes indicate confidential employee information as listed in CCR Title 8 14300.35(b)(2)(E)2*.

EMPLOYEE

30. EMPLOYEE NAME
31. SOCIAL SECURITY NUMBER
32. DATE OF BIRTH (mm/dd/yy)
33. HOME ADDRESS (Number, Street, Department, Zip)
33a. PHONE NUMBER
34. SEX ☐ Male ☐ Female
35. OCCUPATION (Regular job title, NO initials, abbreviations or numbers)
36. DATE OF HIRE (mm/dd/yy)
37. EMPLOYEE USUALLY WORKS _____ hours per day, _____ days per week, _____ total weekly hours
37a. EMPLOYMENT STATUS ☐regular, full-time ☐part-time ☐temporary ☐seasonal
37b. UNDER WHAT CLASS CODE OF YOUR POLICY WHERE WAGES ASSIGNED
38. GROSS WAGES/SALARY $ _____per
39. OTHER PAYMENTS NOT REPORTED AS WAGES/SALARY (e.g. tips, meals, overtime, bonuses, etc.)?

Completed By (type or print)
Signature & Title
Date (mm/dd/yy)

SOURCE
EVENT
SECONDAY SOURCE
EXTENT OF INJURY

FORM 5020 (Rev7) June 2002
FILING OF THIS FORM IS NOT AN ADMISSION OF LIABILITY

Workers' Compensation Claim Form (DWC 1) & Notice of Potential Eligibility

Formulario de Reclamo de Compensación para Trabajadores (DWC 1) y Notificación de Posible Elegibilidad

If you are injured or become ill, either physically or mentally, because of your job, including injuries resulting from a workplace crime, you may be entitled to workers' compensation benefits. Attached is the form for filing a workers' compensation claim with your employer. **You should read all of the information below.** Keep this sheet and all other papers for your records. You may be eligible for some or all of the benefits listed depending on the nature of your claim. If required you will be notified by the claims administrator, who is responsible for handling your claim, about your eligibility for benefits.

To file a claim, complete the "Employee" section of the form, keep one copy and give the rest to your employer. Your employer will then complete the "Employer" section, give you a dated copy, keep one copy and send one to the claims administrator. Benefits can't start until the claims administrator knows of the injury, so complete the form as soon as possible.

Medical Care: Your claims administrator will pay all reasonable and necessary medical care for your work injury or illness. Medical benefits may include treatment by a doctor, hospital services, physical therapy, lab tests, x-rays, and medicines. Your claims administrator will pay the costs directly so you should never see a bill. For injuries occurring on or after 1/1/04, there is a limit on some medical services.

The Primary Treating Physician (PTP) is the doctor with the overall responsibility for treatment of your injury or illness. Generally your employer selects the PTP you will see for the first 30 days, however, in specified conditions, you may be treated by your predesignated doctor. If a doctor says you still need treatment after 30 days, you may be able to switch to the doctor of your choice. Special rules apply if your employer offers a Health Care Organization (HCO) or after 1/1/05, has a medical provider network. Contact your employer for more information. If your employer has not put up a poster describing your rights to workers' compensation, you may choose your own doctor immediately.

Within one working day after an employee files a claim form, the employer shall authorize the provision of all treatment, consistent with the applicable treating guidelines, for the alleged injury and shall continue to provide treatment until the date that liability for the claim is accepted or rejected. Until the date the claim is accepted or rejected, liability for medical treatment shall be limited to ten thousand dollars ($10,000).

Disclosure of Medical Records: After you make a claim for workers' compensation benefits, your medical records will not have the same privacy that you usually expect. If you don't agree to voluntarily release medical records, a workers' compensation judge may decide what records will be released. If you request privacy, the judge may "seal" (keep private) certain medical records.

Payment for Temporary Disability (Lost Wages): If you can't work while you are recovering from a job injury or illness, you will receive temporary disability payments. These payments may change or stop when your doctor says you are able to return to work. These benefits are tax-free. Temporary disability payments are two-thirds of your average weekly pay, within minimums and maximums set by state law. Payments are not made for the first three days you are off the job unless you are hospitalized overnight or cannot work for more than 14 days.

Si Ud. se lesiona o se enferma, ya sea física o mentalmente, debido a su trabajo, incluyendo lesiones que resulten de un crimen en el lugar de trabajo, es posible que Ud. tenga derecho a beneficios de compensación para trabajadores. Se adjunta el formulario para presentar un reclamo de compensación para trabajadores con su empleador. **Ud. debe leer toda la información a continuación.** Guarde esta hoja y todos los demás documentos para sus archivos. Es posible que usted reúna los requisitos para todos los beneficios, o parte de éstos, que se enumeran, dependiendo de la índole de su reclamo. Si se requiere, el/la administrador(a) de reclamos, quien es responsable del manejo de su reclamo, le notificará a usted, lo referente a su elegibilidad para beneficios.

Para presentar un reclamo, complete la sección del formulario designada para el "Empleado", guarde una copia, y déle el resto a su empleador. Entonces, su empleador completará la sección designada para el "Empleador", le dará a Ud. una copia fechada, guardará una copia, y enviará una al/a la administrador(a) de reclamos. Los beneficios no pueden comenzar hasta, que el/la administrador(a) de reclamos se entere de la lesión, así que complete el formulario lo antes posible.

Atención Médica: Su administrador(a) de reclamos pagará toda la atención médica razonable y necesaria, para su lesión o enfermedad relacionada con el trabajo. Es posible que los beneficios médicos incluyan el tratamiento por parte de un médico, los servicios de hospital, la terapia física, los análisis de laboratorio y las medicinas. Su administrador(a) de reclamos pagará directamente los costos, de manera que usted nunca verá un cobro. Para lesiones que ocurren en o después de 1/1/04, hay un límite de visitas para ciertos servicios médicos.

El Médico Primario que le Atiende-*Primary Treating Physician PTP* es el médico con toda la responsabilidad para dar el tratamiento para su lesión o enfermedad. Generalmente, su empleador selecciona al *PTP* que Ud. verá durante los primeros 30 días. Sin embargo, en condiciones específicas, es posible que usted pueda ser tratado por su médico pre-designado. Si el doctor dice que usted aún necesita tratamiento después de 30 días, es posible que Ud. pueda cambiar al médico de su preferencia. Hay reglas especiales que son aplicables cuando su empleador ofrece una Organización del Cuidado Médico (HCO) o depués de 1/1/05 tiene un Sistema de Proveedores de Atención Médica. Hable con su empleador para más información. Si su empleador no ha colocado un poster describiendo sus derechos para la compensación para trabajadores, Ud. puede seleccionar a su propio médico inmediatamente.

El empleador autorizará todo tratamiento médico consistente con las directivas de tratamiento applicables a la lesión o enfermedad, durante el primer día laboral después que el empleado efectúa un reclamo para beneficios de compensación, y continuará proveyendo este tratamiento hasta la fecha en que el reclamo sea aceptado o rechazado. Hasta la fecha en que el reclamo sea aceptado o rechazado, el tratamiento médico será limitado a diez mil dólares ($10,000).

Divulgación de Expedientes Médicos: Después de que Ud. presente un reclamo para beneficios de compensación para los trabajadores, sus expedientes médicos no tendrán la misma privacidad que usted normalmente espera. Si Ud. no está de acuerdo en divulgar voluntariamente los expedientes médicos, un(a) juez de compensación para trabajadores posiblemente decida qué expedientes se revelarán. Si Ud. solicita privacidad, es posible que el/la juez "selle" (mantenga privados) ciertos expedientes médicos.

Pago por Incapacidad Temporal (Sueldos Perdidos): Si Ud. no puede trabajar, mientras se está recuperando de una lesión o enfermedad relacionada con el trabajo, Ud. recibirá pagos por incapacidad temporal. Es posible que estos pagos cambien o paren, cuando su médico diga que Ud. está en condiciones de regresar a trabajar. Estos beneficios son libres de

Workers' Compensation Claim Form (DWC 1) & Notice of Potential Eligibility
Formulario de Reclamo de Compensación para Trabajadores (DWC 1) y Notificación de Posible Elegibilidad

Return to Work: To help you to return to work as soon as possible, you should actively communicate with your treating doctor, claims administrator, and employer about the kinds of work you can do while recovering. They may coordinate efforts to return you to modified duty or other work that is medically appropriate. This modified or other duty may be temporary or may be extended depending on the nature of your injury or illness.

Payment for Permanent Disability: If a doctor says your injury or illness results in a permanent disability, you may receive additional payments. The amount will depend on the type of injury, your age, occupation, and date of injury.

Vocational Rehabilitation (VR): If a doctor says your injury or illness prevents you from returning to the same type of job and your employer doesn't offer modified or alternative work, you may qualify for VR. If you qualify, your claims administrator will pay the costs, up to a maximum set by state law. VR is a benefit for injuries that occurred prior to 2004.

Supplemental Job Displacement Benefit (SJDB): If you do not return to work within 60 days after your temporary disability ends, and your employer does not offer modified or alternative work, you may qualify for a nontransferable voucher payable to a school for retraining and/or skill enhancement. If you qualify, the claims administrator will pay the costs up to the maximum set by state law based on your percentage of permanent disability. SJDB is a benefit for injuries occurring on or after 1/1/04.

Death Benefits: If the injury or illness causes death, payments may be made to relatives or household members who were financially dependent on the deceased worker.

It is illegal for your employer to punish or fire you for having a job injury or illness, for filing a claim, or testifying in another person's workers' compensation case (Labor Code 132a). If proven, you may receive lost wages, job reinstatement, increased benefits, and costs and expenses up to limits set by the state.

You have the right to disagree with decisions affecting your claim. If you have a disagreement, contact your claims administrator first to see if you can resolve it. If you are not receiving benefits, you may be able to get State Disability Insurance (SDI) benefits. Call State Employment Development Department at (800) 480-3287.

You can obtain free information from an information and assistance officer of the State Division of Workers' Compensation, or you can hear recorded information and a list of local offices by calling **(800) 736-7401**. You may also go to the DWC web site at **www.dir.ca.gov.** Link to Workers' Compensation.

You can consult with an attorney. Most attorneys offer one free consultation. If you decide to hire an attorney, his or her fee will be taken out of some of your benefits. For names of workers' compensation attorneys, call the State Bar of California at (415) 538-2120 or go to their web site at **www.californiaspecialist.org**.

impuestos. Los pagos por incapacidad temporal son dos tercios de su pago semanal promedio, con cantidades mínimas y máximas establecidas por las leyes estatales. Los pagos no se hacen durante los primeros tres días en que Ud. no trabaje, a menos que Ud. sea hospitalizado(a) de noche, o no pueda trabajar durante más de 14 días.

Regreso al Trabajo: Para ayudarle a regresar a trabajar lo antes posible, Ud. debe comunicarse de manera activa con el médico que le atienda, el/la administrador(a) de reclamos y el empleador, con respecto a las clases de trabajo que Ud. puede hacer mientras se recupera. Es posible que ellos coordinen esfuerzos para regresarle a un trabajo modificado, o a otro trabajo, que sea apropiado desde el punto de vista médico. Este trabajo modificado, u otro trabajo, podría extenderse o no temporalmente, dependiendo de la índole de su lesión o enfermedad.

Pago por Incapacidad Permanente: Si el doctor dice que su lesión o enfermedad resulta en una incapacidad permanente, es posible que Ud. reciba pagos adicionales. La cantidad dependerá de la clase de lesión, su edad, su ocupación y la fecha de la lesión.

Rehabilitación Vocacional: Si el doctor dice que su lesión o enfermedad no le permite regresar a la misma clase de trabajo, y su empleador no le ofrece trabajo modificado o alterno, es posible que usted reúna los requisitos para rehabilitación vocacional. Si Ud. reúne los requisitos, su administrador(a) de reclamos pagará los costos, hasta un máximo establecido por las leyes estatales. Este es un beneficio para lesiones que ocurrieron antes de 2004.

Beneficio Suplementario por Desplazamiento de Trabajo: Si Ud. no vuelve al trabajo en un plazo de 60 días después que los pagos por incapcidad temporal terminan, y su empleador no ofrece un trabajo modificado o alterno, es posible que usted reúne los requisitos para recibir un vale no-transferible pagadero a una escuela para recibir un nuevo entrenamiento y/o mejorar su habilidad. Si Ud. reúne los requisitios, el administrador(a) de reclamos pagará los costos hasta un máximo establecido por las leyes estatales basado en su porcentaje del incapicidad permanente. Este es un beneficio para lesiones que ocurren en o después de 1/1/04.

Beneficios por Muerte: Si la lesión o enfermedad causa la muerte, es posible que los pagos se hagan a los parientes o a las personas que vivan en el hogar, que dependían económicamente del/de la trabajador(a) difunto(a).

Es ilegal que su empleador le castigue o despida, por sufrir una lesión o enfermedad en el trabajo, por presentar un reclamo o por atestiguar en el caso de compensación para trabajadores de otra persona. (El Codigo Laboral sección 132a). Si es probado, puede ser que usted reciba pagos por perdida de sueldos, reposición del trabajo, aumento de beneficios, y gastos hasta un límite establecido por el estado.

Ud. tiene derecho a estar en desacuerdo con las decisiones que afecten su reclamo. Si Ud. tiene un desacuerdo, primero comuníquese con su administrador(a) de reclamos, para ver si usted puede resolverlo. Si usted no está recibiendo beneficios, es posible que Ud. pueda obtener beneficios de Seguro Estatal de Incapacidad (SDI). Llame al Departamento Estatal del Desarrollo del Empleo (EDD) al (800) 480-3287.

Ud. puede obtener información gratis, de un oficial de información y asistencia, de la División estatal de Compensación al Trabajador *(Division of Workers' Compensation – DWC)*, o puede escuchar información grabada, así como una lista de oficinas locales, llamando al **(800) 736-7401**. Ud. también puede ir al sitio electrónico en el Internet de la DWC en **www.dir.ca.gov.** Enlácese a la sección de Compensación para Trabajadores.

Ud. puede consultar con un(a) abogado(a). La mayoría de los abogados ofrecen una consulta gratis. Si Ud. decide contratar a un(a) abogado(a), sus honorarios se tomarán de sus beneficios. Para obtener nombres de abogados de compensación para trabajadores, llame a la Asociación Estatal de Abogados de California *(State Bar)* al (415) 538-2120, ó vaya a su sitio electrónico en el Internet en **www.californiaspecialist.org**.

Section 9

Frequently Asked Questions

What is an Owner Controlled Insurance Program or OCIP?

An "Owner Controlled Insurance Program" (OCIP) or "wrap-up," is a consolidated insurance program whereby the insurance for the Owner (the Department) and eligible and enrolled subcontractors is provided through a master program for each line of coverage. In this particular instance, the program is called a "OCIP" for "Rolling" OCIP.

Have OCIPs been used previously or is this a new concept?

OCIPs have been used successfully in commercial construction for decades. In the past decade, OCIPs have become the dominant method for insuring large public works.

Why does the Department want to do a OCIP?

The driving force behind the decision to implement a OCIP is to assure comprehensive coverage and high limits of insurance for Caltrans construction projects. There are many other reasons, including possible savings and elimination of cross-suits.

Who pays for OCIP coverages?

The Department pays the OCIP premium to the insurance company.

What coverages are provided under the Caltrans OCIP?

The OCIP will provide General Liability, Workers' Compensation, and Excess Liability , and Contractor Pollution Liability insurance for all of eligible and enrolled contractors.

Are there standard coverages not included in the OCIP?

Automobile coverage and coverage for the contractor's own property are not included in OCIP. The only coverages provided are described above. Contractors and Subcontractors also will be required to provide their own general liability and workers' compensation coverage for off-site activities and automobile coverage for both on-site and off-site. Other coverages may be required of certain contractors depending on the nature of the work. The Department may purchase additional coverages for its own protection.

Are there any special enhancements provided by the OCIP policy?

The general and excess liability policies provide the following coverages that are not readily available to all subcontractors. Products/Completed operations coverage is extended 10 years (current statute of limitations) beyond the final acceptance of the project. The OCIP policy will respond to covered losses that occur up to the statute of limitation dates. Other benefits are described in the policy.

While not a specific coverage enhancement, the fact that all parties have the same coverage is a real benefit of an OCIP. The Department can now be confident all insured parties have met their liability insurance requirements and the subcontractors can now be sure their policies provide the coverage for the work they are performing and are contractually obligated to provide.

What limits of coverage will be purchased for the Department's OCIP?

The combined general liability and excess liability limits are as follows:

$ 200,000,000	Per Occurrence
$ 200,000,000	General Aggregate
$ 200,000,000	Products/Completed operations Aggregate

These limits cover all insureds and will be shared with all projects in the OCIP. Aggregates (policy maximums) are annual except for Products/Completed Operations, which is a one-time limit.

Are there any deductibles that apply to the subcontractors?

The Department will assess the Contractor a "deductible assessment" for losses for which the Contractor or subcontractor is at fault. This contractual obligation is like a policy deductible, but is payable to the Department. The Contractor shall be responsible, at its own expense, for the first $25,000 of each occurrence for property damage to the extent losses payable are attributable to Contractor's Work, acts or omissions, or the acts or omissions of any of its Subcontractors or any other entity or person for whom Contractor may be responsible. This deductible will be reduced to the actual deductible on the contractor's corporate general liability policy, subject to a $5,000 minimum or actual loss whichever is less.

The deductible assessment will apply to contractor pollution liability losses using the same terms and conditions described above except that the assessment for such losses shall be determined by the deductible on the Contractor or subcontractor's pollution liability policy subject to the minimum assessment of $5,000 or actual loss, whichever is less. In the event that the Contractor or subcontractor does not have a contractor's pollution liability policy, the Contractor's or subcontractor's general liability policy deductible will be used to determine the assessment subject to the minimums described above.

How does this affect my regular insurance?

You should discuss this with your insurance broker. Generally, your regular insurer(s) (general liability and workers' compensation) will not charge for the portion of your work done under an OCIP but will exclude losses arising out of work done on the OCIP (covered by the OCIP insurers).

Who must participate in the OCIP?

All Eligible Contractors must participate in the OCIP. Certain contractors are not eligible including consultants, surveyors, hazardous waste remediators, suppliers and transportation companies. See 3 Definitions for a complete listing of excluded contractors.

Who should I call if I have questions?

Many questions are answered in this manual. Any other questions during the bidding process must be referred to the Department's Program Manager. Once your company has been awarded a contract, you may direct your questions to the appropriate party identified on page 5 of the Manual

What Insurance Company writes the Workers' Compensation and Employer's Liability coverage?

Coverage is provided by several insurance companies. These companies will be identified after coverage is bound but before contractor enrollment.

What is the coverage term?

The coverage terms for each Contractor will coincide with the start date provided at OCIP enrollment. OCIP policies are renewed each year until OCIP close-out, unless otherwise stated.

How will the Contractor/Subcontractor's payroll be classified?

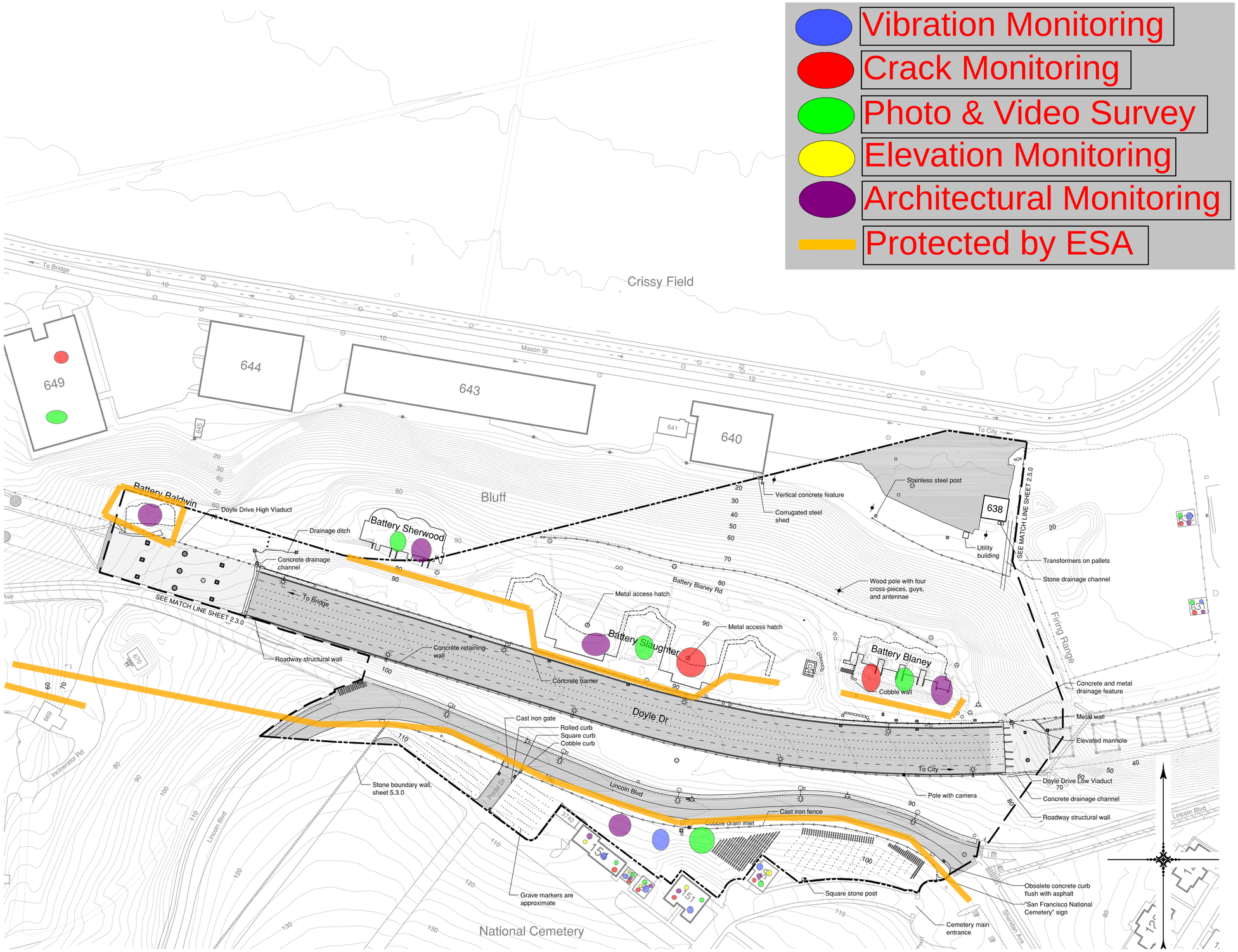
Insurer will classify payrolls in accordance with California law under the Workers' Compensation Insurance Rating Bureau Rules, Classifications, Rates and Rating Plans. Form 2 will be used for Contractors/Subcontractors' monthly payroll submissions.

Will the Insurance Company inspect the job and make recommendations regarding loss control and safety?

Yes. The Insurance Company's safety and loss control professionals will make regular inspections of the job site, lend assistance, make recommendations and suggestions, and in general, assure the insurability of the Job Site.

Will there be other people who will make job site inspections?

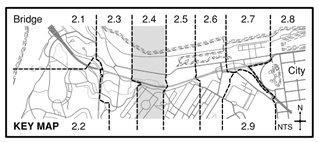
Yes. The OCIP Administrator along with the Insurance Company's safety representative, will conduct periodic site safety inspections to assure compliance with the Contractor's Site-Specific Safety Program. State, city and federal inspectors may also make inspect



LEGEND

- U.O.N. — unless otherwise noted
- HALS documentation boundary
- Sheet match line
- 670 — Building
- Elevated roadway pier, concrete
- Line shown for context
- Hidden line
- Battery, solid line where exposed
- Building foundation
- Building overhang
- Elevated roadway
- Unpaved area - See Vegetation Plan
- Asphalt paving under elevated roadway
- Asphalt paving
- Concrete paving
- Road or trail of compacted soil, gravel, or rubble
- Curbs and gutters
  - Curbs, concrete U.O.N.
  - ADA curb cut, perhaps with safety grooves
  - Curbs, cobble
  - Gutters, concrete
- Walls, fences, and guardrails
  - Walls, concrete
  - Walls, cobble
  - Walls, other
  - K-rail or Jersey barrier, concrete
  - Fences, chain link U.O.N.
  - Guardrails, wood posts and metal rail U.O.N.
  - Elevated sidewalk railing, metal
- Pavement striping
  - Solid lines, single or double
  - Dashed and/or dotted lines
  - Pedestrian crosswalks
  - Movable medians
  - Faded, obsolete striping
- Lights*
  - Circular lamps
  - Box lamps
  - Ovoid or cobra-head lamps
  - Traffic lights
  - Lamps mounted with or without arms
- Site furnishings*
  - Benches
  - Bicycle Racks
  - Bollards, metal cylinders or railroad rail
  - Picnic tables
  - Trash receptacles
- Utilities*
  - In-ground manholes, vaults, boxes, or monitoring wells
  - Possible manhole for defense communications system
  - Above-ground boxes or enclosures
  - Poles, perhaps with cross-piece / anchor tie
  - Drain inlets or collection boxes
  - Fire hydrants or fire mains
  - Signs, two posts or one
- Survey control points
- 50 — 2 foot contour lines

*See Section 6 for field photographs of site features grouped by feature type.



RESOURCE LIST

*NC indicates non-contributing

Type and No.*	Present Use/Name	Historic Use/Name
Battery 635	Vacant	Battery Blaney
Battery 636	Vacant	Battery Sherwood
Battery F47	Vacant	Batteries Baldwin and Slaughter
Building 150	Cemetery Office	Mortuary Chapel, Administration
Building 151	Housing	Housing
Building 152	Restroom	Restroom
Building 153	Garage	Garage
Building 154	Garage	Garage
Building 638	Vacant	Oil Storage
Building 640	Vacant	Aircraft Hanger, Language School
Building 641	Vacant	Latrine, Office
Building 643	Warehouse	Aircraft Hanger, Electric Maintenance Shop
Building 644 [NC]	Warehouse	Unit Motor Pool
Building 645 [NC]	Vacant	Sewage Pump House
Building 3740	Shed	Shed
Gate 3202	Cemetery Gate	Cemetery Gate
Gate 3203	Cemetery Main Entrance	Cemetery Main Entrance

Type and No.*	Present Use/Name	Historic Use/Name
Road [NC]	Doyle Drive	Doyle Drive
Road 2012	Battery Blaney Road	Battery Blaney Road
Road 2094	Lincoln Boulevard	Lincoln Boulevard
Road 2130	Mason Street	Old Mason Street
Wall 3201	National Cemetery Boundary Wall	National Cemetery Boundary Wall

Doyle Drive Corridor at the Presidio of San Francisco, Calif.

2009 Built Environment Plan
CRISSY FIELD / BATTERIES

0 50 100 FEET 1" = 50'-0" | 0 10 20 METERS 1:600

2.4.0

DRAFT 20 Nov 2009

DELINEATED BY: PGADESIGN

PRESIDIO OF SAN FRANCISCO - DOYLE DRIVE CORRIDOR
MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
HIGHWAYS 101 AND 1 BETWEEN MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
SAN FRANCISCO COUNTY
SAN FRANCISCO
CALIFORNIA

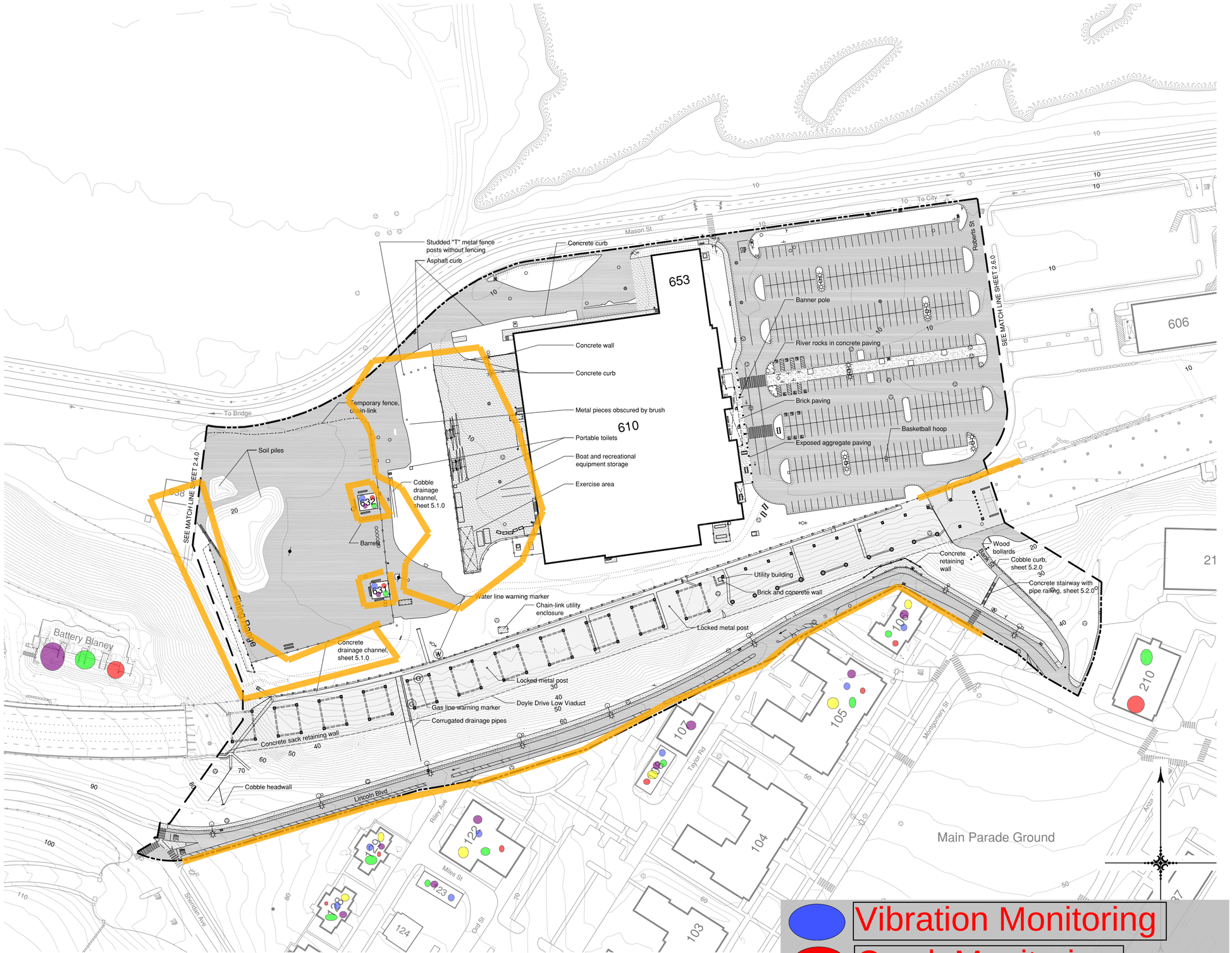
SHEET X OF 44

HISTORIC AMERICAN LANDSCAPES SURVEY
CA-09

LIBRARY OF CONGRESS PRINTS & PHOTOS

DOYLE DRIVE PROJECT, 2008 - 2009
FEDERAL HIGHWAY ADMINISTRATION
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

IF REPRODUCED, PLEASE CREDIT THE HISTORIC AMERICAN LANDSCAPES SURVEY, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF DRAWING



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  - Walls, concrete
  - Walls, cobble
  - Walls, other
  - K-rail or Jersey barrier, concrete
  - Fences, chain link U.O.N.
  - Guardrails, wood posts and metal rail U.O.N.
  - Elevated sidewalk railing, metal
- Pavement striping
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  - Dashed and/or dotted lines
  - Pedestrian crosswalks
  - Movable medians
  - Faded, obsolete striping
- Lights*
  - Circular lamps
  - Box lamps
  - Ovoid or cobra-head lamps
  - Traffic lights
  - Lamps mounted with or without arms
- Site furnishings*
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  - Bicycle Racks
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  - Trash receptacles
- Utilities*
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  - Possible manhole for defense communications system
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  - Drain inlets or collection boxes
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- 50 — 2 foot contour lines

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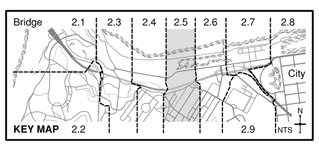

RESOURCE LIST

*NC indicates non-contributing

Type and No.*	Present Use/Name	Historic Use/Name
Building 103	Under Construction	Barracks
Building 104	Museum (Walt Disney)	Barracks with Mess Hall
Building 105	Office and Event Space	Barracks with Mess Hall
Building 106	Office Space	Band Barracks
Building 107	Electrical Substation	Switching Station
Building 108	Museum (Walt Disney)	Storage
Building 122	Museum (Walt Disney)	Gymnasium
Building 123	Vacant	Garage
Building 124	Housing	Enlisted Family Housing
Building 125	Housing	Enlisted Family Housing
Building 127	Housing	Enlisted Family Housing
Building 128	Housing	Enlisted Family Housing
Building 129	Housing	Enlisted Family Housing
Building 610[NC]	Sporting Goods Store	New Commissary
Building 631	Vacant	Ammunition Magazine, Storage
Building 632	Vacant	Ammunition Magazine, Storage
Building 638	Vacant	Magazine
Building 653 [NC]	Sporting Goods Store	New Commissary

Type and No.*	Present Use/Name	Historic Use/Name
Miscellaneous [NC]	Vacant	Firing Range
Miscellaneous 94	Parking	Main Parade Ground
Road 2009	Pedestrian Path (Bank Street)	Bank Street
Road 2094	Lincoln Boulevard	Fort Scott Road
Road 2130	Mason Street	Old Mason Street
Road 2115 [NC]	Miles Street	Miles Street
Road 2119	Montgomery Street	Montgomery Street
Road 2131	Ord Street	Ord Street
Road 2151	Riley Avenue	Riley Avenue
Road [NC]	Roberts Street	Roberts Street
Road 2162	Sheridan Avenue	Sheridan Avenue
Road 2176	Taylor Road	Taylor Road
Stairway 3017	Stairway	Stairway Between Lincoln and Bank
Wall 3018	Retaining Wall	Wall on north side of Lincoln Blvd north of Building 106

Vibration Monitoring

Crack Monitoring

Photo & Video Survey

Elevation Monitoring

Architectural Monitoring

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Doyle Drive Corridor at the Presidio of San Francisco, Cal.

2009 Built Environment Plan
CRISSY FIELD / NEW COMMISSARY

0 50 100 FEET 1" = 50'-0" | 0 10 20 METERS 1:600

2.5.0

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DOYLE DRIVE PROJECT 2008 - 2009
CONSTRUCTION DOCUMENTATION
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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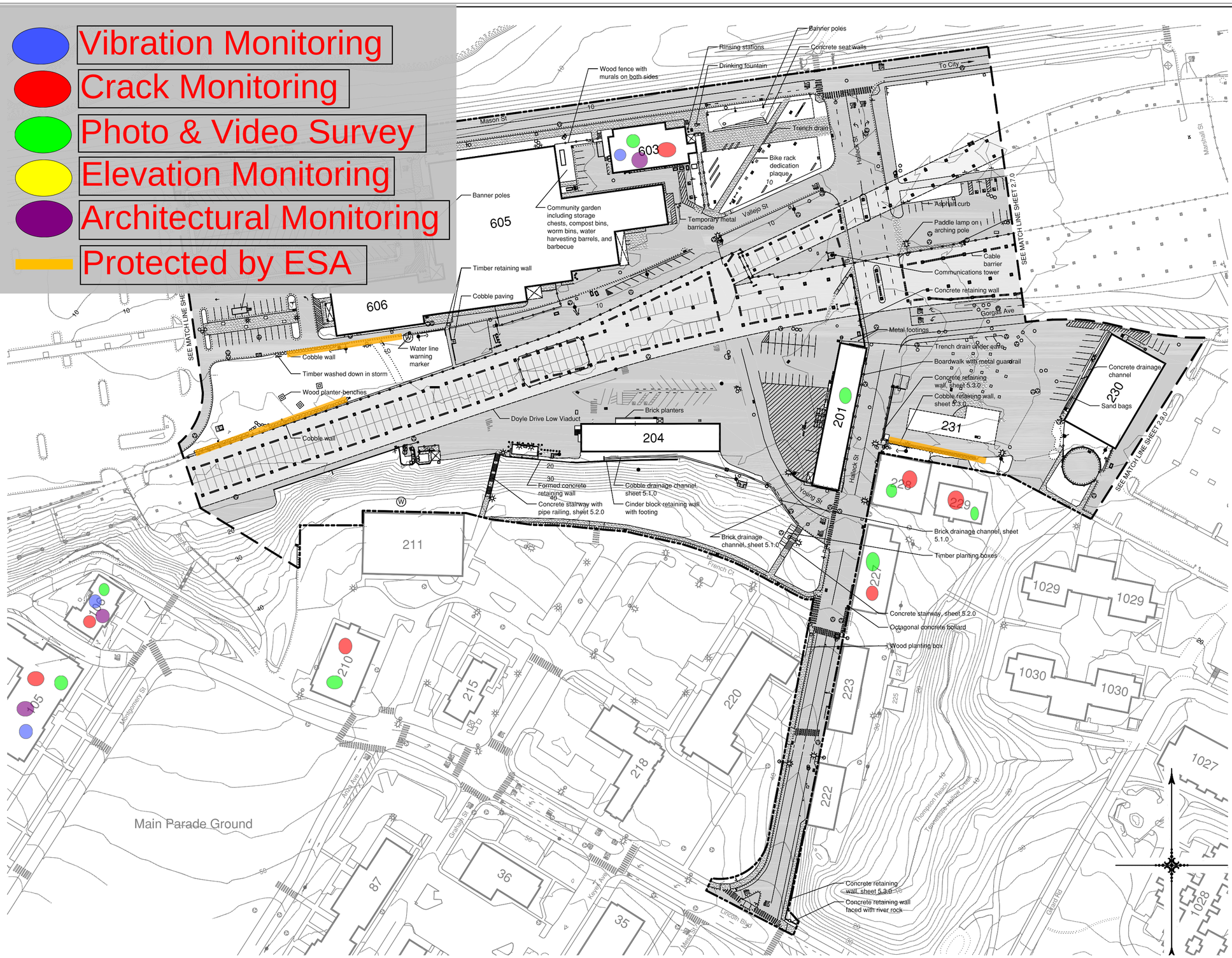

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- Building overhang
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- Unpaved area - See Vegetation Plan
- Asphalt paving under elevated roadway
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- Concrete paving
- Road or trail of compacted soil, gravel, or rubble

Curbs and gutters
- Curbs, concrete U.O.N.
- ADA curb cut, perhaps with safety grooves
- Curbs, cobble
- Gutters, concrete

Walls, fences, and guardrails
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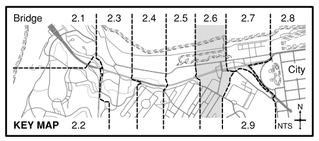

RESOURCE LIST

*NC indicates non-contributing

Type and No.*	Present Use/Name	Historic Use/Name
Building 35	School	Enlisted Men's Barracks and Mess Hall, Administrative Office Space
Building 36	School and Office Space	Barracks, Military Police
Building 37	Office Space	Administration, Office Space
Building 87	Office Space	Barracks and Wagon Shop, Office Space
Building 201	Buffalo Soldier Museum and Library	Exchange Store, Office Space
Building 204	Vacant	Exchange Store, Thrift Shop
Building 205 [NC]	Sewage Pump House	Sewage Pump House
Building 210	Post Office, Bank	Guardhouse
Building 211	Office Space	Cafeteria, Restaurant
Building 215 [NC]	Restaurant, Restroom, Transit Center	Bus Shelter
Building 218	Fire Station	Fire Station
Building 220	Office Space	Cooks' and Bakers' School and Barracks, Main Post Headquarters and Administration
Building 222	Dry Cleaner, Fitness Training	Storehouse, Administration
Building 223	Ranger Station	Warehouse, Administration
Building 224	Vacant	Flammable Storage
Building 225	Vacant	Storehouse
Building 227	Park Ranger Office	Warehouse, Administration
Building 228	Vacant	Bakery, Dry Cleaner
Building 229	Vacant	Bakery, Post Credit Union
Building 230	Archaeology Laboratory	Warehouse, Post Exchange Retail Outlet

Type and No.*	Present Use/Name	Historic Use/Name
Building 231	Foundation	Exchange Gasoline Service Station
Building 603	Crissy Field Center	Commissary, North Cantonment
Building 605	Public Storage	Post Exchange
Building 606	Public Storage	Post Exchange
Parade Ground 94	Parking	Main Parade Ground
Road 2004	Anza Avenue	Anza Avenue
Road 2057 [NC]	French Court	French Court
Road 2065	Graham Street	Graham Street
Road 2068	Halleck Street	Halleck Street
Road 2087	Keyes Avenue	Keyes Avenue
Road 2094	Lincoln Boulevard	Lincoln Boulevard
Road 2130	Mason Street	Old Mason Street
Road 2114	Mesa Street	Mesa Street
Road 2185	Vallejo Street	Vallejo Street
Road	Young Street	Young Street

Type and No.*	Present Use/Name	Historic Use/Name
Wall 3008	Retaining Wall	Wall along north side of Lincoln Blvd east of Halleck St, south of Building 222 extending east to Building 1020
Wall 3009	Retaining Wall	Wall on east side of Halleck St between Lincoln Blvd and Building 222
Wall 3010	Retaining Wall	Wall north of Buildings 228,229
Wall 3011	Retaining Wall	Wall on west side of Halleck St between Building 201 and Doyle Dr
Wall 3012	Retaining Wall	Wall at southwest corner of Building 201
Wall 3013	Retaining Wall	Wall south of Building 204
Wall 3014	Retaining Wall	Wall southwest of Building 204
Stairway 3015	Stairway	Stairway descending from a point northeast of Building 214 to a point west of Building 204
Wall 3016	Retaining Wall	Wall along south side of Young St between Doyle Dr and Building 211

Doyle Drive Corridor at the Presidio of San Francisco, Cal.

2009 Built Environment Plan
CRISSY FIELD / MAIN POST - HALLECK

0 50 100 FEET 1" = 50'-0" | 0 10 20 METERS 1:600

2.6.0

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HIGHWAYS 101 AND 1 BETWEEN MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
SAN FRANCISCO COUNTY

DOYLE DRIVE PROJECT, 2008 - 2009
HISTORIC AMERICAN LANDSCAPES SURVEY
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

SAN FRANCISCO

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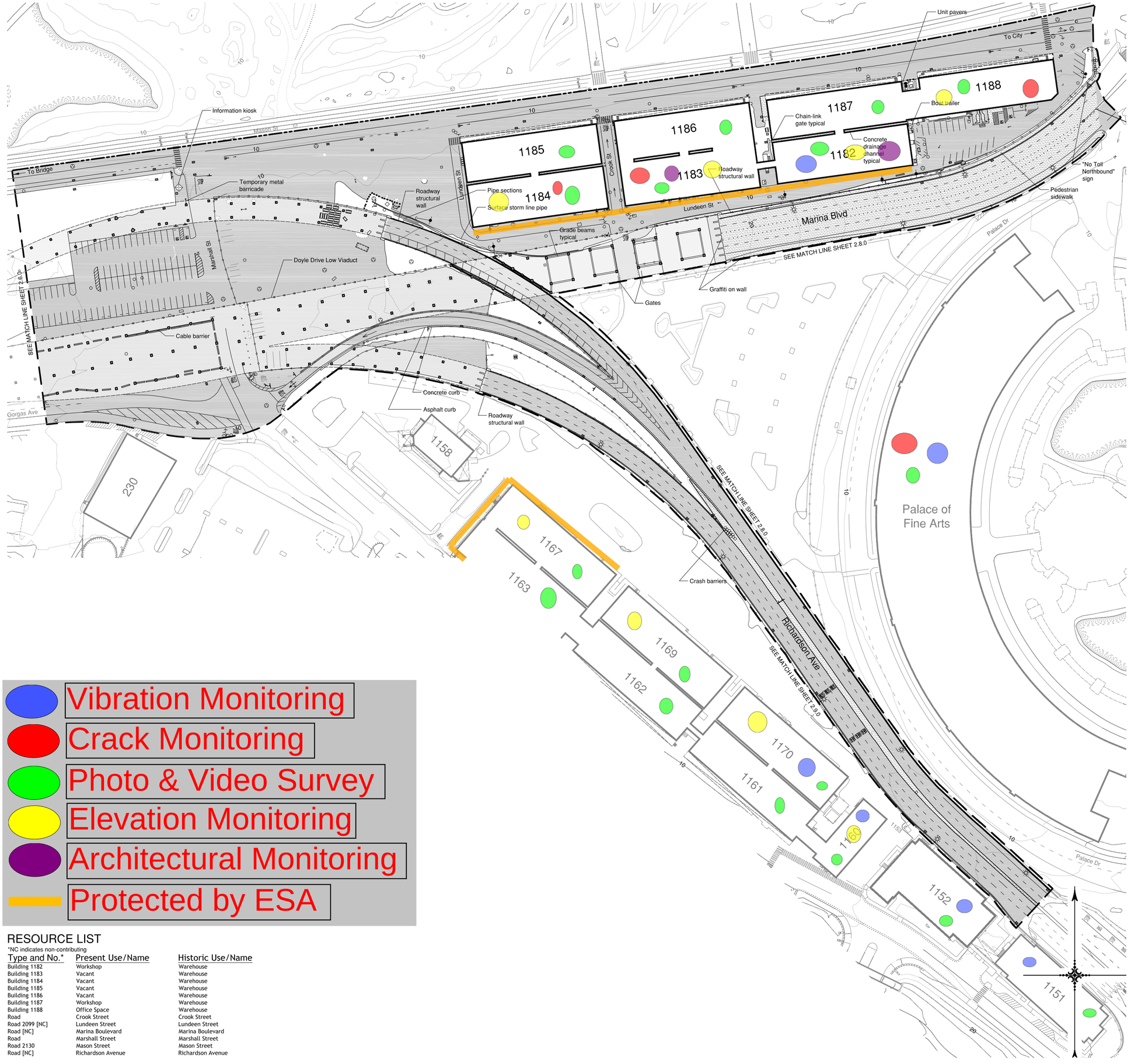

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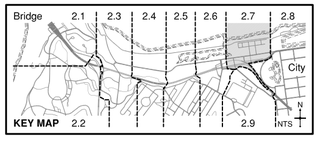
Survey control points

50 — 2 foot contour lines

*See Section 6 for field photographs of site features grouped by feature type.



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Elevation Monitoring

Architectural Monitoring

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RESOURCE LIST

*NC indicates non-contributing

Type and No.*	Present Use/Name	Historic Use/Name
Building 1182	Workshop	Warehouse
Building 1183	Vacant	Warehouse
Building 1184	Vacant	Warehouse
Building 1185	Vacant	Warehouse
Building 1186	Vacant	Warehouse
Building 1187	Workshop	Warehouse
Building 1188	Office Space	Warehouse
Road	Crook Street	Crook Street
Road 2099 [NC]	Lundeen Street	Lundeen Street
Road [NC]	Marina Boulevard	Marina Boulevard
Road	Marshall Street	Marshall Street
Road 2130	Mason Street	Mason Street
Road [NC]	Richardson Avenue	Richardson Avenue

Doyle Drive Corridor at the Presidio of San Francisco, Cal.

2009 Built Environment Plan
CRISSY FIELD / NORTH CANTONMENT

0 50 100 FEET 1" = 50'-0" | 0 10 20 METERS 1:600

2.7.0

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NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

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HIGHWAYS 101 AND 1 BETWEEN MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
SAN FRANCISCO COUNTY

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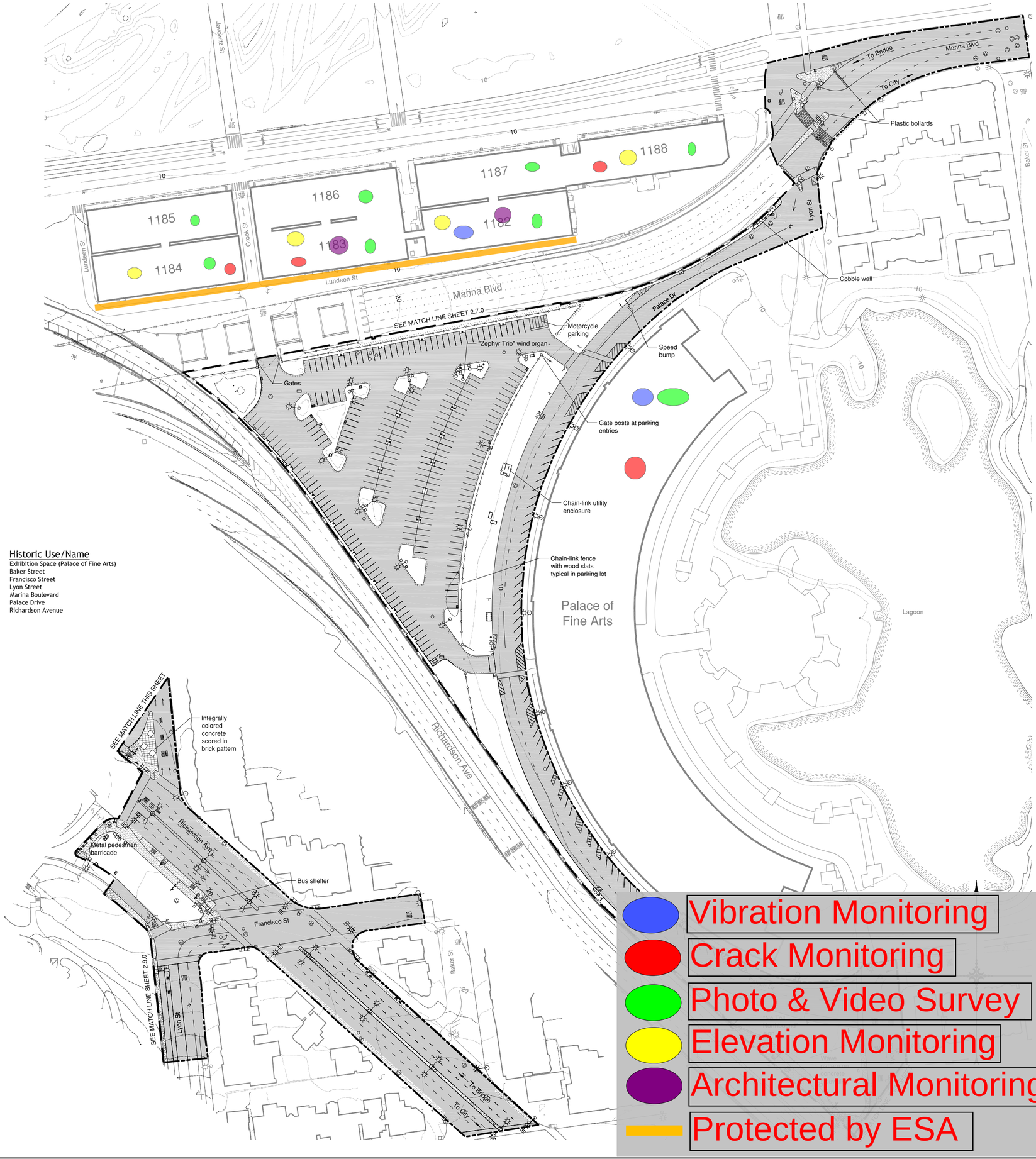

RESOURCE LIST

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Type and No.*	Present Use/Name	Historic Use/Name
Building [NC]	Museum (Exploratorium)	Exhibition Space (Palace of Fine Arts)
Road [NC]	Baker Street	Baker Street
Road [NC]	Francisco Street	Francisco Street
Road [NC]	Lyon Street	Lyon Street
Road [NC]	Marina Boulevard	Marina Boulevard
Road [NC]	Palace Drive	Palace Drive
Road [NC]	Richardson Avenue	Richardson Avenue

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- Concrete paving
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Curbs and gutters
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- ADA curb cut, perhaps with safety grooves
- Curbs, cobble
- Gutters, concrete

Walls, fences, and guardrails
- Walls, concrete
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- Walls, other
- K-rail or Jersey barrier, concrete
- Fences, chain link U.O.N.
- Guardrails, wood posts and metal rail U.O.N.
- Elevated sidewalk railing, metal

Pavement striping
- Solid lines, single or double
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- Pedestrian crosswalks
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- Lamps mounted with or without arms

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Utilities*
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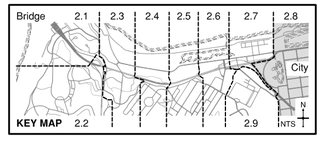

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2009 Built Environment Plan
CRISSY FIELD / PALACE OF FINE ARTS - NO. CANTONMENT

0 50 100 FEET 1" = 50'-0" 0 10 20 METERS 1:600

2.8.0

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PRESIDIO OF SAN FRANCISCO - DOYLE DRIVE CORRIDOR

HIGHWAYS 101 AND 1 BETWEEN MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
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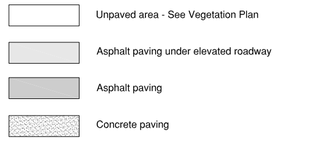

RESOURCE LIST

*NC indicates non-contributing

Type and No.*	Present Use/Name	Historic Use/Name
Building 1027	Administration	Garage and Storage
Building 1028	Housing	Nurses' Quarters
Building 1029	Veterans Academy	1989
Building 1030	Veterans Academy	1989
Building 1040	Vacant	Powerhouse
Building 1047	Vacant	Laundry
Building 1050	Vacant	Hospital Ward
Building 1051	Office Space	Hospital Ward
Building 1055	Foundation	Garage
Building 1056	Vacant	Animal Housing and Laboratory
Building 1059	Vacant	Storage
Building 1060	Vacant	Medical Supply Warehouse
Building 1061	Vacant	Acid Storage
Building 1062	Vacant	Quartermaster Shop
Building 1063	Vacant	Warehouse
Building 1076	Storage	Ambulance Garage
Building 1110	Letterman Digital Arts Center	Letterman Hospital
Building 1151	Indoor Swimming Pool	Indoor Swimming Pool
Building 1152	Gymnasium	Gymnasium
Building 1158 [NC]	Dance Theater	New Branch Exchange
Building 1160	Vacant	Warehouse
Building 1161	Spa	Warehouse
Building 1162	Sport and Medicine	Warehouse
Building 1163	Vacant	Warehouse
Building 1167	Vacant	Warehouse
Building 1169	Sport and Medicine	Warehouse
Building 1170	Spa	Warehouse
Road 2024	Birmingham Road	Birmingham Road
Road 2063	Girard Road	Girard Road
Road 2064	Gorgas Avenue	Gorgas Avenue
Road 2096	Lincoln Boulevard	Lincoln Boulevard
Road 2132	O'Reilly Avenue	O'Reilly Avenue
Road [NC]	Richardson Avenue	Richardson Avenue
Road 2179	Thornburg Road	Thornburg Road

Doyle Drive Corridor at the Presidio of San Francisco, Cal.

2009 Built Environment Plan
LETTERMAN COMPLEX / NORTH CANTONMENT

0 50 100 FEET 1" = 50'-0" | 0 10 20 METERS 1:600

2.9.0

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HISTORIC AMERICAN LANDSCAPES SURVEY
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

PRESIDIO OF SAN FRANCISCO - DOYLE DRIVE CORRIDOR
HIGHWAYS 101 AND 1 BETWEEN MERCHANT ROAD, BAKER STREET, AND KOBBE AVENUE
SAN FRANCISCO COUNTY

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Transportation Management Plan Guidelines

Division of Traffic Operations
Office of System Management Operations

June 2009

California Department of Transportation

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Appendix E - TMP Datasheet E-1

Introduction

With the construction of California's State Highway System virtually complete, the major emphasis of the California Department of Transportation (Department) has largely shifted from new construction to reconstruction, operation, and maintenance of existing facilities. As traffic demand steadily increases, work activities on the State Highway System can result in significant additional congestion, particularly in urban centers. Advance planning and coordination among the Department's various divisions are necessary to ensure that planned highway work will not result in extensive traffic delays to the public.

The concept of implementing a Transportation Management Plan is not new. The Department's Districts have used transportation management strategies for decades to move motorists through work zones quickly and safely. The Department officially established the Transportation Management Plan program in 2000 through Deputy Directive 60 (DD-60) outlining strategies needed to minimize traffic congestion during road work activities. Transportation Management Plan strategies are required for all planned construction, maintenance, and permit activities, which may range from a minor guardrail repair to a major bridge construction project.

These guidelines identify the processes, roles, and responsibilities for preparing and implementing Transportation Management Plans, as well as useful strategies for reducing congestion and managing work zone traffic impacts.

Pertinent Departmental and Federal Policies

The following are departmental and federal policies pertinent to the development and implementation of Transportation Management Plans:

- **DD-60-R1 Transportation Management Plans (September 2007)** establishes departmental policy related to the various roles and responsibilities in TMP development and implementation (see Appendix A).

- **Federal Highway Administration (FHWA) Final Rule, 23 Code of Federal Regulations 630, Subpart J,** referred to as the **"Work Zone Safety and Mobility Rule**" requires the Department to adopt policies and a program that implement Transportation Management Plans on all federally funded highway projects. On October 12, 2007, FHWA issued a Letter of Certification stating that the Department's policies and program are consistent and compliant with the Final Rule.

Key Terminology

The following are key terms used throughout this document.

"Transportation Management Plan (TMP)" is a program of activities for alleviating or minimizing work-related traffic delays by the effective application of traditional traffic handling practices and an innovative combination of various strategies. These strategies encompass public awareness campaigns, motorist information, demand management, incident management, system management, construction methods and staging, and alternate route planning. Depending on the complexity of the work or magnitude of anticipated traffic impacts, a TMP may provide lane requirement charts, Standard Special Provisions for maintaining traffic, and for a major project, a separate comprehensive report.

"Work Zone" is the active area of a highway where construction, maintenance, or utility activities are being conducted. The work zone extends from the location of the first temporary traffic control device to the last temporary control device.

"Major Lane Closures" are closures that are expected to result in significant traffic impacts despite the implementation of TMPs. These closures can be implemented for capital projects, maintenance, or permit activities. A "significant project" as defined by the FHWA Final Rule, is one that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts greater than what is considered tolerable based on State policy or engineering judgment. This term is not used in these TMP Guidelines, because it refers primarily to capital projects and is not all-inclusive; maintenance and permit activities are not necessarily considered as projects, but the Districts prepare TMPs for those activities.

"Significant Traffic Impact" was initially defined in DD-60 as an individual traffic delay of 30 minutes or more above a motorist's normal travel time. Significant traffic impacts can also occur when motorists experience shorter individual delays that may extend over several months or years. In some cases a full closure of a freeway segment may be justified for a short duration when compared to several months of weekend closures that may severely impact the business community and the public in general. The objective in developing TMP strategies is to balance short-term and long-term impacts to the traveling public with the safe, efficient delivery of highway construction projects and work zone activities.

"District Lane Closure Review Committee" (LCRC) is comprised of the Deputy District Directors of Construction, Design, Maintenance, and Traffic Operations, and the District Public Information Officer (PIO). The California Highway Patrol (CHP) may be asked to participate in the committee as appropriate. The District LCRC participates in planned project activities that are expected to (1) result in significant traffic impacts or (2) be of an interregional, statewide, environmental, or otherwise sensitive nature. For example, the District LCRC may decide to implement a full or extended closure to minimize the individual delay (for example, if the individual traffic delay will exceed 30 minutes) or if the total delay over the duration of the project will greatly inconvenience the public. Recent examples include the Interstate 80 Labor Day weekend closures on the San Francisco-Oakland Bay Bridge for retrofit work in 2006 (full closure in the

eastbound direction) and in 2007 (full closure of the bridge in both directions) rather than numerous consecutive weekend closures that would have greatly impacted tourist and commercial traffic. The Interstate 5 "Boat" Project full closures (alternately in the northbound and southbound directions) in the summer of 2008 allowed the Department to complete the work several months ahead of time with significantly less overall impact to the public.

"Headquarters Lane Closure Review Committee" (HQ LCRC) is comprised of the Division Chiefs of Construction, Design, Maintenance, and Traffic Operations, and the Deputy Director of External Affairs. CHP will be asked to participate as appropriate at the Headquarters (HQ) level. In rare instances, the HQ LCRC may be contacted by the District LCRC to inform management of potential impacts that may be considered press-worthy. The HQ LCRC may also be asked to conduct a TMP review and provide recommendations.

Acronyms

ADA	Americans with Disabilities Act of 1990
CCTV	Closed-Circuit Television
CHIN	Caltrans Highway Information Network (511)
CHP	California Highway Patrol
CMS	Changeable Message Signs
COS	Capital Outlay Support
COZEEP	Construction Zone Enhanced Enforcement Program
CPSD	Capital Project Skills Development
CTC	California Transportation Commission
DD	Deputy Directive
DTM	District Traffic Manager
EA	Expenditure Authorization
EMS	Extinguishable Message Sign
FHWA	Federal Highway Administration
FSP	Freeway Service Patrol
HAR	Highway Advisory Radio
HOV	High-Occupancy Vehicle
HQ	Headquarters
ITS	Intelligent Transportation System
LCRC	Lane Closure Review Committee
LCS	Lane Closure System
MAZEEP	Maintenance Zone Enhanced Enforcement Program
PA&ED	Project Approval and Environmental Document
PCMS	Portable Changeable Message Sign
PeMS	Freeway Performance Measurement System
PID	Project Initiation Document
PIO	Public Information Officer
PS&E	Plans, Specifications and Estimates
RE	Resident Engineer
RTL	Ready to List
RTPA	Regional Transportation Planning Agencies
SSP	Standard Special Provisions
TMC	Transportation Management Center
TMP	Transportation Management Plan
TMT	Traffic Management Team
TTC	Temporary Traffic Control
WBS	Work Breakdown Structure

1.0 WHAT'S IN A TRANSPORTATION MANAGEMENT PLAN (TMP)?

1.1 GENERAL

A TMP encompasses activities that are implemented to minimize traffic delays that may result from lane restrictions or closures in a work zone. TMP strategies are designed to improve mobility, as well as safety for the traveling public and highway workers.

1.2 TRANSPORTATION MANAGEMENT PLAN STRATEGIES

TMP strategies are categorized as follows:

A. Public Information
B. Motorist Information
C. Incident Management
D. Construction
E. Demand Management
F. Alternate Routes (or Detours)

The TMP strategies selected are dependent on the type of work that is planned, the geographic and demographic area in which the work is located, and the anticipated traffic impacts. This section describes strategies that may be considered where appropriate.

1.2.1 CATEGORY A. PUBLIC INFORMATION

The public is highly interested in advance roadway information so that they can plan their travel accordingly. Due to the strong emergence of the Internet and hand-held electronic devices, public notification of planned and ongoing highway work is one of the most effective tools for reducing congestion in work zones. When the public is equipped with work zone information before they begin traveling, they have the opportunity to adjust their travel plans. Advance roadway delay information can decrease the number of vehicles that may travel through the work area and can help to minimize traveler frustration. The information provided should include alternative transportation modes, such as transit services and bicycle routes that can be accessed during project construction and can lead to fewer vehicles on our highways and less congestion. In addition, public awareness campaigns inform the public of the overall purpose of the project and can help generate and maintain public support. Many of these strategies are typically used for major construction projects but can also be effectively applied to highway maintenance work or permit activities that may significantly affect traffic conditions.

A1. Brochures and Mailers. Brochures and mailers are printed material containing project-related information such as advance notice of the project's start date, schedules, pictures/graphics of the project, a description of the need for the project, alternative routes, alternative modes of transportation, and transit services. These may be disseminated to motorists at key locations, including businesses, rest stops, travel information centers,

automobile associations, and through direct mailings to affected businesses and residents in the project area.

A2. Press Releases/Media Alerts. This strategy provides timely project-related information to the news media, affected businesses, and other affected or interested parties using print and/or electronic media. Examples of these groups include local and cable television newsrooms, traffic navigation systems groups, schools, local major employers and businesses, and emergency services (fire, law enforcement, and ambulance). News media strategies (for example, newspaper, television, and radio press releases) are a no-cost alternative proven to be very effective in notifying travelers of planned roadway work. Various mechanisms fax, e-mail, telephone message, and mailings can be used to communicate information relating to start dates, work schedules, significant traffic pattern changes, transit routes, traffic collisions, and other incidents within the work zone.

A3. Paid Advertisements. Paid public service announcements of an upcoming major project may be transmitted through newspaper, radio, and television ads, as well as billboards. Paid advertisements can also be used for progress updates or to provide information regarding major changes to the work zone configuration and traffic management strategies. A cost analysis should be conducted to determine the expense of developing a public service announcement against the value of the number of targeted audiences the information will reach.

A4. Public Information Center. This is a small-scale facility typically located on or near the project site that contains such materials as scale-model displays, maps, brochures, videos describing the project, its potential traffic impacts, and available travel alternatives to minimize those impacts, including available transit routes and transit agency contact information.

A5. Telephone Hotline. This traveler information strategy provides traffic or travel information for the work zone using a toll-free telephone number. It can include prerecorded messages or real-time, interactive request/response information and a link to 511 (travel information telephone direct line).

A6. Planned Lane Closure Web Site. The Lane Closure System (LCS) is a statewide Web-based application that allows users to request, review, approve or deny, and monitor planned lane closures on the State Highway System. The purpose of the LCS is to provide California highway workers and motorists with a single source of information on traffic closures on the State's highways. The system operates continuously, providing real-time information on lane closures located in both urban and rural areas. The information is posted to District Web sites listing the routes involved, the type of work being performed, and the closure start and end dates and times. The LCS information is planned to be incorporated into the statewide 511 travel map.

A7. Project Web Site. A project Web site provides information for a specific work zone including long-term static information on project plans and progress, as well as real-time interactive information.

A8. Public Meetings/Hearings. This strategy involves the presentation of project information to the community and businesses by public relations staff and solicitation of input of potential concerns, impacts, and management strategies. Public meetings often involve the use of videos, slides, and graphical presentations to supplement public announcements and public information center displays.

A9. Community Task Force. The development of a community task force, which includes various stakeholders (businesses, neighborhood groups, employee transportation coordinators, interested individuals, public officials, or other representatives) that may be impacted by the work zone, can facilitate the dissemination of information related to a transportation project. A task force can also help generate interest and support for a project.

A10. Communication with Selected Stakeholders. Stakeholders most directly affected can be identified and can receive information during construction on a regular basis through periodic meetings or e-mail and fax notices.

A11. Information Kiosk. A kiosk is a small information center that can provide handouts and other information to passersby. The kiosk should be located in an area with high foot traffic in the general vicinity of the work location. Sample locations are shopping malls, rest stops, and gas stations.

A12. Freight Travel Information. This strategy may be appropriate when there is a moderate to high percentage of freight movement through the work zone. It involves coordination with the freight community (trucking companies and truck drivers) to disseminate work zone information considered useful (for example, truck restrictions, occurrences of traffic incidents, planned closures, and detours) and development of a mechanism to provide that information to freight stakeholders at central locations or to truckers as they approach the work zone.

1.2.2 CATEGORY B. MOTORIST INFORMATION

Motorist information is vital to travelers approaching a work zone and who still have time to make a decision that could divert them away from possible congestion. Given available information on travel delays or alternative routes prior to a decision point, the motorists can play an active role in completing their trips more smoothly and help reduce the overall congestion. When motorists are stuck in congestion, they can become frustrated and impatient. When they are given information on the length of delay and the reasons for the delay, their frustration levels are usually reduced.

B1. Traffic Radio Announcements. Traffic-related information is typically disseminated via regularly scheduled traffic reports on commercial radio stations. These reports are usually scheduled during morning and evening peak hour commute periods.

B2. Fixed Changeable Message Signs (CMS). These are fixed, overhead message signs placed along roadways to notify road users of lane and road closures, work activities, traffic incidents, potential work zone hazards, traffic queues (backups), travel time, or delay information, as well as alternate routes in or around the work zone. In some cases new CMS may be warranted; these signs should be installed before actual construction of the project to provide ample notification to the public. Communication and coordination with the District Transportation Management Center (TMC) for activation and use of the CMS during construction should be included in the TMP.

B3. Portable Changeable Message Signs (PCMS). PCMS can be placed at key locations to notify motorists of lane closures, alternate routes, expected delay, and upcoming road closures. These signs can be used to inform drivers of speed limit reductions and enforcement activities in a work zone, as well as projected delay or road opening times. The appropriate sign placement is included in the project plans. PCMS are typically deployed as a part of project signing. As a TMP measure, additional PCMS may be specified when warranted, based on factors, such as roadway geometrics or proximity to interchanges.

B4. Temporary Motorist Information Signs. Temporary conventional signs mounted in the ground or overhead provide traveler information to guide motorists through the work zone.

B5. Dynamic Speed Message Sign. This portable system can be mounted as a fixed sign or located on a portable trailer. Radar measures the speed of approaching vehicles, which is displayed on the sign along with the work zone speed limit. The objective of this system is to enhance safety by encouraging speed limit compliance.

B6. Highway Advisory Radio (HAR). Fixed or portable HAR systems provide detailed messages beyond the limitations of roadside signage. HAR involves the dissemination of

information to motorists over wide-area wireless communications directly to in-vehicle radios. Extinguishable message signs (EMS) are typically associated with HAR systems where the sign indicates how to obtain information on roadway conditions by tuning into a specific radio station (for example, "Tune in to 1610 AM"). These signs turn on and off depending on whether the HAR has a message available. EMS, signs with flashing beacons, fixed CMS, and PCMS can be used to inform motorists of the radio frequency for the available information.

B7. Caltrans Highway Information Network (CHIN or 511) Traveler Information Systems. This strategy provides motorists with work zone-related information, static (project dates) or real-time (potential delays) or both, using technology such as cellular telephones, pagers, in-vehicle systems, and e-mail notifications.

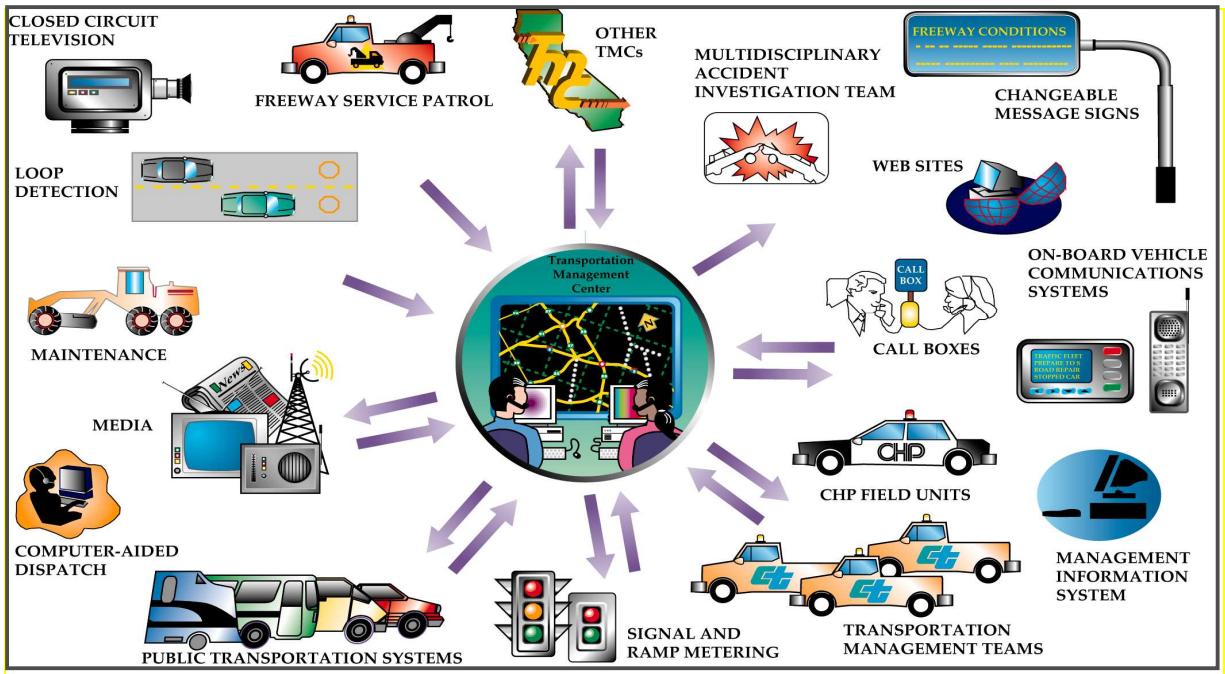
B8. Wizard CB Alert System. The Wizard CB Alert System is a device that continuously broadcasts over CB radio a message that warns approaching drivers of the work zone ahead. The information, specifically targeting truckers, can be broadcast over any selected CB channel, but since most truckers listen to channel 19, broadcasting over that channel means truckers generally do not need to take action to receive the message.

1.2.3 CATEGORY C. INCIDENT MANAGEMENT

When traffic incidents occur on the State Highway System in or near a work zone, the most effective tool in reducing potential congestion is to remove the elements of the incident from the roadway as quickly as possible. An incident may range in severity from a flat tire to a multiple big rig collision with a hazardous waste spill that closes a section of highway for several hours. A standing protocol is in place for all traffic incidents as a part of the Traffic Operations Division's Incident Management Program. However, the TMP Manager should determine whether the standard protocol should be supplemented or whether additional strategies may be needed for certain types of projects or in certain areas.

C1. Transportation Management Center (TMC). This strategy involves the use of a TMC for coordinating and managing traffic and incident information dissemination. The TMC controls all fixed Intelligent Transportation System (ITS) elements and in some cases portable HAR and PCMS. If the project is large and of long duration, a mobile project-specific TMC vehicle may be used to help manage traffic incidents and maintain efficient traffic flow through and around the work zone. The following diagram depicts the many components used at the TMC:

TMC COMPONENTS



C2. Traffic Management Teams (TMT). The TMTs respond to assist in managing traffic during incidents and planned lane closure activities that are expected to result in significant vehicle queuing. The primary purpose of the TMTs is to minimize secondary, end-of-queue collisions. In some cases these services can be provided by the contractor with the appropriate contract provisions.

C3. Intelligent Transportation Systems (ITS). ITS can be used in work zones to identify areas where traffic flow is impeded so traveler information can be provided and adjustments to the work zone can be made. Work zone ITS deployment uses sensors to detect traffic conditions and can automatically feed the information to traveler information outlets such as CMS, Web sites, or a TMC. ITS elements already installed in the field should be used as part of a TMP when practical. ITS elements installed as part of a project should be maintained in operational condition by the contractor throughout the duration of the work. This can be accomplished by reviewing contract plans, identifying and evaluating potential impacts to ITS elements, and including the appropriate standard special provisions in contract documents.

C4. Surveillance Equipment. This strategy involves the use of surveillance equipment, such as closed-circuit television (CCTV), loop detectors, lasers, probe vehicles, or cameras, to help identify traffic problems and to detect, verify, and respond to expected traffic impacts and incidents in the work zone.

C5. Helicopter for Aerial Surveillance. This strategy involves the use of aerial surveillance to identify and verify traffic problems and incidents. Helicopters are especially

useful in highly urbanized areas where several routes may be severely impacted by traffic congestion on any one route.

C6. Tow/Freeway Service Patrol. This strategy involves the use of dedicated or on-site (or near-site) towing services to reduce the time required to remove vehicles involved in a traffic incident (breakdown or crash) from the roadway. Any type of incident near a work zone can significantly impact traffic conditions and may result in secondary collisions due to driver lack of attention.

C7. Dedicated (paid) Law Enforcement. The Department contracts with the CHP to provide enhanced enforcement services through two programs:

- The Construction Zone Enhanced Enforcement Program (COZEEP).
- The Maintenance Zone Enhanced Enforcement Program (MAZEEP).

The visibility of CHP presence alerts motorists that road work is being performed on the roadway and that motorist behavior is under surveillance. The officers are directed by the onsite field supervisor (construction or maintenance supervisor) to patrol the work zone area or to remain stationary. Priority should be given to these services during night time operations and where workers are on foot in the work zone. Workers on foot have an increased exposure to serious injury or death from errant motorists. Refer to the Construction or Maintenance manual for implementation criteria to determine when these services are warranted or recommended. A COZEEP/MAZEEP Pocket Guide has been developed for the Resident Engineer's (RE) use in work zones, describing suggested enforcement strategies to be used, and contact names and phone numbers including TMC contact information (see Appendix B). The Pocket Guide should be distributed to CHP and to other field staff.

1.2.4 CATEGORY D. CONSTRUCTION

Construction strategies can be effective in reducing congestion in a work zone. These strategies include, among others, innovative construction staging plans, lane requirement charts requiring crews to work at night instead of during daily peak commute periods, full closures of a roadway segment for a short period instead of nightly closures for several months or years, use of reversible lanes that can be modified to accommodate peak hour traffic in either direction, and use of contractor incentive and disincentive clauses within the contract. Similarly, reduced speed limits in work zones may not reduce congestion, but may make travel through the work zone safer for workers and the traveling public.

D1. Lane Requirement Chart. These charts identify the number of lanes that must be open for traffic each hour of the day to minimize delay when work activities are being conducted. These charts restrict work hours so that traffic is not affected during periods of peak travel demand and congestion (for example, peak hours, holidays, or special events).

Work is typically performed during off-peak periods, such as at night, to minimize work zone impacts to motorists and adjacent businesses.

D2. Construction Staging. The Stage Construction Plan shows the sequence of construction activities. The Order of Work specification may identify portions of the project to be completed in a specific sequence to minimize impacts to the traveling public.

D3. Traffic Handling Plans. Traffic handling plans contain sufficient alignment detail, profiles, and typical cross-sections to guide traffic through the work zone in the sequence shown in the Stage Construction Plan.

D4. Full Facility Closures. This strategy involves complete closure of a roadway (either in one or both directions) or a freeway-to-freeway connector (ramp closures are typically not considered full closures). Full closures can minimize the duration of the project and improve worker safety. Full closures may be brief (intermittent, off-peak), short-term (night, weekend), or long-term (continuous for the duration of the project). Full closures typically require the involvement of the District PIO to ensure that a public information campaign with adequate advance notification is developed and implemented. The TMP Manager determines if a full roadway or freeway-to-freeway connector closure should be reviewed by the District LCRC and the HQ LCRC. Impacts to the alternate route should be monitored and managed to the extent possible. The Department encourages the use of full closures where feasible as long as adequate advance planning is conducted and appropriate TMP measures are implemented.

D5. Lane Modifications. It is essential to maintain the existing number of highway lanes to the extent possible. This can be done through lane modifications, which are typically in place for extended periods. Special consideration should be given to accommodate extra-high and extra-wide trucks where possible. Lane width reductions to less than 12 feet require approval from the District Traffic Liaison as well as a design exception. Lane modifications must also consider bicycle and pedestrian users and emergency parking. Efforts should be made to limit the time a lane or shoulder is closed or reduced in width. Modifications may include the following:

- **Reduced Lane Widths to Maintain Number of Lanes (Constriction).** This involves reducing the width of one or more lanes in order to maintain the existing number of lanes on the facility while permitting work access to part of the facility.
- **Lane Closures to Provide Worker Safety.** This strategy closes one or more existing traffic lanes to accommodate work activities.
- **Reduced Shoulder Width to Maintain Number of Lanes.** This involves reducing the width of the shoulder for use as part of the traffic lane by shifting traffic onto the shoulder, allowing access for the work activities to take place. Adequacy of the shoulder pavement section to handle mainline traffic should be verified before using this strategy.
- **Shoulder Closures to Provide Worker Safety.** This strategy closes the shoulder for use by the public, making it available to accommodate the work activities. Where bicyclists or pedestrians are allowed, shoulder closures must provide for alternate accommodations.
- **Lane Shift to Shoulder or Median to Maintain Number of Lanes.** This strategy involves diverting traffic onto the shoulder/median, or a portion of the shoulder/median, for use as a traffic lane.

D6. One-Way Reversing Operation. On two-lane highways, one-way reversing traffic control involves alternately stopping traffic in one direction, allowing work activities to occur in the lane that is closed. The TMP Manager determines the maximum time that each direction should be stopped so that motorists do not experience undue delays.

D7. Two-Way Traffic on One Side of Divided Facility (contra-flow or crossover). This strategy involves closing one side of a divided facility to permit work to proceed without traffic interference while both directions of traffic are accommodated on the opposing side of the roadway. For example, on a four-lane highway, two lanes in the northbound direction would shift to the southbound side so that work could be done on the northbound side. When completed, all traffic would shift to the northbound side, while work was conducted on the southbound side.

D8. Reversible Lanes. This strategy, also known as variable lanes, involves sharing lane(s) of travel to accommodate peak-period traffic flow. The direction of travel in the shared lane switches by time of day or day of the week.

D9. Ramp Closure/Relocation. A ramp closure involves closing one or more ramps in or near the work zone for specific periods or construction phases to allow work access. In some cases, a temporary ramp may be constructed to maintain access. Standard special provisions typically do not allow the closure of consecutive off-ramps.

D10. Night Work. Work is performed at night (end of evening peak period to beginning of morning peak period) to minimize work zone impacts on motorists and adjacent businesses. Consideration should be given to potential impacts to residents due to noise, worker safety, and temperature requirements for paving operations.

D11. Extended Weekend Work. A construction work window may allow work to be performed during weekend periods from the end of the Friday afternoon peak period to the beginning of the Monday morning peak period (a 55-hour closure). This strategy may be difficult to implement in an area where there is a high volume of weekend tourist traffic. Consideration should be given to avoiding weekends in areas that may have a high volume of special events or tourist traffic.

D12. Pedestrian/Bicycle Access Improvements. This requirement involves providing alternate facilities for bicyclists and pedestrians per DD-64-R1 in places where the work zone may impact their accessibility and movement during highway work activities. Provisions of shuttle service may be necessary (see Section E9).

D13. Maintain Business Access. When a project has a direct impact on businesses, accessibility issues may warrant signage or specific information to direct motorists to the businesses and relocation of access locations.

D14. A+B Bidding. A+B bidding encourages contractors to minimize construction impacts by reducing construction time. Part A refers to the contractor's bid for the actual items of work. Part B is the total number of days bid to complete the project multiplied by the daily road user cost (road user cost plus standard liquidated damages) stipulated in the contract. The combined values of the A and B parts determine the winning bid. The contractor may be assessed additional liquidated damages if the work is not completed and will impact the designated routes specified in the special provision. A+B bidding is primarily used on projects of $5 million or more with a daily road user delay cost of $5,000 or more.

D15. Incentive/Disincentive Clauses. This strategy involves the use of incentives and disincentives in the construction contract to minimize construction duration. Calculations to support incentive and disincentive clauses are prepared with the proposed specification language.

D16. Innovative Construction Techniques (for example, precast members, rapid cure materials). These strategies involve the use of special materials, such as rapid curing concrete or precast items (for example, culverts, bridge deck slabs, and pavement slabs) to minimize the duration of construction or maintenance activities where traffic restrictions need to be minimized (for example, roadways with high volumes), and when work activities need to be completed during night or weekend periods to allow reopening travel lanes for normal weekday travel.

D17. Railroad Crossing Controls. When a rail crossing is located within a work zone or on a detour or diversion route, traffic control enhancements at the crossing may become necessary for safety purposes, especially if work zone delays and congestion have the potential to force vehicles to stop on the tracks or between the crossing gates. Enhancements may include advance warning signs, railroad crossing signs, pavement markings, flashing lights, gate arms, flaggers or law enforcement officers, and possibly closure of crossing to traffic during work periods.

D18. Coordination with Adjacent Construction Site(s). This strategy involves combining, coordinating or staging projects within a specific corridor to minimize the combined impacts on the motoring public and community. The objective is to ensure that adequate capacity remains available to accommodate the anticipated travel demand within the corridor by not implementing work zones on adjacent or parallel highways at the same time. This may entail communicating information about the timing of lane closures and coordinating diversion routes. It may also involve the completion of needed capacity and safety improvements on a highway prior to its use to carry traffic diverted or detoured from another project. Construction staging can be used to remove work at the same location or traffic control conflicts between adjacent projects.

D19. Speed Limit Reduction. A reduced speed limit may improve traffic and worker safety in a work zone. Speed limit reductions may be implemented through an entire work zone or only in active work areas. Reduced speed limits may also be appropriate on detours where traffic volumes and conflicts are increased. This strategy can be used in combination with a speed radar trailer (dynamic speed message sign) to alert motorists of their speed.

D20. Traffic or "Gawk" Screens. Traffic screens help prevent driver distractions in work zones by blocking the motorist's view of the activities. This strategy helps to keep traffic moving and enhance safety. Screens may be mounted on top of temporary traffic barriers to discourage gawking.

D21. Bus Priority Access. Providing bus-only lanes or other features to ensure buses can travel through a construction zone with minimal delay will entice the public to use transit and decrease the number of vehicles that travel through the corridor.

1.2.5 CATEGORY E. DEMAND MANAGEMENT

Demand management strategies can be used to encourage motorists to travel either in carpools or mass transit vehicles, or to vary work hours to reduce the typical peak hour traffic volumes. Rideshare incentives include free transit tickets or tickets at a reduced price. Park-and-ride lots can be built as a part of the project to encourage commuters to travel together, not only during but also after construction is completed.

TMP teams should contact local transit providers to establish a plan, using the elements below, to use existing transit services and resources to lessen the impact of the construction project on person-throughput throughout the corridor. Public information methods should educate the public on the plan and transit elements that are available. This could lead to a short-term reduction of traffic during construction and might lead to long-term benefits of increased ridership after the project is finished. Transit incentives should be considered for all projects and implemented when deemed effective.

E1. Telecommuting. Telecommuting means working outside of the traditional office or workplace, usually at home. Motorists, particularly in an urbanized area, who normally travel through the work zone, can be encouraged to telecommute for the duration of a project to reduce the travel demand.

E2. Truck/Heavy Vehicle Restrictions. This strategy encourages truckers to use detours or alternate routes during specific periods or at all times increasing passenger vehicle capacity of the roadway on a facility that normally has a high truck volume.

E3. Parking Supply Management. This strategy involves reducing traffic demand in the work zone area by limiting parking supply, typically through price increases.

E4. Variable Work Hours. This strategy involves encouraging motorists who typically travel through the work zone during peak periods to work variable hours (off-peak) to reduce travel demand.

E5. Ramp Metering. Ramp meters are traffic signals located on on-ramps or freeway connectors designed to decrease demand on a highway facility by controlling the entrance of vehicles, matching entering vehicles to gaps in the traffic stream. Various strategies for ramp metering include preset timing, traffic actuated metering changes (based on mainline traffic volumes), or centrally controlled metering. Ramp metering may be used during peak periods or all day to modify on-ramp traffic directly upstream of the work zone. Portable or temporary ramp meters are options.

E6. Ramp Closures. Temporary closure of one or more on-ramps in or around the work zone may be used to improve traffic flow on the mainline. Consideration must be given to notify emergency services and to provide adequate alternatives for emergency vehicles.

E7. Transit Service Improvements. Where appropriate, transit service improvements may include the modification of transit schedules or routes, increases in frequency, or the establishment of transit service in or near the project corridor.

E8. Transit Incentives. Transit incentives include employer or traveler transit subsidies and guaranteed ride home programs.

E9. Shuttle Services. Shuttles and charter buses can reduce traffic volumes through a work zone if a sufficient number of users along the corridor are anticipated to use the service. Shuttle services must be used where pedestrians or bicyclists are allowed and do not have alternate access through a work zone.

E10. Ridesharing/Carpooling Incentives. This strategy involves the use of rideshare/carpool incentives to reduce the number of vehicles traveling through a work zone. Incentives may include preferential parking for carpools, the addition of mainline High-Occupancy Vehicle (HOV) lanes or bypass lanes on ramps, and provisions for vanpool vehicles.

E11. Park-and-Ride Promotion. This involves the development, expansion, and promotion (advertising) of Park-and-Ride lots to encourage ridesharing or transit use, thus reducing the number of vehicles traveling through the work zone.

1.2.6 CATEGORY F. ALTERNATE ROUTES (OR DETOURS)

Alternate route (or detour) strategies can be used to give travelers the opportunity to avoid the work zone completely by diverting to other highways or adjacent surface streets. This strategy includes examining the adequacy of detour or alternate routes and coordinating with the agencies responsible for those routes and the transit services on the routes. Use of a detour may require improving the effectiveness of the detour route by restricting parking or placing traffic control officers at critical intersections to help move traffic along during peak periods. Bicycle and pedestrian accommodations (for example, access and length) must be considered when using alternate routes during construction.

F1. Off-site Detours/Use of Alternate Routes. This strategy involves rerouting some or all traffic from the roadway under construction or repair to other roadways. Detours need to be evaluated to accommodate extra-high and extra-wide trucks; any restrictions must be reported to the Transportation Permit Office. Before the work begins, it is advised to record the condition of the detour route to allow assessment of the roadway condition after the work is completed. During the work, traffic conditions on detours should be monitored to make sure that motorist delays remain within acceptable levels.

F2. Signal Timing/Coordination Improvements. This strategy involves retiming traffic signals to increase vehicle throughput of the roadway(s), improve traffic flow, and optimize intersection capacity in and around the work zone. Signal timing and coordination could include transit vehicle priority.

F3. Temporary Traffic Signals. The installation of temporary traffic signals can be used to improve traffic flow through and near the work zone. At a corridor or network level, the use of temporary traffic signals is more effective than stop signs or flaggers for providing mobility through the work zone area. These temporary traffic signals may also be coordinated with existing signals.

F4. Street/Intersection Improvements. Improvements on streets and intersections for the roadway or alternate routes may be necessary to provide increased capacity to handle the traffic through the work zone or within the adjacent corridor. This may include improvements to the mainline and intersections, including roadway or shoulder widening and construction of new through lanes and turn lanes. Pedestrian, bicycle, and transit needs should be carefully considered to maximize the positive impact of alternative modes.

F5. Bus Turnouts. This strategy involves the construction of bus stop areas that are recessed from the travel lanes. This strategy may be helpful in work zones or on detour routes with a high frequency of bus traffic.

F6. Turn Restrictions. This involves restricting turning movements for driveways and intersections to increase roadway capacity, reduce potential congestion and delays, and improve safety. Restrictions may be applied during peak periods or all day.

F7. Parking Restrictions. This strategy involves the restriction of parking in all or part of the work zone or alternate routes during work hours or peak traffic periods along alternate routes. Parking restrictions can be used to:

- Increase capacity by converting the parking lane to an additional travel lane.
- Reduce traffic conflicts.
- Provide improved access to the work area.

1.3 PRELIMINARY INFORMATION NEEDED FOR DEVELOPING A TMP

When developing a preliminary TMP, use the most current layout of the roadway (geometrics) information and plans available. The most current traffic volumes either at the specific location or as close as possible to the work zone site should be used to determine possible traffic impacts. Traffic information can be accessed through various sources: through the Department's Internet traffic data Web site (http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/), the Freeway Performance Measurement System (PeMS – https://pems.eecs.berkeley.edu) via the loop detection system (devices set into the pavement that collect traffic data), special manual vehicle and occupancy counts, and through tachometer surveys which provide time and speed information. If current traffic counts are not readily available, a request for a new count should be submitted to the Department's Traffic Data and Photolog Office.

The data is typically used to determine the expected traffic delay at the work site and the work windows that will be made available. Sometimes projects that have been programmed and funded are "shelved" or delayed for a year or more, due to funding or environmental issues. When these projects are put back on the schedule, the traffic volumes and associated work windows need to be reviewed and updated to reflect the latest traffic conditions.

Information to consider when developing a TMP is listed in the following table.

Table 1.0 Items for Consideration in Developing a TMP

- Latest traffic volumes (motorized, nonmotorized and truck traffic).
- Lane closure policies and procedures.
- Political or environmental issues.
- Multijurisdictional communication and buy-in.
- CHP and local law enforcement involvement.
- Percentage of truck volume.
- Business and affected activity centers impacts.
- Clearance of alternate routes for Surface Transportation Assistance Act and oversized trucks.
- Concurrent corridor (including conflicting) construction projects.
- Length of project (miles).
- Urban versus rural conditions.
- Time constraints (including duration).
- Transit and Railroad services.
- Viability of alternate routes.
- Impacts on bicyclists, pedestrians, senior citizen facilities, or schools.
- Current project layout and staging.

1.4 TMP CLASSIFICATIONS

TMPs can be classified by the anticipated impact of the highway work on the traveling public. The District TMP Manager determines the level of treatment required for the proposed work. The three classifications are described below.

1.4.1 "Blanket" TMPs

Certain low-impact Maintenance and Encroachment Permit activities do not require the development of detailed work specific TMPs. Those activities performed during off-peak hours on roadways with low volumes might be treated adequately with a "blanket" TMP. A blanket TMP may range in detail from approval for a lane closure by the DTM to a few selected strategies (such as PCMS activation) that would be taken to keep delay below the delay threshold (see example in Appendix C). District Maintenance and Encroachment Permit offices should have a list of activities to which blanket TMPs apply. Depending on the type and duration of the proposed work, a blanket TMP may also include a one-page description of the activities to be performed and contact information for personnel involved in the activities.

1.4.2 "Minor" TMPs

Certain activities may result in traffic impacts on the State Highway System that are not "significant," as defined in this document, and may require a "Minor" TMP. A Minor TMP will likely include lane requirement charts specifying when the work can be conducted. Depending on the type and duration of the proposed work, a Minor TMP may also include a schedule and detailed description of the activities to be performed and the TMP strategies to be used, such as enhanced enforcement services, motorist information (such as PCMS),

freeway service patrol during peak hours, and advance public information provided to the media.

1.4.3 "Major" TMPs

"Major" TMPs are prepared for capital, permit, and maintenance projects that could significantly impact traffic. Major TMPs may involve full closures (Interstate 5 "Boat" Project closures in District 3, alternating in the northbound and then southbound direction), weekend closures (Interstate 80 San Francisco Oakland-Bay Bridge Labor Day weekend closures in District 4) and continuous closures (Interstate 15 Devore closures in District 8). Generally, major TMPs are typically identified as follows:

- Multijurisdictional in scope, often encompassing the interests of CHP, local law enforcement, city, county, and regional governments, bordering state transportation departments, employers, merchants, developers, transit operators, ridesharing agencies, neighborhood and special interest groups, emergency services, and transportation management associations.

- Multifaceted, comprised of traffic operations, facility enhancement, demand-management, and public relations strategies, as well as more traditional work zone actions, construction methods and contract incentives, customized to meet the unique needs of the impacted corridor.

- In place over an extended period of time, sometimes implemented a year or more before the start of actual construction, with specific elements often implemented incrementally to coincide with construction phasing.

Major TMPs may include the full spectrum of strategies, including lane requirement charts, special provisions for unique project characteristics, a large-scale public awareness campaign (with brochures, public meetings, project Web site, and telephone hotline), COZEEP services, freeway service patrol, detours to alternate highways or surface streets, and special arrangements with local transit services to accommodate a significant increase in ridership. Due to the effort typically required on major TMPs, the Districts may choose to contract with a consultant.

1.5 TMP RESOURCES

The development of TMP strategies is a continuous effort to efficiently and effectively manage traffic in work zones on the State Highway System. Appendix D provides contact information and additional supporting TMP information sources.

2.0 TRANSPORTATION MANAGEMENT PLAN PROCESS

2.1 PROCESS OVERVIEW

TMP development begins at the initiation of the planning process. In the case of capital projects, it begins with the preparation of a TMP datasheet or checklist for each phase of the project as part of the Project Initiation Document (PID) process. The TMP is a "living" document and continues to be modified as work information warrants it. Frequently after construction or maintenance activities begin, if traffic conditions differ from what was anticipated, changes in TMP strategies may be necessary to keep motorist delays below acceptable levels. When modifications are made in the TMP, they should be approved by the TMP Manager.

2.1.1 Corridor, Regional, Multifunctional Area TMPs

When multiple or consecutive projects are within the same general corridor, the cumulative impact can result in excessive traffic delays, detour conflicts, direct traffic control, and work conflicts. These may be multiple capital projects, the involvement of more than one District or local jurisdiction, or a combination of capital projects and encroachment permit and maintenance activities. Corridor, regional, or local coordination will mitigate these impacts thereby minimizing inconvenience to the traveling public.

When multiple projects are in the same corridor or on corridors within the same traffic area, it may be possible to develop a single corridor or regional TMP. In other cases, individual TMPs are developed and funded from their own sources and a "bare bones" corridor or regional TMP addresses the cumulative impact. Each project covered by corridor and regional TMP contributes resources in proportion to its traffic impact.

The TMP Manager coordinates the development and implementation of corridor and regional TMPs. The TMP Manager forms a TMP team including, at a minimum, representatives from the Department's Divisions of Construction, Maintenance, Project Management, and Traffic Operations for each of the affected Districts. The District PIO and CHP participate as needed. The initial meeting is held several months in advance of construction to set milestones, and to allow time to prepare and distribute project information.

During TMP implementation, the TMC serves as an information clearinghouse and coordinates operations. The TMC helps identify conflicts and recommends appropriate action. When provided with accurate and up-to-date lane closure information, the TMC provides real-time traffic information via electronic media, PCMS, and HAR.

The corridor/regional TMP may call for strategies in addition to those provided by the individual TMP for each project. Those elements may include CMS at key locations outside individual project limits, the establishment of an information hotline, Web sites for all projects involved, use of the statewide 511, and the use of TMCs as a central reporting hub.

If the corridor/regional TMP calls for strategies beyond the individual project TMP, it is recommended that:

- The service be provided through a Construction Change Order on one of the corridor projects.
- The requirement be included in one of the corridor projects as part of the project plans and standard special provisions.

2.1.2 TMP Team

For Major TMPs, the TMP Manager solicits team members based on the projects proposed TMP elements, and anticipated traffic impacts. The TMP team may include representatives from the following:

- Divisions of Design, Project Management, Construction, and Traffic Operations.
- Local law enforcement, transit, and emergency services agencies.
- FHWA and CHP.
- District transit representative, District bicycle and pedestrian coordinator, and field staff from the Division of Maintenance.
- Other entities as appropriate.

2.2 TMP IN THE PROJECT INITIATION DOCUMENT PHASE

The extent of a TMP is determined by the District TMP Manager during the preliminary studies of a capital project. At the request of the project initiating unit (typically Design or Planning), the TMP Manager coordinates the preparation of TMP information that will be included in the PID phase. Projects are generally programmed, budgeted, and scheduled upon project approval at the end of the PID phase. It is extremely important to identify the proper scope and cost of the TMP activities in the PID, as significant post-PID approval changes will be difficult to obtain.

As soon as possible and prior to PID approval, the initiating unit sends conceptual geometrics to the District Office of Traffic Operations for evaluation. The TMP Manager and the DTM estimate the extent of the TMP required and determine whether potential traffic delays are anticipated that cannot be mitigated by traditional traffic handling practices or well-planned construction staging.

2.2.1 TMP Datasheet Preparation

During the PID process, the TMP Manager coordinates the development of the TMP datasheet. The datasheet identifies the proposed TMP strategies that may be included to minimize the traffic impacts of the planned work (see Appendix E). Contact your District TMP Manager to identify the information that will be needed.

For all TMPs, an itemized estimate of the proposed strategies and their respective costs may be included in the TMP for proper funding consideration. If an itemized estimate is not included, the TMP Manager should review the project cost estimate prepared for the PID.

2.2.2 TMP Cost Estimate

A TMP cost estimate should be developed for each alternative being considered and should not be based only on the project cost. The cost of a TMP could range from a small percentage of project cost to 20 percent or more and often is not dependent on the size of the project. The cost of the TMP strategies should be weighed against the potential delay savings that the motorists might experience, as well as mobility and safety effects on all modes of travel.

Further guidance can be obtained from the Department's Project Development Procedures Manual.

2.3 TMP DURING THE PROJECT APPROVAL AND ENVIRONMENTAL DOCUMENT PHASE (PA&ED)

During this phase, studies of the identified alternatives are performed to determine the preferred TMP alternative. During the development of the project concept and staging, the Division of Design has the opportunity to incorporate traffic considerations that could potentially eliminate the need for extensive and expensive TMP strategies. During this phase the highest level deliverables completed are the Final Project Report and the Final Environmental Document.

2.3.1 TMP Refinement During the PA&ED Process

The planning or design team should work with traffic engineering/operations personnel and other relevant technical specialists (such as right-of-way experts, pavement engineers, and environmental specialists) to obtain the necessary project information and help identify potential issues or concerns. This collaboration can help to develop the best combination of design, construction phasing/staging, and work zone management strategies. With proper planning, potential traffic problems can be eliminated by modifying the design or construction phasing.

If traffic studies are needed to develop TMP strategies, these should be initiated as soon as possible to make sure that the needed data is available. As information becomes available during the PA&ED phase, the preliminary scope and cost of the overall TMP and the individual elements should continue to be refined. The TMP Manager (or TMP team for a major project) will coordinate the TMP strategies with the project engineer and appropriate functional units, with each team member handling their area of expertise. For major projects, subcommittees or task forces may be formed to handle the planning, implementation, monitoring, and evaluation details of specific elements. The TMP Manager will keep the Project Manager and District Construction Coordinator updated and must sign off on the TMP datasheet of the project report.

It is appropriate at this point to develop a schedule for major TMPs. Many TMP elements may be bid and constructed or initiated separately from the project or may be included in the project plans and installed or implemented as the first order of work. On major capital projects, public awareness campaigns may need to be initiated well before the actual work begins, oftentimes a year or more in advance. For example, if new park-and-ride lots are necessary for the ridesharing element, the planning phase would have to be extended for several months and a design phase added.

An additional activity involves analyzing the existing traffic volume and user mix (such as pedestrians, bicyclists, trucks, and buses in the corridor, both on the freeway and surface streets). This will provide a basis for establishing the goal of the TMP, that is, the number of vehicles that should be removed from the freeway, and in determining the capability of the surrounding surface streets to handle the additional vehicular demand and the impact on bicycle and pedestrian traffic. Assessing transit alternatives available and considering service enhancements may decrease the need for other investments and will show the public that the Department encourages partnerships with transit agencies.

2.4 TMP DURING THE PLANS, SPECIFICATIONS AND ESTIMATES (PS&E) PHASE

The Project Engineer should coordinate with the TMP Manager to ensure that all TMP requirements are addressed in the Standard Special Provisions (SSPs), Engineer's Estimate, and project plans.

2.4.1 Preparation of TMPs During Design

During project design, the TMP strategies may be further developed or modified by the TMP Manager as the details of the work become more specific. Design engineers should consider work zone impacts in the evaluation and selection of the project alternatives. For some projects, it may be possible to choose a design alternative that alleviates many work zone impacts. These broader strategies cross various disciplines and highlight the need for a multidisciplinary approach. As the design progresses, a selected alternative is typically chosen and the TMP is reviewed and updated to reflect the most current project information. During this time the highway historical conditions and current traffic volumes are evaluated to determine the anticipated traffic impacts during construction and to verify that the appropriate TMP strategies are being proposed.

The TMP Manager receives input from the other Divisions that may be involved on the Project Development Team or the TMP Team if one is established. The other Divisions on the team would typically include Design, Project Management, Construction, Traffic Operations, Maintenance, and the PIO. The team should also include CHP and local agencies that might be affected by the project. When applicable, it is recommended that a representative from Environmental Analysis be included in the Project Development Team.

The Department maintains Standard Plans and Standard Specifications that include generic traffic control plans. Any deviations from those Standard Plans and Specifications (such as detours or special work windows) require the inclusion of specific SSPs or special details in the project plans for TMP-related work that needs to be implemented by the contractor. All TMP-related special details and SSPs or changes to those SSPs must be approved by the TMP Manager. Nonstandard special provisions must be approved by the District Deputy Director of Traffic Operations or designee.

2.4.2 Acceptable Delay Thresholds

Lane requirement charts are prepared based on historical traffic volumes at the specific location. Typically they are prepared so that no congestion will result from work; that is, "zero delay" will be expected. If the project has been shelved, the charts should be

reviewed in case updating is needed. The best available traffic data should always be used to develop the charts. If that data is not available, information on appropriate traffic projections may be obtained from the Planning Division.

Certain activities (such as approach slab replacement) may require more time than allowed by the original lane requirement charts. In those instances, the Design Engineer should contact the Engineer of Record (the group that developed the charts) to request a longer work window. If that individual determines that minimal delays would be acceptable based on current traffic conditions, the charts may be adjusted to provide a longer work window. The TMP would then need to be modified to mitigate the traffic impacts created by the longer work window.

2.4.3 Construction Work Windows

Congestion in work zones with high traffic volumes is typically minimized by only allowing work to be conducted during off-peak commute periods. For example, in urban areas, peak hours might occur between 6 a.m. – 10 a.m. and 3 p.m. – 7 p.m. during weekdays. Peak hour traffic volumes during weekdays do not allow for adequate day work windows; certain highway work activities often can only be done at night. Night work that involves noisy equipment and operations could create a nuisance for residential housing nearby; pile driving during working hours could also be a nuisance for businesses in the area.

Through TMPs, the Department strives to strike a balance between reducing the overall construction duration, minimizing disruption to the traveling public, and maximizing safety in the work zone. DD-60-R1 states that, when possible, the maximum allowable delay at any location at any time should be limited to less than 30 minutes. Application of this criterion has resulted in a general shift from day work activities to night work, particularly for capital projects.

This strategy has been successfully implemented in general. However, its effectiveness has been questioned in circumstances where materials or methods require day work conditions or where longer work windows are required to complete certain activities. Overall delay over an extended construction period could have significant impacts on the traveling public, as well as on commercial interests in the project area.

Alternative construction strategies and work windows should be considered early in the design phase, for example, during the Project Development Team process. These alternatives might include:

- Extended closure options:
  - o 55-hour weekend closures (typically from 10 p.m. on Friday until 5 a.m. on Monday).
  - o 72-hour weekday closures.
  - o Continuous closures (for example, 10 days including weekends).
- Full closures in one direction.
- Full facility closures (in both directions).
- Closed facility for all vehicles except for buses.

Extended work windows and full closures often provide a shorter project duration, which in turn may result in cost savings and in overall delay savings to the traveling public. The time

for setting up and breaking down traffic control and construction equipment mobilization is reduced, resulting in more effective work time. For example, in 2006 the Interstate 15 Devore Pavement Rehabilitation Project team opted for a continuous nine-day closure of the full facility (alternately in each direction) rather than six months of night work. These alternatives also enhance safety.

Projects with the following characteristics might be likely candidates for full closures:

- Projected night time or weekend closures, indicating the potential for significant delay.
- Available alternate routes or ability to increase transit service, or both.
- A significant reduction in the number of working days.
- Sufficient lead time available for TMP development, specifically focusing on a public information campaign.
- Willing partners at the local and regional levels.
- Possibility of mitigating impact of major special events, holidays, or other major traffic generators.

Use of alternative work windows must include consideration of the need for revised or additional public awareness strategies. The District PIO should be included when determining which strategies are needed and the appropriate timing for implementation.

Use of alternative work windows or extended work windows beyond the lane requirement chart hours must also include consideration of the need for monitoring traffic flow approaching the work zone to protect motorists approaching the "end of queue." These queues can often result in secondary traffic collisions (usually rear-end collisions) when motorists fail to slow down. This monitoring can be done by the contractor or a District Traffic Management Team.

If the work methods cannot be modified or avoided, select the least detrimental period and be sure to notify the public why the work is necessary and when it will occur.

2.4.4 Pedestrian and Bicycle Traffic

Work zone activities can disrupt the public's mobility and access. Temporary lane restrictions, use of shoulders as travel lanes, detours, and other transportation management strategies should be designed to accommodate nonmotorized travelers wherever they are legally permitted. Safe and convenient access should be maintained for pedestrians and bicyclists, who are susceptible to disruptions because of their slower speeds and sensitivity to noise, airborne dust, road debris, and fumes. Special care should be taken to consider areas where schools or senior citizen centers are located. A travel path that replicates, if possible, the most desirable characteristics of their usual travel route should be provided.

The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, including persons with disabilities in accordance with the Americans with Disabilities Act of 1990 (ADA)) through a Temporary Traffic Control (TTC) zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents. The California Manual of Uniform Traffic Control Devices (MUTCD) Part 6 contains figures that can be adapted for traffic handling plans. Figure 6H-29, "Crosswalk Closures and Pedestrian Detours," of the California MUTCD is an example of accommodating the needs and control of pedestrians. Public participation should be

used to ascertain the extent of public impacts of proposed construction activities and to discuss the appropriate temporary accommodations that can be reasonably achieved.

DD-64-R1 - Complete Streets - Integrating the Transportation System requires full consideration of nonmotorized travelers (including pedestrians, bicyclists and persons with disabilities) in all programming, planning, maintenance, construction**,** operations, and project development activities and products.

Design Information Bulletin 82 - Pedestrian Accessibility Guidelines for Highway Projects provides highway design guidance to accommodate persons with disabilities within the public rights-of-way. This document satisfies the requirements of the ADA. SSP 12-150 contains details on pedestrian walkway materials and construction. Further guidance for pedestrian and bicyclist accommodations is provided in the California MUTCD, Part 6 "Temporary Traffic Control."

California MUTCD Part 6 addresses the needs and control of all road users (motorists, bicyclists, and pedestrians) within the highway, including persons with disabilities in accordance with the ADA, through a TTC zone. The TTC shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

2.4.5 Transit Services

In preparing a TMP, the team should meet with local transit providers to understand existing transit services, to ensure the transit level of service remains at an acceptable rate, and entice commuters to use this transportation mode. Higher transit ridership leads to a decrease in the number of vehicles the Department must accommodate during project construction.

2.4.6 TMP Certification

When preparation of the PS&E package is complete and the project is Ready to List (RTL) for bid, certification that all the latest TMP strategies are included must be obtained from the TMP Manager. If the project is shelved, the TMP strategies need to be reviewed, updated, and recertified before RTL.

2.4.7 Retrofitting TMPs for Programmed Projects

Generally, the extent of the TMP is determined prior to programming (PID approval). However, it may be necessary to retrofit a TMP to a project that is already programmed due to project changes, policy changes, emergencies, or unforeseen conditions. These projects must be handled on a case-by-case basis since the course of action will depend on how far along the project development process is and how extensive the TMP needs to be. A project that was initially designed to be constructed as a night time operation over several months may be converted just prior to construction to a full closure or a continuous closure to reduce the overall project duration. The Interstate 15 Devore project is an example of continuous closures implemented over a nine-day period in each direction of travel, rather than several months of night closures.

2.5 TMP MODIFICATIONS DURING CONSTRUCTION

Contract-related TMP strategies are implemented by the contractor with Department oversight. Strategies related to public awareness may also be implemented by Department personnel. If project conditions change, traffic volumes increase or project staging changes, the DTM or the TMP Manager must be notified and consulted to determine if the TMP needs to be revised. The District PIO also needs to be involved early in the planning phase to ensure adequate public awareness funding will be available throughout the project.

At times, certain activities may require more time than allowed by the lane requirement charts. In those instances, the Registered Engineer (RE) should contact the Engineer of Record (the group that developed the charts) or DTM and TMP Manager to request a longer work window. If that individual determines that minimal delays would be acceptable based on current traffic conditions, the charts may be adjusted to provide a longer work window. When work is allowed outside of the original work window, the District Transportation Management Team (TMT) should be contacted to monitor potential traffic backups.

2.5.1 Traffic Monitoring During Construction

The RE should ensure that inspectors monitor traffic conditions while work is being performed to avoid impacts in excess of what was identified in the TMP. When excessive queues occur, the TMC should be notified to initiate mitigation.

When congestion due to highway work zone activities is anticipated, traffic monitoring can be made a part of the construction contract or conducted by District TMT personnel. The traffic monitor typically uses a vehicle with a truck-mounted CMS and stations the vehicle where approaching motorists can clearly read the CMS. This strategy provides periodic assessments of the effectiveness of project safety features and is often done at the beginning of a project to make sure that the TMP strategies are effective. Electronic monitoring and warning systems can also be used for this purpose.

2.5.2 TMP Coordination During Construction

TMP activities are to be monitored and evaluated by the TMP Manager or the TMP team and those elements found ineffective should be appropriately modified.

During construction, those TMP elements that are part of the main contract or Encroachment Permit are implemented under the general direction of District Construction or Encroachment Permits. Those separate contracts or agreements, for example, for rideshare and transit activities and public awareness campaigns, will be under the direction of their respective contract managers.

Special effort should be given to assure that CMS, HAR, and other media tools provide accurate and timely information to motorists, bicyclists, and pedestrians regarding lane closure times and locations.

2.5.3 Late Lane Closure Pickup

The RE needs to ensure that lane closures will not be picked up beyond the lane closure window. Exceptions can occur when the activity needs to be completed for the safety of the public and workers. The RE should coordinate with the DTM if the contractor needs to work outside the lane requirement chart hours. The TMC should also be notified and the TMT may need to be called to monitor possible queuing.

In order to avoid significant traffic impacts, it is essential to monitor and respond immediately to delay, pick up closures on time, and have solid traffic handling and contractor (construction operations) contingency plans.

Contractor compliance with lane closure pickup deadlines can be enforced in two ways. SSP 12-220 is often included in the contract allowing the contractor to be assessed for damages based on the value of traffic delay when the contractor exceeds the lane closure window. The minimum damages are generally $1,000 per 10 minutes, but the damages can greatly exceed the minimum, depending on traffic volumes and the highway facility. Traffic Operations staff (normally the DTM) calculates the delay damages during PS&E. The second method to ensure that the lane closures are picked up on time is for the RE to suspend the contract work.

A contractor or departmental forces (such as Maintenance) can be ordered to pick up a lane closure early if traffic impacts become significant either due to a project incident or activities outside the project area. During construction, remedial actions may be based on contingency plans submitted by the contractor. Early pickup should only be ordered when traveler and worker safety will not be compromised. The SSPs for “maintaining traffic” for capital projects provide for compensating contractors for early pickup. Encroachment Permit provisions require the permittee to pick up a closure early without compensation.

A Department staff member who can make informed decisions about implementing contingency plans and modifying, terminating, or extending approved lane closures should be available to respond to significant delays and other unexpected events whenever lane closures are in place. The designated employee(s) may be Traffic Operations, Construction, or TMC staff, depending on the District.

2.5.4 “After-Action” Reporting

At the end of a major project, where the actual delay exceeded the threshold set by the DTM, the District LCRC or HQ LCRC may request that a brief “After-Action” (post-TMP) report be completed by the TMP Manager (for example, the San Francisco-Oakland Bay Bridge Labor Day closures in District 4). Post TMP meetings with the CHP and other partners can be held to identify the elements that went well and those that could have been done differently. Samples of past “After-Action” reports can be obtained from the individual District Traffic Operations offices.

2.6 CONTINGENCY PLANS

There are two types of contingency plans. The "Construction Operations Contingency Plan" is developed for the purpose of construction operations equipment and materials backup; the second plan developed by the Division of Traffic Operations is referred to as the "Traffic Handling Contingency Plan."

2.6.1 Construction Operations Contingency Plan

The contingency plan is developed by the contractor to identify operations, equipment, processes, and materials that may fail and cause delayed opening of lane closures. The contingency plan identifies alternative or additional equipment, materials, or workers necessary to ensure continuing operations and on-time opening of closures when a failure occurs. If the alternative or additional equipment, materials, or workers are not on site, the contingency plan specifies the method of mobilizing these items and the required time to complete the mobilization.

Critical pieces of equipment are those that are necessary to complete the planned work in the closure, for which no close on-site substitutes exist, and which, if rendered inoperative, would cause the closure to have to be kept in place past the pick-up time indicated in the requirement charts.

Critical work operations are any work to be performed in a lane, shoulder, or ramp closure that will render any portion of the traveled way unsuitable for use by public traffic, or that would make the use of the traveled way unsafe, and would therefore cause the closure to remain in place past the pick-up time indicated in the lane requirement charts.

As the SSP is written, the RE determines when the contractor will be required to submit a contingency plan. The contractor develops a contingency plan and submits the plan within one day of the RE request. The contingency plan should be discussed at the partnering meeting or at the project preconstruction meeting.

The following list provides samples of operations that may require a contingency plan:

- Slab replacement
- Roadway excavation
- Cold planning asphalt concrete
- Asphalt paving
- Asphalt or concrete grinding
- Chip seal
- Asphalt or concrete pavement sealing operations
- Bridge work
- Placement of reinforcing steel or structural members
- Erection of falsework
- Bridge demolition
- Striping

The Construction Operations Contingency Plan describes:

- Critical stage for each operation when the alternative or additional equipment, materials, or workers are to be activated.
- Communication equipment (cellular telephones) and procedures to be followed when communicating with the RE's field representative(s) during activation of the contingency plan.
- Intended amount of work to be done during each lane, shoulder, or ramp closure. The amount of work is described in terms of length, width, and unit of measure conforming to the appropriate progress pay items.
- Operation work schedule with a time line set at 20 minute intervals.
- Contractor plans to comply with the projected material delivery rates to the jobsite. Material delivery may be delayed due to various factors including, but not limited to, plant breakdown, loss of trucking due to breakdown, independent truckers leaving to another job, or trucking delayed by traffic congestion due to accidents or the project itself.
- Times for beginning and ending critical work operations for work being conducted in lane, shoulder, or ramp closure.
- A general time-scaled logic diagram displaying the major activities and sequence of planned operations that comply with the requirements of these special provisions and a set of “contingency action plans” for each stage of the operations to prevent late opening of the traffic lanes shall be specified. “Early finish” and “late finish” milestones shall be clearly identified for every major activity. The “contingency action plans” shall include detailed operations that will be conducted should a major activity pass the “late finish” milestone.
- Anticipated cooling times for asphalt concrete pavements necessary prior to opening a lane, shoulder, or ramp to public traffic.
- Anticipated time it will take to completely pick up the lane, shoulder, or ramp closure(s) rounded to the nearest 5 minutes.
- Anticipated time(s) for beginning pickup of lane, shoulder, route, or ramp closure(s).
- Timelines for the contractor and the RE to meet at the worksite to review actual progress and forecast the time work will be stopped to open the lane, shoulder, ramp, or route to public.

The contractor verifies or updates the contingency plan concurrent with submission of the written schedule of planned closures. If a revision is required, the contractor should not close any lanes until the contingency plan has been reviewed by the RE.

2.6.2 Traffic Handling Contingency Plan

The Traffic Handling Contingency Plan is a method of operation consisting of strategies or actions taken to restore or minimize effects on traffic when the congestion or delay resulting from construction, maintenance, or permit activities exceeds original TMP estimates. This situation may result from unforeseen events such as work zone incidents, higher-than-predicted traffic demand, or late lane closure pickups.

These traffic handling contingency strategies may include, but are not limited to, the following:

- Notification to the TMC
- Request for TMT assistance
- Activation of CMS or PCMS
- Activation of the HAR system
- Notification to the CHP
- Notification to transit agencies
- Notification to the media
- Activation of a detour
- Follow-up with the RE if activation of the contractor's (construction operations) contingency plan is appropriate
- Notification to the HQ Communication Center if the District TMC is not available

Depending on the District or the situation, these strategies may be implemented by the DTM, the Construction Traffic Manager, or the TMC.

On lane closures that will be implemented outside of typical lane closure hours and that are expected to have significant traffic impacts, the Project Development Team or TMP Team should develop a specific traffic handling contingency plan that may include:

- Activation of a TMT when available to monitor congestion and queues.
- Trigger points to identify when certain traffic handling strategies should be taken.
- "Decision tree" with clearly defined lines of communication and authority.
- Specific duties of all participants during lane closure operations, such as coordination with CHP or local agencies.
- Names, telephone numbers, and pager numbers for the DTM or their designee, RE, Maintenance Superintendent, Encroachment Permit Inspector, on-site traffic advisor, CHP Division or Area Commander, and appropriate local agency representatives. (One means of disseminating this contact information would be via the COZEEP/MAZEEP Pocket Guide (see Appendix B), which should be prepared for individual projects.)
- Coordination strategy (and special agreements if applicable) between DTM, RE, on-site traffic advisor, Maintenance, CHP, local agencies, and the Office of Public Information.

3.0 TMP ROLES AND RESPONSIBILITIES

DD-60-R1, released in September 2007, clearly defines the roles and responsibilities of Department personnel involved in the TMP process, including:

- District Directors
- Chief, Division of Traffic Operations
- Deputy District Directors of Construction, Design, Project Management, Maintenance and Traffic Operations
- Chief District Public Information Officer (PIO)
- District Lane Closure Review Committee (LCRC)
- HQ LCRC
- District TMP Managers
- District Project Managers
- District Traffic Manager
- District Design, Office Engineer, Maintenance, and Encroachment Permit Engineers
- District Construction Engineers, RE, Encroachment Permit Inspectors, and Maintenance Supervisors/Superintendents
- Construction Traffic Managers
- TMC Staff

DD-60-R1 is included in this document as Appendix A.

4.0 LANE CLOSURE REVIEW COMMITTEE

4.1 SIGNIFICANT TRAFFIC IMPACTS AND MAJOR LANE CLOSURE APPROVAL BY THE DISTRICT LCRC

This process applies to all "major" lane closures on the State Highway System. Major lane closures are those lane closures that are expected to result in significant traffic impacts despite the implementation of TMP strategies. A "significant traffic impact" is defined in DD-60-R1 as a delay of 30 minutes or more above normal recurring traffic delay on the facility, but may also refer to work that may affect traffic conditions over a long period. When a planned lane closure is expected to have a significant traffic impact, District LCRC review and approval are required. The functional unit directly involved in the work must submit the major lane closure request to the District LCRC for approval as detailed below. The District LCRC is comprised of the Deputy District Directors of Construction, Design, Maintenance, and Traffic Operations, and the District PIO. The CHP may also need to participate as appropriate.

The District LCRC does not have to review and approve emergency closures due to natural events or incidents. However, the TMC and the DTM must be notified, and every effort must be made to minimize traveler delay and reopen traffic lanes as soon as practical.

4.2 HQ LCRC REVIEW

The District LCRC will decide when to submit lane closure requests to the HQ LCRC for their review and recommendations or approval. The District LCRC would usually consider lane closures that are of an interregional, statewide, environmental, or otherwise sensitive nature. The District LCRC is expected to resolve most issues at the District level with the focus on mitigating delay over 30 minutes or developing full or extended closures that would reduce overall traveler delay for projects that may extend for several months or years.

The HQ LCRC is comprised of the Division Chiefs from Construction, Maintenance, Design, and Traffic Operations, along with the Deputy Director of External Affairs, and a representative from CHP. The HQ LCRC may review the closure or leave the decision to the District LCRC. As a notification process, information on planned lane closures that are reviewed by the District LCRC should be provided to the Chief of the Office of System Management Operations.

The Division Chief of Traffic Operations serves as Chair of the HQ LCRC and may refer the decision back to the District or meet first with the District to discuss major concerns before deciding to call the full committee together. A full HQ LCRC review is only warranted in rare circumstances (for example, full closure of the San Francisco-Oakland Bay Bridge in the eastbound direction over Labor Day Weekend 2006).

If the District is confident that the necessary TMP strategies are planned and will be implemented when needed, it is not necessary to request a meeting with the HQ LCRC. The District LCRC, however, should prepare adequate information (one-page or two-page fact sheet) so that the District Director can inform the Director of the steps being taken to minimize potential traffic problems for those projects that may be press worthy.

In its evaluation of the proposal, the District LCRC will give consideration to the accuracy, reliability, and completeness of information provided, as well as other reliable sources of information available to the District LCRC.

Proposals will be evaluated on the basis of effectiveness in the following areas:

- Traveler and worker safety improvements.
- TMP strategies.
- Plans for coordination with adjacent construction, maintenance, encroachment permits, and special events activities.
- Plans for coordination with TMC and field personnel.
- Plans for coordination with public media.
- Plans for use of existing field elements such as traffic surveillance loops, CMS, HAR and CCTV cameras.
- Lines of communication and authority (top to bottom).
- Plans for monitoring delay (or corresponding queue length) during lane closure operations.
- Alternatives to proposed closures.
- Contingency plan viability.
- Plans for coordination with local agencies, particularly as strategies pertain to detours on local roadways.
- Plans for coordination with the trucking industry on routes with heavy truck traffic.
- Transit agency coordination plan.

4.3 CONTENTS OF MAJOR LANE CLOSURE REQUEST SUBMITTAL

The functional unit that plans to request the lane closure and is responsible for its performance prepares a major lane closure request submittal with support from the TMP Manager and the DTM. Sufficient information is provided to ensure complete understanding of the proposal. At a minimum, the following information is recommended:

- Location and vicinity maps showing the State highway(s), local street network, and other adjacent lane closures or nearby work that may affect traffic during the same period, including special events.
- Dates, times, and locations of the lane closure(s).
- Brief description of the work being performed during the lane closure(s).
- Brief description of each lane closure and its anticipated effect on traffic conditions and transit services.
- Amount of expected delay and corresponding queue length for each lane closure.
- Summary of TMP strategies that will be used to reduce delay and motorist inconvenience during the lane closure(s). A copy of the approved TMP for the project, if available.
- Detailed detour information if applicable.
- Construction operations contingency plan.
- Map of transit routes in pedestrian/bicycle facilities.

5.0 TMP EVALUATION PROCESS

5.1 TMP STRATEGY EFFECTIVENESS

Monitoring traffic impacts during highway work should help determine how well or poorly the TMP strategies are performing and if the TMP strategies have been properly implemented. Field personnel should observe traffic conditions to determine if the actual impacts comply with the Department's policies and fall within a reasonable range of the impacts that were expected. Monitoring strategies may involve manual traffic volume counts, surveys using "floating cars" to assess travel time through the work zone, or automatic measuring devices. Record keeping on project events and traffic incidents (collisions and traffic queues) may also serve as good sources of information.

The RE, DTM and TMP Manager should determine whether the implemented strategies are reaching the predetermined goals for reducing congestion within reasonable cost limits. If an element's predetermined goal is not immediately reached during implementation, but there is a general trend toward meeting that goal, the element can remain in effect but may be modified as appropriate. Elements that show no sign of approaching their predetermined goals as determined by the TMP Manager should be revised or dropped and other actions may be needed to minimize congestion through the work zone.

The effectiveness of TMP strategies can be evaluated through various ways:

A. Field Counts and Surveys

- Field measurements of actual delay to the public (through electronic or manual data collection).
- Field observation of congestion queues by Department TMT personnel or by the contractor.

B. Public Surveys

- Questionnaires regarding how and when the public found out about the work.
- Logging of public complaints on Department Web pages or through telephone calls.

C. TMP Effectiveness Checklist Reporting on Factors, such as:

- The actual delay experienced
- Additional travel time
- Queue length
- Number of incidents in or near the work zone
- Incident response
- Impacts on adjacent construction activities
- The number of times that planned lane closures were picked up late and the reason
- Delay to transit services and ridership impacts
- Delay to bicyclists and pedestrians.

5.2 POSTCLOSURE EVALUATION STATEMENT

A Postclosure Evaluation statement may be submitted to HQ Division of Traffic Operations, Office of System Management Operations, on projects that cause major delay. Typically, the majority of postclosure evaluation statements are prepared for closures formally approved by the District LCRC under this process. However, any delay over 30 minutes should trigger a postclosure evaluation statement.

No more than one page is suggested. The functional unit performing or overseeing the lane closure will prepare the statement within five working days of the date the lane closure exceeded the threshold criteria. The statement should explain the following:

- The cause and impact of delays.
- Either actions taken or to be taken to avoid or mitigate an occurrence or recurrence.
- Why the expected delay was exceeded and why it was necessary to exceed the closure window.
- How the situation can be avoided in the future.

5.3 TMP PROCESS REVIEW

The objective of the process review is to evaluate statewide TMP practices and strategies and use the results to guide improvements in the Department's policies and procedures regarding safety and mobility. These reviews may include the evaluation of work zone data at the State level or field observations of selected projects. The information gathered is typically brought to the attention of the DTMs and the TMP Managers. They may analyze and review the information and make recommendations to revise policy or standard specifications, identify training needs, or update guidelines if needed.

By reviewing possible trends, the Department may determine that some adjustments to its practices would be appropriate, such as changes to standard design specifications. For example, during a process review, a DTM or TMP Manager might determine that work zone traffic delays in one part of the region have been more than experienced in the past and may warrant modifications in permitted lane closure times. During a process review, the Department may review its training requirements to determine whether they are still adequate.

The DTMs and TMP Manager's throughout the State meet twice a year to discuss ongoing issues relating to traffic management. These meetings address evaluations of traffic management strategies for work zone activities. Presentations are often given on strategies that have been used on past or current projects, whether or not those strategies were effective, and lessons learned. Discussions are held on proposed projects and strategies; feedback is provided by the various Districts on whether these strategies might be improved or modified. The review process may include changes to strategies on a statewide basis for future work zone activities. Some of the issues that have been recently addressed include the effectiveness of COZEEP and MAZEEP, monitoring the end of queue during construction, damages assessed for late lane closure pickup, construction and traffic handling contingency plans, flexible work windows, and the use of truck-mounted attenuators for lane closure installation and removal.

Department personnel from Construction, Maintenance, PIO and Traffic Operations, as well as representatives from FHWA, CHP, universities, consultants, contractors, suppliers, and local agencies participate on a joint Work Zone Safety Committee. This committee meets quarterly to address safety and mobility issues and makes recommendations to influence policy.

The Division of Construction conducts ongoing reviews of construction practices on randomly selected projects. The Division of Construction publishes a report entitled the Contract Administration Process Evaluation every four years. Example issues that have been addressed in recent years include work zone safety equipment and apparel, construction contingency plans, A+B bidding practices, construction methods, and flexible work windows.

Construction safety meetings are held twice a year to discuss work zone safety issues and make recommendations to improve policy and specifications, to modify the construction manual, and to improve work zone training. Other topics have included discussions on collision data and changes that may be needed in work zone practices to improve safety.

6.0 TMP TRAINING

6.1 TRAINING PROGRAM AND MATERIALS

TMP training courses are conducted in all 12 Districts throughout the State. The training program and materials were initially prepared by Capital Project Skills Development (CPSD) and the Office of System Management Operations staff and have been modified and updated by the Districts to reflect their own issues. This eight-hour course consists of several PowerPoint presentations and videos, as well as technical handouts and interactive class exercises. The subject matter includes the TMP process, strategies, and roles and responsibilities.

The course is conducted by the District TMP Manager and DTM staff, with the assistance of the HQ TMP coordinator and the CPSD coordinator as required. Course materials can be found at:

http://onramp.dot.ca.gov/hq/traffops/otrafopr/system_development/tmp.htm

6.2 TARGET AUDIENCE

TMP training is mandatory for all statewide personnel directly involved in the TMP process, generally, the Divisions of Planning, Environmental Analysis, Design, Program Management, Traffic Operations, Maintenance, and Construction.

7.0 TMP FUNDING AND PROGRAMMING

7.1 TMP CHARGING PRACTICES

When identifying funding for various TMP elements, it is important to distinguish between capital outlay costs and capital outlay support (COS) costs. Work done by District staff for the planning and design of TMP activities for capital projects is a normal part of the project development process and should be captured as capital outlay support. The TMP Manager and each functional manager should work closely with the project manager to ensure that TMP activities are included in all project work plans.

TMP support activities to consider include ridesharing programs, Freeway Service Patrol (FSP), public awareness campaigns, parallel route improvements, temporary bicycle and pedestrian facilities, and the Request for Proposal (RFP) process up to award of the contract. Some of these activities may also have a capital component in addition to the support component discussed here.

The workload required to develop and implement TMPs is estimated in advance. Workload hours for TMP activities must be included in the COS project's work plan in order to be resourced (funded) by COS. These activities should then be charged to each project's expenditure authorization (EA) number, using the appropriate Work Breakdown Structure (WBS) code for that stage of the project. TMP-related work should be charged only to the WBS codes reserved for those activities. These codes can be found on the Department's Division of Project Management's intranet site in a document entitled "Guide to Project Development Workplan Standards".

Work performed by District staff for implementing TMP elements during construction of capital projects is also a normal part of the project development process. Again, workload (hours) for implementing TMP activities must be included in the project's work plans to be resourced by COS. These activities should then be charged to the appropriate project's phase 3 EA, and WBS code, that is, 270 (Perform Construction Engineering and Contract Administration), 270.65 (TMP Implementation during Construction).

Some funds necessary to implement TMP elements not done by staff, including consultant contracts, can be sourced from capital outlay funds allocated by the California Transportation Commission (CTC) as itemized in the plans, specifications, and estimates. Various TMP elements, such as parallel route improvements and HAR, could be a phase of the construction contract or separate construction contracts while others such as public awareness campaigns and transit subsidies must be separate contracts or cooperative agreements.

The TMP elements that need to be in place prior to start of construction are identified and funded as stage construction or first order of work under a single package presented to the CTC. Service contracts such as those for public service or consultant contracts, information campaigns, or establishing telephone hotlines must be arranged separately with consultants and other providers. For most projects, it takes four to six months to obtain a service contract. This means that all consultant contracts have been advertised, the consultant selected, and the contract ready for signature and awarded immediately following CTC allocation of funds. Other activities such as parallel route improvements are usually included in the main construction contract and as a first order of work under a cooperative agreement.

In some cases, the CTC can be petitioned to fund a portion of the TMP as an initial phase of the main project. This is usually for a high-priority project where plans, specifications, and estimates for the main project are not finalized, but early funds are needed to initiate TMP activities such as making transit arrangements with local governments. The petition to fund an initial phase comes from the District, explaining why a portion of the project must proceed before funding for the main project is allocated. These early funds reduce the programmed funds for the main project accordingly.

The FHWA supports the TMP concept and views major reconstruction projects as an excellent opportunity to initiate continuing TMP strategies that provide improved traffic operations long beyond the completion of work.

7.2 CHARGING FOR MAINTENANCE AND ENCROACHMENT PERMIT TMP ACTIVITIES

TMPs and contingency plans for Encroachment Permit projects are developed by the permittee or by Department staff. Staff time for development, review, and implementation of TMPs for Encroachment Permits is charged to the permit. Maintenance normally develops TMPs for its projects. Maintenance and staff from other functional areas that expend time on a Maintenance TMP charge to the designated Maintenance EA. The Office of Public Information should be notified on all Encroachment Permit TMP and contingency plans to ensure proper expenditure charging.

7.3 FREEWAY SERVICE PATROL FUNDING

The Freeway Service Patrol (FSP) is a congestion relief program of roving tow trucks operating in most metropolitan and some rural areas. The FSP program is operated by Regional Transportation Planning Agencies (RTPAs) with funding from the Department. The Department also reimburses CHP for training and supervisory services provided for the FSP. The RTPAs contract with tow companies for commute time service and some weekend and mid-day service to assist motorists with simple repairs (for example, flat tire or one gallon of gasoline) or tow the automobile from the highway.

FSP is available for incident management during construction. However, construction-related FSP service needs to be funded as part of the TMP. A cooperative agreement with the RTPA is required, outlining the services provided and the fund transfer. An interagency agreement with the CHP is also required for any support services (field supervision and dispatch operator services). These agreements should be initiated with the RTPA and the CHP as soon as it is determined that FSP should be in the project TMP.

The Department's HQ Division of Traffic Operations no longer initiates Master Agreements with the RTPAs for future FSP services. The Master Agreement is developed at the District level, usually by the TMP Manager. Having a Master Agreement in place will simplify the process for both the Department and the RTPAs by eliminating the need for a cooperative agreement for each project. Only a task order form will be needed for each project. A similar agreement is handled at HQ with the CHP. A simple task order can be completed by the District for CHP supervision funded by the construction project. Please contact HQ Division of Traffic Operations, Freeways Operations Branch for more information.

7.4 COZEEP AND MAZEEP FUNDING

The Department has contracted with CHP to provide enhanced enforcement services in work zones through the COZEEP and the MAZEEP. CHP is the sole provider of these services. On oversight projects, the local agency typically contracts with the CHP to provide these services. Contact CHP, Special Projects Unit, for more information at webmaster@chp.ca.gov.

7.5 BASIC ENGINEERS ESTIMATE SYSTEM (BEES) ITEM CODES

Those TMP elements that are not part of the main contract, but are identified as Capital Outlay costs tied to the main project, should be itemized as State Furnished Materials and Expenses using the appropriate BEES item cost (see Table 7.1).

TABLE 7.1 TMP BEES ITEM CODES

066003	State-Furnished Materials
066004	Miscellaneous State-Furnished Materials
066005	Concurrent Work
066006	Miscellaneous Concurrent Work
066008	Incentive Payment
066009	Utility Expense
066010	Work by Others
066060	Additional Traffic Control
066061	CHP Enhanced Enforcement
066062	COZEEP Contract
066063	Traffic Management Plan Public Information
066064	Specter Radar Unit
066065	Tow Truck Service Patrol
066066	Public Transit Support
066067	Rideshare Promotion
066070	Maintain Traffic
066072	Maintain Detour
066074	Traffic Control
066076	Temporary Traffic Control
066077	Install Traffic Control Devices
066578	Portable Changeable Message Signs
066825	Temporary Striping
066872	Service Contract
120100	Traffic Control System
128602	Traffic Control System (One Way)
128650	Portable Changeable Message Sign
129150	Temporary Traffic Screen
860793	Telephone Service (Location 1)
860811	Detector Loop
860925	Traffic Monitoring Station (Count)
860927	Traffic Monitoring Station (Incident)
860930	Traffic Monitoring Station
861088	Modify Ramp Metering System
869070	Power and Telephone Service
994920	Bicycle Parking Rack
995000	Bus Shelter

7.6 CHARGE TO OTHER PROJECT PHASE 4 (CONSTRUCTION) FUNDS

Funds from other construction contracts in the District may be used if those projects are in the vicinity of, or will be affected by, the project requiring TMP funds. At the discretion of the Deputy District Director for Construction, a list of chargeable project EAs may be submitted to HQ Division of Accounting for prorated charging.

7.7 LOCAL INVOLVEMENT (SPECIAL-FUNDED PROJECTS)

DD-60-R1 applies to all projects on State facilities, including those not funded by the State. District Directors are responsible for assuring local compliance. Since many measure projects are split funded, the Department and local entities must work cooperatively to develop an effective TMP. The Department is responsible for approving all Project Study Reports, and it is at this point that agreements should be reached concerning the costs and scope of TMP strategies.

The TMP Manager has not always been included in discussions regarding these types of projects and often traffic-handling issues have been set aside until the last minute. The TMP unit is then asked to approve a traffic handling plan that would not be acceptable for a project designed and implemented by the Department. The consultant preparing the lane requirement charts is often unfamiliar with the process and the specification requirements. This results in additional work for the TMP group as well as the DTM. The TMP Manager must be contacted early in the project development phase to ensure that adequate TMP strategies and hours for TMP and DTM tasks are included for special-funded projects.

APPENDIX – A
Deputy Directive – 60-R1

Deputy Directive

Number: DD-60-R1

Refer to Director's Policy: DP-03 Safety and Health
DP-05 Multimodal Alternatives Analysis
DP-08 Freeway System Management

Effective Date: September 2007

Supersedes: DD-60 (06-15-00)

TITLE Transportation Management Plans

POLICY

The California Department of Transportation (Department) minimizes disruption to the traveling public during construction or other planned activities necessary on the State Highway System. The Department uses innovative means to accelerate completion of highway work activities while taking necessary steps to maintain public and worker safety and the quality of the work being performed.

Transportation Management Plans are required for all planned activities on the State Highway System. Transportation Management Plan measures and associated road user costs and additional construction costs are considered during the project initiation or planning stage to the fullest extent feasible. Transportation Management Plans include strategies that strive to minimize work-related traffic delays while reducing overall duration of work activities where appropriate. Strategies that may result in a net reduction of overall delay for motorists include: full facility closures, extended weekend closures, continuous weekday closures, A+B contract specifications, and performance-based traffic handling specifications.

BACKGROUND

The Department's major emphasis on transportation projects has largely shifted from new construction to reconstruction, operation, and maintenance of existing facilities. With the ever-increasing traffic volumes on California's State Highway System and more complex project corridors, the need to actively manage the State's highway facilities has become critical.

APPENDIX – A
Deputy Directive – 60-R1

In order to prevent unreasonable traffic delays resulting from planned work, Transportation Management Plans must be carefully developed and implemented to maintain acceptable levels of service and safety during all work activities on the State Highway System.

The Federal Highway Final Rule, 23 Code of Federal Regulations 630, Subpart J, referred to as "Work Zone Safety and Mobility" requires the Department to adopt a policy that implements Transportation Management Plans on all federally-funded highway projects. Transportation Management Plans are to be consistent with the Final Rule guidelines for developing and implementing that policy.

Transportation Management Plans are to be consistent with Deputy Directive-64, "Accommodating Non-Motorized Travel."

DEFINITIONS

Transportation Management Plan is a program of activities for alleviating or minimizing work-related traffic delays by the effective application of traditional traffic handling practices and an innovative combination of various strategies. These strategies encompass public awareness campaigns, motorist information, demand management, incident management, system management, construction methods and staging, and alternate route planning. Depending on the complexity of the work or magnitude of anticipated traffic impacts, a Transportation Management Plan may provide lane closure charts, Standard Special Provisions for maintaining traffic, traffic control plans, and for a major project, a separate comprehensive report. The Department's "Transportation Management Plan Guidelines" provide more information on the recommended level of detail for Transportation Management Plans.

Major Lane Closures are those that are expected to result in *significant traffic impacts* despite the implementation of Transportation Management Plans.

Significant Traffic Impact is defined as being an individual traffic delay of 30 minutes or more above normal recurrent travel time on the existing facility. Transportation Management Plan strategies are designed to maintain additional delays below this maximum threshold, i.e. less than 15 or 20 minutes. This 30 minute maximum delay may be exceeded with approval by the District Lane Closure Review Committee.

District Lane Closure Review Committee is comprised of the Deputy District Directors of Construction, Design, Maintenance and Traffic Operations, and the District Public Information Officer (PIO).

Headquarters Lane Closure Review Committee is comprised of the Division Chiefs of Construction, Design, Maintenance and Traffic Operations, and the Deputy Director of External Affairs. The California Highway Patrol (CHP) will be called upon to participate as appropriate at the District or Headquarters Level.

RESPONSIBILITIES

District Directors:

- Enforce Transportation Management Plans and lane closure policies to ensure compliance with established procedures, guidelines, and policies.
- Ensure that resources for all Transportation Management Plan activities are provided.

Chief, Division of Traffic Operations:

- Develops, implements, and maintains statewide policy regarding Transportation Management Plans.
- Provides direction and assistance to District staff on all Transportation Management Plan activities as well as resources for training of District staff involved in Transportation Management Plans.
- Ensures consistency among the Districts on the development and implementation of Transportation Management Plans.

Deputy District Directors, Construction, Design, Project Management, Maintenance and Traffic Operations:

- Require all staff involved in Transportation Management Plan activities to participate in Transportation Management Plan training.
- Ensure that staff involved in highway work activities consider alternatives that will strike a balance between reducing the overall construction duration and minimizing disruption to the traveling public.

Chief District PIO:

- Participates in the project development phase of appropriate projects as determined by the Project Development Team to provide input on the cost of public awareness campaigns, which should be included in the construction contract allotment under State Furnished Materials and Expenses.
- Attends preconstruction or planning meetings as needed and prepare a project plan for community outreach strategies.
- Works with the District Project Manager to ensure that Transportation Management Plan funding for community outreach strategies is planned accordingly as well as expended appropriately, and that personnel time is included in the Work Breakdown Structure for the project.
- Assists or be the lead in implementation of a project's public awareness campaign.

- Develops and maintains liaisons with the media, affected local jurisdictions and legislators, and other external partners both prior to and during the construction period, as needed.

District Lane Closure Review Committee:

- Reviews proposed work activities and approves or makes recommendations in a timely manner when planned activities are expected to 1) result in significant traffic impacts, or 2) be of an interregional, statewide, or otherwise sensitive nature.
- When the District Lane Closure Review Committee determines that consultation or approval by the Headquarters Lane Closure Review Committee is appropriate, requests through the District Traffic Manager that the Headquarters committee convene to discuss a specific project and its anticipated impacts.

District Transportation Management Plan Managers:

- Act as single focal points for planning and development of Transportation Management Plans. Participate in the evaluation of design, potential traffic impacts and mitigation measures for project alternatives and in the preparation of Project Study Reports, Project Reports, Plans, Specifications, and Estimates. The Transportation Management Plan Manager should involve District Traffic Manager, members of the Planning, Maintenance and Construction Divisions and the Project Development Team in the planning and development of the Transportation Management Plan to address all pertinent issues, including multi-modal strategies, roadway maintenance during temporary closures, and constructability review.
- Work with the District Traffic Manager, District Design, Project Manager, Construction and PIO as appropriate to determine the extent of a Transportation Management Plan and ensure that the Transportation Management Plans are updated during all phases of a project. Facilitate review, approval, modification or disapproval of all Transportation Management Plan measures.
- Consider the cumulative impact of multiple projects as well as other activities that may create or generate an increase in traffic demand within the limits and during the work period. Oversee implementation and coordination of inter-regional Transportation Management Plans between corridors, districts, neighboring states and Mexico.
- Ensure that Transportation Management Plan planning and implementation is coordinated with the CHP and other local and regional transportation stakeholders as appropriate.

District Project Managers:

- Require Transportation Management Plans to be considered in the earliest stages of development for all projects and activities performed on the State Highway System.
- Identify needed project resources for all Transportation Management Plan measures and activities.
- Schedule projects to combine with other work activities to the extent possible.
- Encourage the use of innovative construction staging and contracting methods to accelerate project completion when appropriate.
- Include the District Transportation Management Plan Manager, the District Traffic Manager, and the PIO as needed on Project Development Teams from project initiation through completion of construction and provide adequate project information for review.
- Coordinate development of Transportation Management Plans with affected local and regional transportation stakeholders as needed.

District Traffic Managers:

- Consult with the Transportation Management Plan Manager during the planning and development of the Transportation Management Plan.
- Responsible with the District Construction Engineers, Resident Engineers, Encroachment Permit Inspectors, Maintenance Supervisors/Superintendents and PIO to ensure implementation of the Transportation Management Plan and make changes to the Transportation Management Plan if needed during conduct of the work.
- Determine when review of work activities by the District Lane Closure Review Committee or Headquarters Lane Closure Review Committee is required or necessary.
- Responsible for the day-to-day traffic decisions pertaining to traffic impacts from planned activities on the State Highway System.
- Coordinate with the Transportation Management Center or District Communication Center staff to respond with appropriate measures when significant travel delays occur on the State Highway System.
- Facilitate review, approval, modification, or disapproval of planned lane closure requests on the State Highway System.
- Recommend termination or modification of active planned lane closure operations without compromising the safety of the public or workers, when traffic impact becomes significant.
- Review construction contingency plans.

District Design, Office Engineer, Maintenance, and Encroachment Permit Engineers:

- Ensure Transportation Management Plan measures are fully incorporated in the development of a project.

- Coordinate with the District Traffic Manager and the District Transportation Management Plan Manager to consider alternative strategies as appropriate to determine the best alternatives for balancing traffic impact cost, and construction duration and cost.
- Ensure that impacts of Transportation Management Plan options are fully considered during the development of work schedules and cost estimates.
- Coordinate with District Traffic Management and District Transportation Management Plan Manager if changes in Transportation Management Plan strategies are warranted during all phases of the work. Ensure that Transportation Management Plan content is up-to-date by obtaining certification of the Transportation Management Plan by District Traffic Manager and District Transportation Management Plan Manager before submittal to the Office Engineer at Ready-to-List phase.
- Develop project information in consultation with the Project Manager, District Traffic Manager and Transportation Management Plan Manager to present to the District Lane Closure Review Committee or Headquarters Lane Closure Review Committee when deemed appropriate.

District Construction Engineers, Resident Engineers, Encroachment Permit Inspectors, and Maintenance Supervisors/Superintendents:

- Ensure full implementation of approved Transportation Management Plans in close coordination with the District Traffic Manager so that disruption to the traveling public is minimized.
- Work with the District Traffic Manager to ensure that project activities conform to the Transportation Management Plan, contingency plans are implemented if necessary, and disruption to the traveling public is minimized and does not exceed limits established in the Transportation Management Plan.
- Include the District Transportation Management Plan Manager, the District Traffic Manager, and the PIO as appropriate in preconstruction or work planning meetings.
- Determine when a construction contingency plan from the contractor is required.
- Ensure contractor is prepared to comply with Transportation Management Plans as related to work performance.
- Notify District Communication Centers or Transportation Management Centers when unforeseen traffic impacts result from planned work.
- Notify the District Communication Center or Traffic Management Centers to report the status of all lane closures in a timely manner (when closures are put in place and when they are picked up) so that accurate information is provided to the public. When reporting, provide specific details, particularly when a planned lane closure may be picked up late and significant traffic impacts are expected to result.

- Coordinate work activities with the CHP and other local and regional transportation stakeholders as appropriate.

Traffic Management Center Staff:

- Status lane closures in the statewide Lane Closure System.
- Activate Transportation System Management elements in support of the Transportation Management Plan.
- Inform the District Traffic Manager when notified of potential significant impacts due to planned highway activities.

APPLICABILITY

All departmental employees involved in Transportation Management Plan activities.

Randell H. Iwasaki
RANDELL H. IWASAKI
Chief Deputy Director

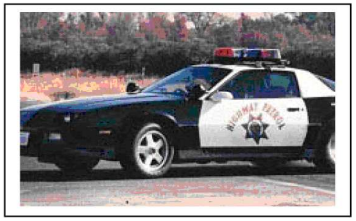
September 28, 2007
Date Signed

APPENDIX – B
Work Zone Enforcement Pocket Guide

California Department of Transportation
in partnership with the California Highway Patrol

WORK ZONE ENFORCEMENT
(COZEEP/MAZEEP*)

Pocket Guide



(Project Name)

(Route)
(Post Miles)

(Type of Project)

Primary Contact Numbers:

- Resident Engineer/Maintenance Supervisor: (Name and Phone Number)
- Field Inspector: (Name and Phone Number)
- CHP Cell Phone:
- Contractor Phone:
- TMC Phone:

First – Drive through the Work Zone to check setup

* * * * *

Help Identify:

- Potentially Hazardous Conditions of any kind
- Signs / Cones out of position
- Inconsistent or Inadequate Advance Warning Signs

If Unexpected Problems arise:

- Notify the Caltrans Resident Engineer/Maintenance Supervisor or Inspector
- Call the TMC if necessary

STAY ALERT!

WATCH OUT FOR EACH OTHER!

- *COZEEP – Construction Zone Enhanced Enforcement Program
- *MAZEEP – Maintenance Zone Enhanced

Daily Briefing - Resident Engineer / Maintenance Supervisor, CHP Officer, and Contractor Rep

Enforcement Specifics:

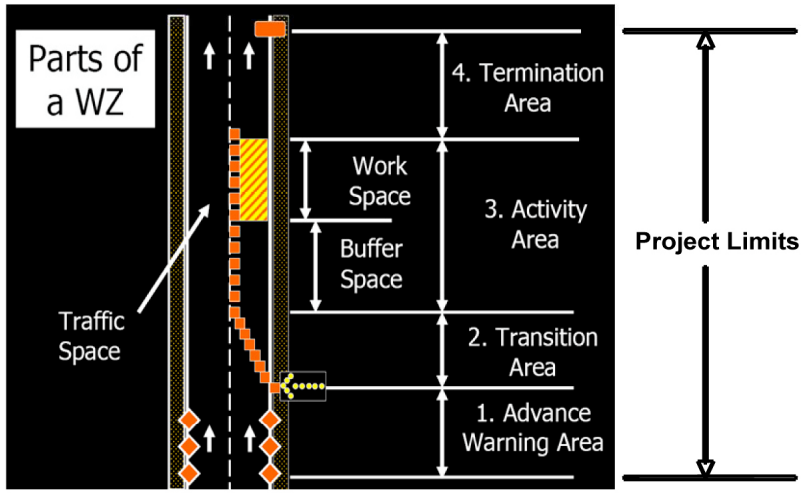
- Start & end times
- Type of work being done
- Where work is being done
- Suggested location of CHP vehicle(s)
- Strategy(ies) to be used (roving unless stationary specifically requested)
- Communication protocol – contact R.E./Maintenance Supervisor or Field Inspector for inquiries or to report potential problems
- Questions or suggestions

Enforcement Services:

- Presence – speeding deterrent
- Enforcement
- Traffic control (detours/queue assistance)

Work Zone Diagram

Parts of a Work Zone



Advance Warning Signs
3-step process:
- 1st sign: Gets motorist's attention
- 2nd sign: Tells what's ahead
- 3rd sign: Tells them what to do

Stationary Strategies (usually COZEEP):
- **Stay on the shoulder**
- **Not in buffer space**
- **Relocate as needed based on traffic conditions**
- **1/4 mile ahead of the end of the queue**

Moving Operations (usually MAZEEP):
(Examples: Paving, Striping..)

→ **The Work Zone moves continuously.**
→ **You Should Move with it!**

Investigations...?

- In order to remain in the Work Zone vicinity, all enforcement action that may result in an in-custody arrest should be relinquished to a Beat Officer. (CHP MM 05-120)

Observe the "15-minute Rule":
- Arrive 15 minutes before traffic control devices are being placed, moved or taken down.
- Stay 15 minutes after these changes have taken place, to ensure that the new traffic control change is working properly.
- Pass on info to the next shift if needed.

APPENDIX – C
MAINTENANCE BLANKET TMP

List of activities that occur typically occur off the traveled way:

- Litter removal
- Freeway Patrol for debris and litter
- Tree work (trimming/pruning)
- Landscaping area work (irrigation and repair, weed control, trimming, pruning, thinning, replacing)
- Delineator/post mile marker repairs/replacement
- Culvert/drainage facility work (cleaning/inspection)
- Sign repairs/replacement
- Off travel way median barrier/guard rail/attenuator repairs
- Right-of -Way fence repair work
- Sump pump repairs/cleaning
- Ditch and channel cleaning work
- Rest Area/Vista Points/Map View Area/Weigh Station/Park and Ride Lot (Public Facilities) maintenance work
- Graffiti abatement/cleanup on walls/signs/equipment cabinets
- Nonlandscaped area tree/brush/vegetation work
- Nontraveled way electrical work
- Roadside mowing
- Shoulder area grading for lateral support

Work that can be terminated (shoulder/lane closure picked up) if unacceptable delay occurs:

- Pavement marking operations
- Sign lighting repair
- Traffic signal knockdown repairs
- Sweeping litter/debris operations
- Moving shoulder/lane closure operations
- Asphalt Concrete (AC) and Portland
- Cement Concrete (PCC) pavement crack sealing
- Pothole repairs
- Drain inlet cleaning
- Pavement striping operations
- Raised pavement marker replacement
- Sign and highway lighting relamping operations
- Roadside vegetation control (spraying/mowing) operations

Work that must be completed prior to reopening to traffic (shoulder/lane closure pick-up):

- Moving shoulder/lane closure operations
- PCCP slab replacement
- Pavement chip seals
- Culvert replacement operations
- Guardrail/gore attenuator repairs
- AC pavement blankets
- Pavement mudjack operations
- Most bridge repair on traveled way
- Pavement grinding (AC Digouts) operations

APPENDIX – D
TMP RESOURCES

STATEWIDE TMP RESOURCES

For further guidance or questions on TMP content and this process, contact the TMP Manager in your District. For questions regarding TMP policy, contact HQ Office of System Management Operations. Organizational charts and contact information are on the Department's intranet at http://onramp.dot.ca.gov/hq/traffops/otrafopr/system_development/tmp.htm. External entities may contact their local Office of System Management at http://www.dot.ca.gov/localoffice.htm.

SOURCES OF TMP INFORMATION

A publication by the Federal Highway Administration, "Developing and Implementing Transportation Management Plans for Work Zones," contains a comprehensive work zone strategies matrix which that provides information on triggers for considering various strategies, potential benefits and challenges, and other considerations that might help to determine the strategies that would work best.

Two sources for guidance on selecting the most effective TMP elements, in terms of cost and informational content are Wilbur Smith Associates' "Traffic Management Plan Effectiveness Study (May 1993)" and Frank Wilson & Associates' "A Traffic Management Plan Study for State Route 91 During Construction of HOV Lanes." Both of these publications can be obtained from HQ Traffic Operations, Office of System Management Operations.

The Public Information Office in each District is also an experienced source for public awareness campaign strategies, and they can help the TMP Manager estimate the cost and effectiveness of the proposed TMP strategies in reducing traffic demand through the project area.

TRANSPORTATION MANAGEMENT PLAN DATASHEET
(Preliminary TMP Elements and Costs)

Co/Rte/KP _____ EA _____ Alternative No. _____

Project Limit _____

Project Description _____

Expected Construction Schedule _____

1) Public Information

- ☐ a. Brochures and Mailers $ _____
- ☐ b. Press Release
- ☐ c. Paid Advertising $ _____
- ☐ d. Public Information Center/Kiosk $ _____
- ☐ e. Public Meeting/Speakers Bureau
- ☐ f. Telephone Hotline
- ☐ g. Internet
- ☐ h. Others _____ $ _____

2) Motorists Information Strategies

- ☐ a. Changeable Message Signs (Fixed) $ _____
- ☐ b. Changeable Message Signs (Portable) $ _____
- ☐ c. Ground Mounted Signs $ _____
- ☐ d. Highway Advisory Radio $ _____
- ☐ e. Caltrans Highway Information Network (CHIN)
- ☐ f. Others _____ $ _____

3) Incident Management

- ☐ a. Construction Zone Enhanced Enforcement Program (COZEEP) $ _____
- ☐ b. Freeway Service Patrol $ _____
- ☐ c. Traffic Management Team
- ☐ d. Helicopter Surveillance $ _____
- ☐ e. Traffic Surveillance Stations (Loop Detector and CCTV) $ _____
- ☐ f. Others _____ $ _____

APPENDIX – E
SAMPLE TMP DATASHEET

4) Construction Strategies

- ☐ a. Lane Closure Chart
- ☐ b. Reversible Lanes
- ☐ c. Total Facility Closure
- ☐ d. Contra Flow
- ☐ e. Truck Traffic Restrictions $ _____
- ☐ f. Reduced Speed Zone $ _____
- ☐ g. Connector and Ramp Closures
- ☐ h. Incentive and Disincentive Clause $ _____
- ☐ i. Moveable Barrier $ _____
- ☐ j. Others _____ $ _____

5) Demand Management

- ☐ a. HOV Lanes/Ramps (New or Convert) $ _____
- ☐ b. Park and Ride Lots $ _____
- ☐ c. Rideshare Incentives $ _____
- ☐ d. Variable Work Hours
- ☐ e. Telecommute
- ☐ f. Ramp Metering (Temporary Installation) $ _____
- ☐ g. Ramp Metering (Modify Existing) $ _____
- ☐ h. Others _____ $ _____

6) Alternative Route Strategies

- ☐ a. Add Capacity to Freeway Connector $ _____
- ☐ b. Street Improvement (widening, traffic signal... etc) $ _____
- ☐ c. Traffic Control Officers $ _____
- ☐ d. Parking Restrictions
- ☐ e. Others _____ $ _____

7) Other Strategies

- ☐ a. Application of New Technology $ _____
- ☐ e. Others _____ $ _____

TOTAL ESTIMATED COST OF TMP ELEMENTS = $ _____

APPENDIX – E
SAMPLE TMP DATASHEET

Project Notes:

Assumptions/ Comments:
1. Entire project will take approximately XX working days to construct.
2. Current dollar values used. Inflation was not factored into the estimate.
3. Traffic Control/Maintain Traffic costs were not provided. Please consult with the OE or Construction office for this estimate.
4. Portable CMS specified for this project by this estimate are designated for congestion relief as outlined by DD-60. Portable CMS required for other purposes should be included under other specifications.
5. The COZEEP specified for this project by this estimate is designated for congestion relief as outlined by DD-60. The COZEEP required for other purposes should be included under other specifications.
Note 1: All projects who's contract value is $5 million or more, and/or meet certain other criteria should be evaluated for applicability of A+B Bidding. Consult the Lane Closure Charts Coordinator for the analysis, and the OE for more details about A+B Bidding.
Note 2: As outlined in Deputy Directive 60, this TMP is a living document, subject to change as required by changing circumstances. If there is material change to the project scope which will affect the function or adequacy of the TMP, then changes to the TMP must be addressed. If traffic conditions at the project site demonstrate that TMP elements need to be adjusted to adequately address congestion, then the TMP shall be altered accordingly.
Note 3: Hospitals with emergency services and fire stations that may require access through work zones at all hours should be accommodated. Schools, major venues, shopping malls, and other heavily utilized areas should also be notified of construction activities that may impact their services.

PREPARED BY _____ DATE _____

APPROVED BY _____ DATE _____

DEVELOPMENT OF PRESIDIO-WIDE CLEANUP LEVELS FOR SOIL, SEDIMENT, GROUNDWATER, AND SURFACE WATER

PRESIDIO OF SAN FRANCISCO, CALIFORNIA

Prepared for:

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30 October 2002
Table 7-6 Revised May 2006

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Presidio of San Francisco, California

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LIST OF ACRONYMS/ABBREVIATIONS

§	Section
1,2-DCA	1,2-dichloroethane
2,4-D	2,4-dichlorophenoxyacetic acid
AA	graphite furnace atomic absorption
ABS	absorption factor
ACM	asbestos-containing material
AF	soil adherence factor
ARAR	Applicable or Relevant and Appropriate Requirement
Army	United States Department of Defense, Department of the Army
Army FS	*Final Feasibility Study Report, Presidio Main Installation, Presidio of San Francisco*, prepared by Dames & Moore, 1997
AT	averaging time
ATSDR	United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry
AUF	area use factor
BAAQMD	Bay Area Air Quality Management District
BAF	bioaccumulation factor
BAT	Best Available Technology
bgs	below ground surface
BRAC	Base Realignment and Closure Act
BTAG	U.S. EPA Region IX Biological Technical Advisory Group
BTEX	benzene, toluene, ethylbenzene, and xylenes
BW	body weight
CCR	California Code of Regulations
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	conversion factor
CFR	Code of Federal Regulations
COC	chemical of concern
Contd	continued
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium

LIST OF ACRONYMS/ABBREVIATIONS

CTR	California Toxics Rule
DEH	Directorate of Engineering and Housing
dicamba	3,6-dichloro-2-methoxybenzoic acid
DIR	total dietary ingestion rate
DOD	United States Department of Defense
DOE	United States Department of Energy
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
EBEP	SWRCB *California Enclosed Bays and Estuaries Plan, Water Quality Control Plan for Enclosed Bays and Estuaries of California*, dated 11 April 1991
Eh	oxidation-reduction potential
EKI	Erler & Kalinowski, Inc.
EqP	equilibrium partitioning
EPC	exposure point concentration
FD	field duplicate
FPALDR	Montgomery Watson *Fuel Product Action Level Development Report*, dated October 1995
FS	Feasibility Study
gm	gram
GMPA	NPS *General Management Plan Amendment*, dated July 1994
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
ICP	inductively coupled plasma
$Intake_i$	Intake (or dose) from pathway *i*
IRIS	Integrated Risk Information System
ISQG	interim sediment quality guideline
ISWP	SWRCB *California Inland Surface Waters Plan, Water Quality Control Plan for Inland Surface Waters of California*, dated 11 April 1991
IT Corporation	International Technology Corporation
kg	kilogram

LIST OF ACRONYMS/ABBREVIATIONS

L	liter
LOAEL	lowest-observed-adverse-effect level
LOEC	lowest-observed-effects-concentration
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCPP	2-(4-chloro-*o*-to(yl)oxy)propionic acid
µg	microgram
µg/dl	micrograms per deciliter
µg/kg	microgram/kilogram
µg/L	microgram per liter
mg	milligram
mg/kg	milligram per kilogram
mg/L	milligram per liter
mV	millivolt
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEIC	U.S. EPA National Enforcement Investigations Center
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no-observed-adverse-effect-level
NOEC	no-observed-effects-concentration
NPS	United States Department of the Interior, National Park Service
OEHHA	California Environmental Protection Agency, Office of Environmental Health Hazard Assessment
ORNL	Oak Ridge National Laboratory, U.S. Department of Energy
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCOC	potential chemical of concern
PEA	Preliminary Endangerment Assessment

LIST OF ACRONYMS/ABBREVIATIONS

PEC	probable effects concentration
PEL	probable effect level
PHGs	Drinking Water Public Health Goals
PHSH	Public Health Service Hospital
Presidio	Presidio of San Francisco
Presidio soil	serpentinite, Colma Formation, and beach/dune sand
PRG	Preliminary Remediation Goal
PRG_c	PRG based on carcinogenic effects
PRG_{nc}	PRG based on non-carcinogenic effects
Proposition 65	Safe Drinking Water and Toxic Enforcement Act
PTMP	*Presidio Trust Management Plan, Land Use Policies for Area B of the Presidio of San Francisco*, dated May 2002 (presents Trust's vision for use of Area B of the Presidio)
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RAP	Remedial Action Plan
RBSL	Risk-based Screening Level
RCRA	Resource Conservation and Recovery Act
Revised Final FS Report	*Revised Final Feasibility Study Report for Main Installation Sites*
RfD	Reference Dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
RTECS	Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health
RWQCB	California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region
SA	surface area
SDWA	Safe Drinking Water Act
SF	slope factor
Soil Lead Guidance	*Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, U.S. EPA, 14 July 1994

LIST OF ACRONYMS/ABBREVIATIONS

soil/sed	soil and sediment
SQB	sediment quality benchmark
SQC	sediment quality criterion
Superfund	collectively refers to CERCLA and SARA
SVOC	semivolatile organic compound
SWRCB	California Environmental Protection Agency, State Water Resources Control Board
TBV	Toxicity benchmark value
TCE	trichloroethene
TEC	threshold effects concentration
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons
TOXNET	National Library of Medicine Toxicity Data Network
Trust	The Presidio Trust
TSCA	Toxic Substances Control Act
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound
VMP	NPS and Trust *Vegetation Management Plan and Environmental and Assessment for the Presidio of San Francisco*, dated May 2001

1. EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

The Presidio Trust ("Trust") is in the process of transforming the Presidio of San Francisco ("Presidio") from an Army base to a financially self-sufficient National Park. To successfully complete the conversion, some remedial activities must be performed to address environmental issues from previous land uses and activities. This document presents the approach to develop cleanup levels and the framework to apply these cleanup levels to chemical release sites at the Presidio. These cleanup levels are anticipated to be applied to new decision documents at the Presidio.

The Trust has been working to develop cleanup levels with representatives of the Department of the Interior, National Park Service ("NPS"), California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"), United States Environmental Protection Agency ("U.S. EPA"), California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB"), and community members of the Restoration Advisory Board ("RAB"). This document summarizes the derivation of human health and ecological cleanup levels for soil, sediment, groundwater, and surface water at the Presidio, and the development of background metal concentrations at the Presidio. This document presents for approval by regulatory agencies the proposed methodology for determining Presidio-specific cleanup levels based on the protection of human health and ecological receptors for a wide range of chemicals that may potentially be encountered in soil, sediment, and water at the Presidio.

The Presidio-specific cleanup levels presented in this document are based on site-specific preliminary remediation goals ("PRGs") calculated for the Presidio, and chemical-specific Applicable or Relevant and Appropriate Requirements ("ARARs") for potential chemicals of concern ("PCOCs") detected in various media at the Presidio. Chemical-specific ARARs and site-specific PRGs are compared to naturally occurring or background concentrations of metals in soil to establish cleanup levels for use at all areas of the Presidio. Also presented in this document are the procedures to determine which specific cleanup levels are applicable to a given chemical release site.

The cleanup levels developed in this document are anticipated to be applied to new decision documents at the following Presidio Operable Units ("OUs"): the Main Installation, Firing Ranges, Miscellaneous Sites, Basewide Cumulative Effects, as well as any unknown sites encountered in the future, and lead-based paint in soil. Petroleum program sites are technically covered by RWQCB Site Cleanup Requirements specified in Order No. 96–070, as described in Section 3. However, the cleanup levels presented in this document comply with Order No. 96–070, so this cleanup level document also applies to petroleum program sites and petroleum sites with CERCLA components.

2. INTRODUCTION

2. INTRODUCTION

This document presents the development and application of cleanup levels at chemical release sites at the Presidio. To develop cleanup levels, the Trust has been working with representatives of the NPS, DTSC, U.S. EPA, and RWQCB, and RAB community members. This document summarizes the derivation of human health and ecological cleanup levels for soil, sediment, groundwater, and surface water at the Presidio, and the development of background metal concentrations at the Presidio. The Presidio-specific cleanup levels are based on site-specific PRGs calculated for the Presidio, and chemical-specific ARARs for PCOCs detected in various media at the Presidio. Chemical-specific ARARs and site-specific PRGs are compared to naturally occurring or background concentrations of metals in soil to establish cleanup levels for use at all areas of the Presidio.

ARARs are laws, requirements, or other cleanup standards that pertain to the chemical release at a site. Chemical-specific ARARs for PCOCs identified at the Presidio are discussed in Section 3 and have been adopted as cleanup levels, when available and greater than naturally occurring or background concentrations of metals in soil and water. In the absence of such ARARs, Presidio-specific risk-based PRGs derived in Sections 4 and 5 are used as cleanup levels if the PRGs are greater than background concentrations of metals. Background concentrations of metals need to be considered in establishing cleanup levels because it is impracticable to remediate releases of metals to less than naturally occurring concentrations. Background concentrations of metals in soil and water are addressed in Section 6.

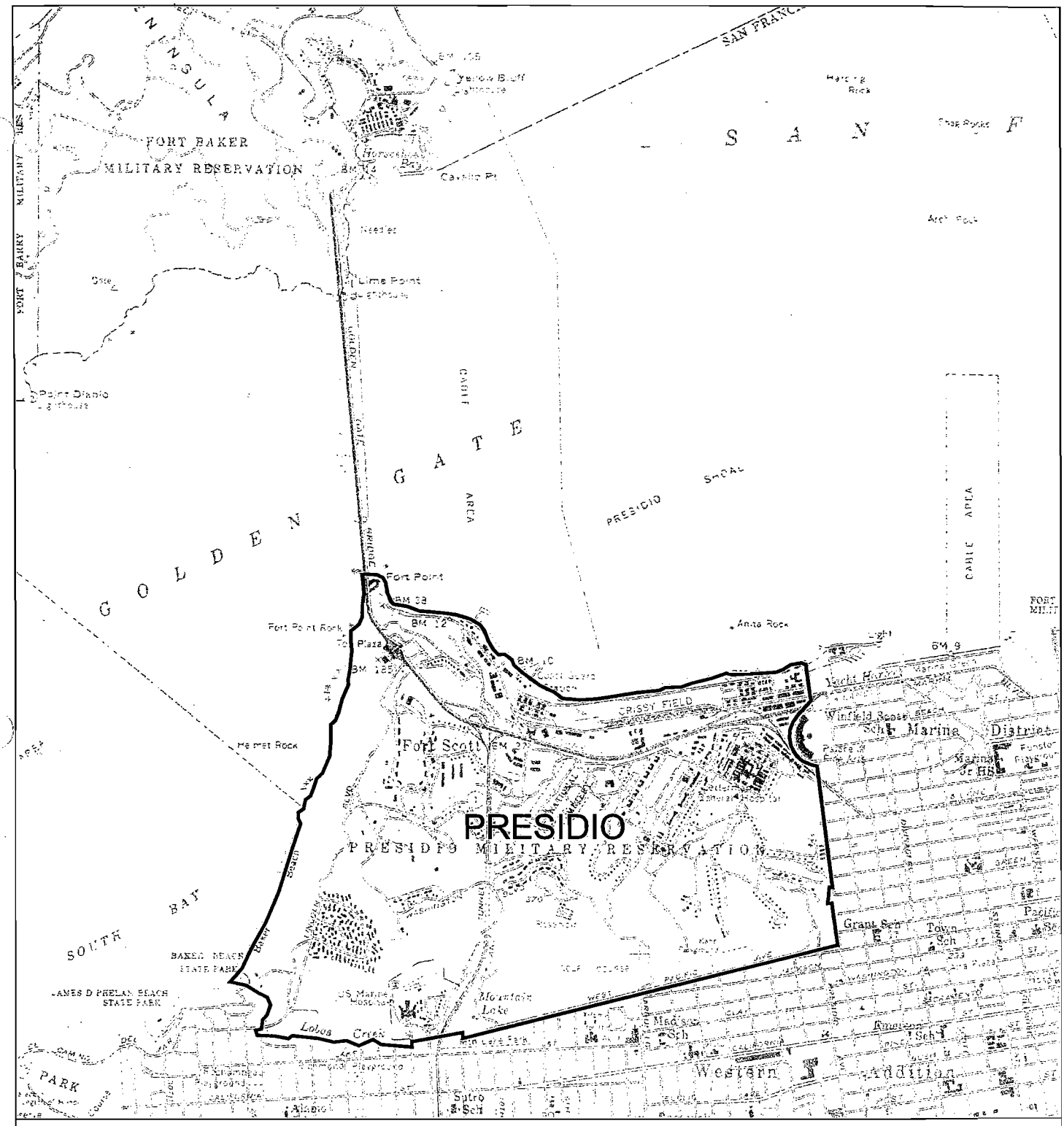
As part of its environmental restoration efforts, the Trust retained Erler & Kalinowski, Inc. ("EKI") to prepare a Revised Final Feasibility Study Report for Main Installation sites ("Revised Final FS Report") at the Presidio. In the process of preparing the Revised Final FS Report, the Trust identified a need to establish cleanup levels for soil, sediment, and groundwater at identified sites to determine if remediation is required, and if so, to what level. This Presidio-wide Cleanup Level Document presents the steps taken to create cleanup levels for Main Installation sites as well as other sites at the Presidio. Figure 2-1 is a vicinity map showing the location of the Presidio; Figure 2-2 shows known CERCLA sites within the Presidio. The list of PCOCs included in this document is based on the chemicals detected in soil, sediment, groundwater, and surface water samples collected at Main Installation and Public Health Service Hospital sites, as included in the database given to the Trust by the Army and as augmented with analytical data collected by the Trust.[1] This list of PCOCs also includes chemicals that have been detected at the Firing Ranges and at petroleum release sites.

[1] Data that were excluded from the database used to create the PCOC list include the following: (a) results from non-representative media (e.g., wipe samples), (b) tentatively identified compounds (TICs), (c) surrogates added by the laboratory during analysis, (d) inorganic chemicals unrelated to chemical releases (e.g., major elements in the earth's crust), (e) common water quality parameters (e.g., hardness), (f) phthalates, which were determined to be laboratory contaminants, and (g) unreliable or rejected data.

The key factors that are used to develop cleanup levels are background metal concentrations, human health exposure, and ecological exposure. Background metals concentrations are based on the predominant soil lithologies encountered within the Presidio. Thus, for any given site, the applicable cleanup level incorporates the planned land use (residential, recreational, institutional, or commercial/industrial), the predominant soil or sediment lithology, and potential ecological species present (including the presence of special-status species). In addition, some cleanup levels, particularly for petroleum hydrocarbons and related constituents, are determined by Presidio-wide Site Cleanup Requirements as adopted in RWQCB Order No. 96–070 ("Order"). The Order allows varying cleanup levels depending on the existing and future use, depth to groundwater, and the Presidio drainage basin.

Chemical-specific ARARs, Presidio-specific risk-based PRGs, and background metals concentrations are combined in Section 7 to develop the Presidio-wide cleanup levels. Also presented in Section 7 is the framework used to identify the specific cleanup levels that will apply to a given Presidio site based on the specific characteristics of an individual site (e.g., human land use, presence of sensitive ecological species, predominant lithology). These site-specific cleanup levels can then be used to identify chemicals of concern ("COCs"), followed by an assessment of required remedial actions.

FIGURES



Reference: U.S.G.S. Topographic Maps, San Francisco North and Point Bonita, Photorevised 1973.

Note:

1. All locations are approximate.

N

0 1/2 1

(Approximate Scale in Miles)

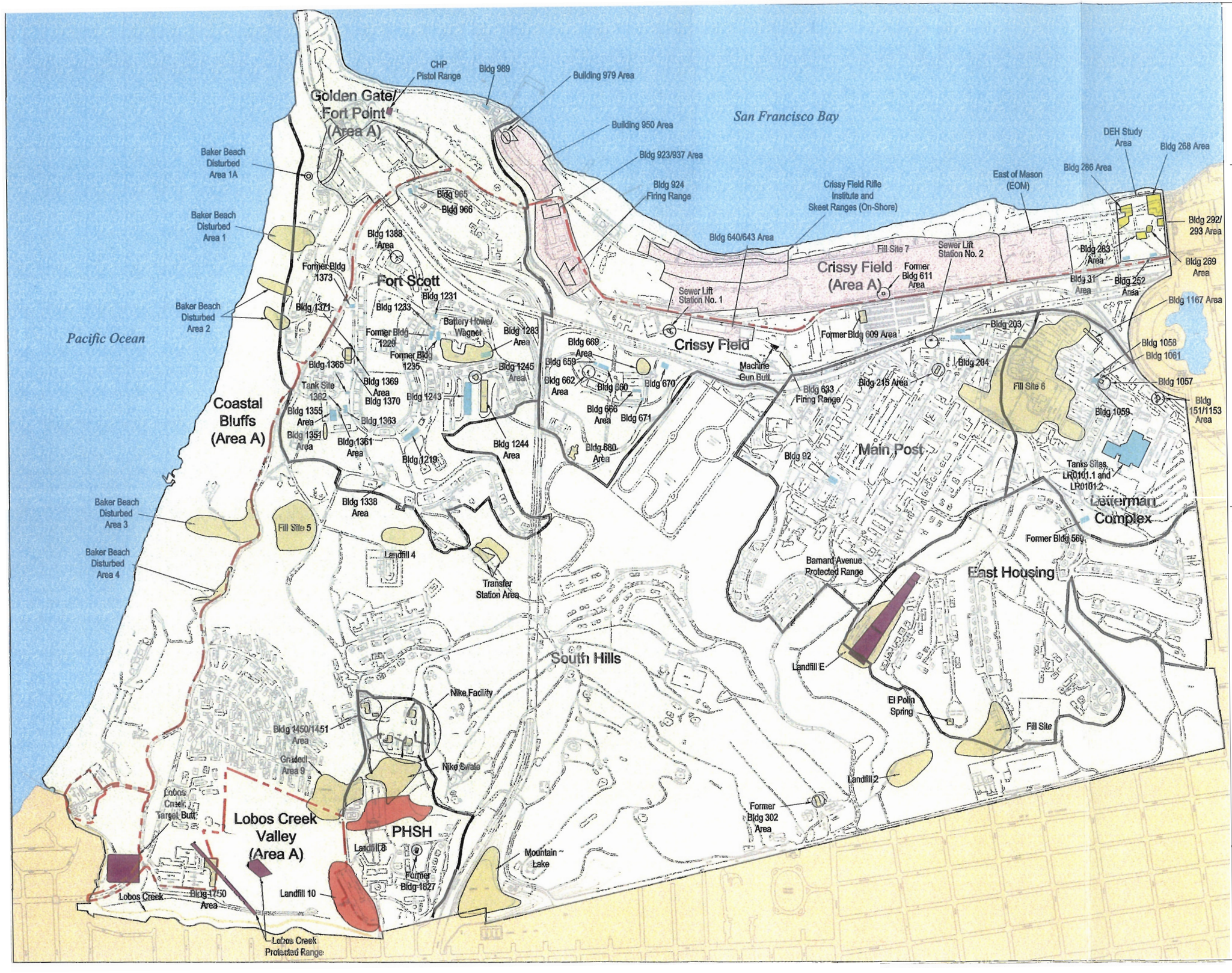
Erler & Kalinowski, Inc.

Vicinity Map

THE PRESIDIO TRUST

Presidio Trust
San Francisco, CA
September 2002
EKI A000003.04

Figure 2–1



Notes:

1. All locations are approximate.
2. Basemap developed from site plan provided by the Presidio Trust.
3. PHSH is the Public Health Service Hosiptal.
4. "OU" is an "Operable Unit".
5. Site boundaries are approximate. For individual tank sites or smaller sites, the associated building is shaded.
6. The Army identified 35 additional potential chemical release sites. These sites are mapped in OU6, but need a site inspection to determine their status.

Erler & Kalinowski, Inc.

Operable Units being Addressed by The Presidio Trust

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04

Figure 2-2

3. CHEMICAL-SPECIFIC ARARS

3. CHEMICAL-SPECIFIC ARARS

This section identifies some potential chemical-specific ARARs that may be applicable to some Presidio sites. This discussion is not intended to be a complete evaluation of all potential ARARs for all sites at the Presidio; such an evaluation will be included in future decision documents. However, ARARs warrant discussion because the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP") at 40 CFR §300.430(f)(1)(i)(A) provides that releases of hazardous substances at a site be cleaned up to meet ARARs, unless circumstances for a waiver exist. ARARs are used in conjunction with risk-based cleanup goals to establish cleanup levels as part of Remedial Action Objectives ("RAOs") for a site. According to U.S. EPA (1991b), "ARARs represent the minimum that a remedy must attain; it may sometimes be necessary, where there are multiple contaminants with potentially cumulative and synergistic effects, to go beyond what ARARs require to ensure that a remedy is protective."

If available, chemical–specific ARARs were used to establish cleanup levels for water and soil for protection of human health and the environment. Table 3-1 provides a summary of numerical values of potential chemical-specific ARARs for Presidio sites. Not all of these requirements will be an ARAR at every site; other location- or action-specific ARARs may also apply, and, in fact, may be more stringent than the chemical-specific ARARs listed. Section 3.1 addresses potential ARARs in water, seeps, and groundwater, and Section 3.2 addressees potential ARARs in soil. RWQCB Order 96-070 is a specific ARAR for petroleum sites that addresses petroleum hydrocarbons and related constituents in both soil and water; therefore ARARs for petroleum hydrocarbons are presented in Section 3.3. In the development of future decision documents, additional chemical-specific ARARs may be identified and used as cleanup levels.

3.1 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR WATER

For groundwater and surface water, promulgated Maximum Contaminant Levels ("MCLs") or published action levels have been adopted as cleanup levels to protect human health due to groundwater ingestion (U.S. EPA, 2000d). These are listed in Table 3-1. Maximum Contaminant Level Goals ("MCLGs") are the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. MCLGs are also listed in Table 3-1. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration.

The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment ("OEHHA") has prepared Drinking Water Public Health Goals ("PHGs") for many contaminants in drinking water. In February 1999 OEHHA prepared a PHG for chromium in drinking water, setting a goal of 2.5 µg/L. In November 2001, the chromium PHG was withdrawn by OEHHA because the PHG was calculated using a

study that was determined to have flawed data and should not be used as a basis for health risk assessments. According to OEHHA's webpage, there is uncertainty regarding the carcinogenicity by the oral route. OEHHA is in the process of developing a PHG for hexavalent chromium ("Cr(VI)"). Like MCLGs, PHGs are not enforceable.

Promulgated water quality criteria were applied to existing and planned freshwater surface bodies, and groundwater that recharges surface water or emerges as seeps. Existing surface water bodies at the Presidio include Mountain Lake, Crissy Field wetlands, and Lobos Creek. In addition, Tennessee Hollow and Dragonfly Creek are recognized surface water resources of the Presidio and will be treated as such in applying cleanup levels. Water quality criteria adopted as cleanup levels for surface water and groundwater that recharges surface water at the Presidio are intended to protect freshwater aquatic organisms, marine organisms, and humans who may drink the water and consume fish or other organisms inhabiting the water bodies from chronic exposure to PCOCs. Water quality criteria adopted as cleanup levels for freshwater seeps at the Presidio are intended to protect freshwater aquatic organisms from chronic exposure to PCOCs. Seeps observed at the Presidio are not considered potential habitat that would support fish or other organisms that could be consumed by humans. Water quality criteria used to establish surface water, groundwater recharge to surface water, and seep cleanup levels are listed in Table 3-1 and were obtained from the following sources:

- RWQCB Water Quality Control Plan, San Francisco Bay Basin, ("Basin Plan") amended 16 April 1997.

- Title 40 of the Code of Federal Regulations ("CFR") §131.38, *Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California*, also known as the California Toxics Rule ("CTR").

3.2 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR SOIL

Chemical-specific ARARs for soil are available for only a limited number of contaminants. Cleanup levels for lead, polychlorinated biphenyls ("PCBs"), and volatile organic compounds ("VOCs") in soil are based on the more stringent of ARARs and risk-based PRGs. Cleanup levels for petroleum hydrocarbons and related constituents in soil and water at the Presidio are derived from ARARs as described below. Cleanup levels for remaining PCOCs in soil are risk-based PRGs or, in the case of metals, background concentrations if naturally occurring levels of metals in soil are greater than PRGs. Background concentrations of metals in serpentinite, chert/shale, Colma Formation, and beach/dune sand are described in Section 6. Serpentinite, Colma Formation, and beach/dune sand are the main lithologies encountered at the Presidio. Chert/shale is believed to have been imported to the Presidio by the Army for use as fill material.

In its *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (U.S. EPA, 1994), U.S. EPA recommends using a screening level of 400 mg/kg of lead in soil for residential scenarios. The 5 January 2001 *Federal Register*

stated that effective 6 March 2001, the Toxic Substance Control Act ("TSCA") was amended to establish a hazard standard of 400 mg/kg lead in bare residential soil. A cleanup level of 400 mg/kg of lead in soil is being used as a not-to-exceed value for residential areas at the Presidio.[2]

Requirements governing cleanup of PCB-containing soil and wastes were broadened by amendments to TSCA in 1998. As part of these amendments, U.S. EPA added 40 CFR §761.61 to Subpart D of TSCA, which provides cleanup and disposal provisions for PCB-containing soil and other types of remediation wastes. This section of Subpart D sets cleanup levels for high occupancy areas (e.g., residence) at 1 mg/kg of PCBs in soil. The TSCA value of 1 mg/kg for PCBs in soil is compared with the Presidio-specific human health PRGs for PCBs (see Section 4). The more stringent of the ARAR of 1 mg/kg or the Presidio-specific human health PRGs for PCBs is being used as the human health cleanup level.

In December 2001 RWQCB (2001a) released interim final soil and groundwater risk-based screening levels ("RBSLs") for over 100 chemicals commonly found at sites where releases of hazardous substances have occurred. RBSLs are generally not cleanup levels. RBSLs are used to evaluate whether a chemical release may pose a risk at the site that warrants further investigation. In addition, RBSLs can be used, if appropriate, as cleanup levels if site-specific cleanup levels are not available.

For VOCs, the RBSLs were used to incorporate potential risks due to vapor intrusion into indoor air and protection of groundwater due to leaching to groundwater, in addition to direct contact with soil which is addressed by the Presidio-specific human health PRGs developed in Section 4. RBSL values for VOCs for indoor air and potential leaching to groundwater are summarized in Table 3-2.

3.3 POTENTIAL CHEMICAL-SPECIFIC ARARS FOR PETROLEUM HYDROCARBONS

RWQCB issued Order No. 96-070 - *Site Cleanup Requirements for the Cleanup of Petroleum Impacted Soil* to the Army in 1996 (RWQCB, 1996). In this order, the Tennessee Hollow riparian corridor, the Crissy Field wetlands, and a 150-foot buffer zone along the Crissy Field shoreline were identified as sensitive habitats requiring more stringent petroleum hydrocarbon cleanup levels than elsewhere on the Presidio. The area where more stringent cleanup levels apply to the Tennessee Hollow riparian corridor is designated as the freshwater ecological protection zone. The area where more stringent cleanup levels apply to the Crissy Field wetlands and shoreline is designated as the saltwater ecological protection zone.

[2] A Presidio-specific Preliminary Remediation Goal ("PRG") for lead in soil at residential sites has been developed in Section 4. This Presidio-specific PRG will be used as the maximum average lead concentration in soil at residential sites.

The Army conducted several studies and worked closely with RWQCB to develop cleanup levels for petroleum hydrocarbons and related constituents at the Presidio. Human health and ecological cleanup levels for soil and groundwater were developed by Montgomery Watson and presented in its *Fuel Product Action Level Development Report* ("FPALDR"), (Montgomery Watson, 1995). Soil cleanup levels in the FPADLR were subsequently adopted by the RWQCB in Order No. 96-070 for all areas of the Presidio except the freshwater and ecological protection zones. The RWQCB requested that the Army conduct bioassay studies to develop cleanup levels for the saltwater ecological protection zone. International Technology ("IT") Corporation (1997) conducted these studies on behalf of the Army and proposed saltwater and sediment cleanup levels for protection of marine organisms. The Army worked collaboratively with RWQCB to develop cleanup levels for the freshwater protection zone. RWQCB conducted bioassay studies, and Montgomery Watson (1999b) interpreted the results and reviewed toxicological data published in scientific literature, which led to the proposal of freshwater and sediment cleanup levels for protection of freshwater aquatic organisms. Cleanup levels for petroleum hydrocarbons and related constituents developed in connection with Order No. 96-070 have been adopted for the Presidio, and are listed in Table 3-3.

TABLES

TABLE 3-1
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs
FOR WATER AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Clean Water Act					Safe Drinking Water Act		
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			Drinking Water Standards		
	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	Maximum Contaminant Levels ("MCLs") (µg/L); (d)	Maximum Contaminant Level Goals ("MCLGs") (µg/L); (d)	Secondary MCLs (µg/L); (d)
Inorganic Chemicals								
Antimony	- (e)	-	-	-	14	6	6	-
Arsenic	36	190	190	36	-	10	-	-
Barium	-	-	-	-	-	1,000	-	-
Beryllium	-	-	-	-	-	4	4	-
Cadmium	9.3	1.1 (f)	1.1 (f)	9.3	-	5	5	-
Trivalent Chromium	-	-	180	-	-	-	-	-
Hexavalent Chromium	50	11	11	50	-	-	-	-
Total Chromium	50	11	11	50	-	50 (g)	-	-
Cobalt	-	-	-	-	-	-	-	-
Copper	4.9	11.8 (f)	7	2.9	1,300	1,300 (h)	-	1,000
Cyanide	5	5.2	5	5.2	700	200	200	-
Lead	5.6	3.2 (f)	3.2 (f)	5.6	-	15 (h)	0	-
Tetraethyl lead	-	-	-	-	-	-	-	-
Mercury	0.025	0.025 (i)	0.025 (i)	0.025	0.05	2	2	-
Molybdenum	-	-	-	-	-	-	-	-
Nickel	8.3	158 (f)	56	7.1	610	100	-	-
Selenium	-	-	5	71	-	50	50	-
Silver	2.3	4.1 (f)	1.2	2.3	-	50 (m)	-	100
Thallium	-	-	-	-	1.7	2	0.5	-
Vanadium	-	-	-	-	-	-	-	-
Zinc	58	106 (f, j)	58	58	-	-	-	5,000
Semivolatile Organic Compounds								
Acenaphthene	-	-	-	-	1,200	-	-	-
Acenaphthylene	-	-	-	-	-	-	-	-
Anthracene	-	-	-	-	9,600	-	-	-
Benzo(a)anthracene	-	-	-	-	0.0044	0.1 (k)	0 (k)	-
Benzo(a)pyrene	-	-	-	-	0.0044	0.2	0	-
Benzo(b)fluoranthene	-	-	-	-	0.0044	0.2 (k)	0 (k)	-
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	0.0044	-	-	-
Benzyl alcohol	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	-	-	-	-	1.8	4	0	-
Chrysene	-	-	-	-	0.0044	-	-	-
Dibenzo(a,h)anthracene	-	-	-	-	0.0044	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-

TABLE 3-1
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs FOR WATER AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Clean Water Act					Safe Drinking Water Act		
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			Drinking Water Standards		
	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	Maximum Contaminant Levels ("MCLs") (µg/L); (d)	Maximum Contaminant Level Goals ("MCLGs") (µg/L); (d)	Secondary MCLs (µg/L); (d)
emivolatile Organic ompounds								
luoranthene	-	-	-	-	300	-	-	-
luorene	-	-	-	-	1,300	-	-	-
deno(1,2,3-c,d)-pyrene	-	-	-	-	0.0044	-	-	-
methylnaphthalene	-	-	-	-	-	-	-	-
methylphenol (p-Cresol)	-	-	-	-	-	-	-	-
aphthalene	-	-	-	-	-	-	-	-
doctriacontane	-	-	-	-	-	-	-	-
hentriacontame	-	-	-	-	-	-	-	-
nitrosodiphenylamine	-	-	-	-	5	-	-	-
triacontane	-	-	-	-	-	-	-	-
entachlorophenol	-	-	15	7.9	0.28	1	0	-
henanthrene	-	-	-	-	-	-	-	-
henol	-	-	-	-	21,000	1 (m)	-	-
olycyclic aromatic ydrocarbons	0.031	0.031	-	-	-	-	-	-
yrene	-	-	-	-	960	-	-	-
olatile Organic ompounds								
cetone	-	-	-	-	-	-	-	-
romodichloromethane	-	-	-	-	0.56	80	0	-
-butanone (MEK)	-	-	-	-	-	-	-	-
arbon disulfide	-	-	-	-	-	-	-	-
arbon tetrachloride	-	-	-	-	0.25	0.5	0	-
hlorodibromomethane	-	-	-	-	0.401	80	60	
hloroform	-	-	-	-	-	80	0	
hloromethane	-	-	-	-	-	-	-	-
,4-dichlorobenzene	-	-	-	-	400	5	5	5
,2-dichloroethane	-	-	-	-	0.38	0.5	0	-
,1-dichloroethene	-	-	-	-	0.057	6	6	-
-Isopropyltoluene (p-cymene)	-	-	-	-	-	-	-	-
lethylene chloride	-	-	-	-	4.7	5	0	-
etrachloroethene	-	-	-	-	0.8	5	0	-
,2,3-trichlorobenzene	-	-	-	-	-	-	-	-
,2,4-trichlorobenzene	-	-	-	-	-	70	70	-
richloroethene	-	-	-	-	2.7	5	0	-
,1,1-trichloroethane	-	-	-	-	-	200	200	-
richlorofluoromethane	-	-	-	-	-	150	-	-

TABLE 3-1
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs
FOR WATER AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Clean Water Act					Safe Drinking Water Act		
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			Drinking Water Standards		
	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	Maximum Contaminant Levels ("MCLs") (µg/L); (d)	Maximum Contaminant Level Goals ("MCLGs") (µg/L); (d)	Secondary MCLs (µg/L); (d)
PCBs, Pesticides, and Herbicides								
PCBs	-	-	0.014	0.03	0.00017	0.5	0	-
Aldrin	-	-	-	-	0.00013	-	-	-
Chlordane	-	-	0.0043	0.09	0.00057	0.1	0	-
2,4-D	-	-	-	-	-	70	70	-
4,4'-DDD	-	-	-	-	0.00083	-	-	-
4,4'-DDE	-	-	-	-	0.00059	-	-	-
4,4'-DDT	-	-	0.001	0.001	0.00059	-	-	-
Dicamba	-	-	-	-	-	-	-	-
Dieldrin	-	-	0.056	0.0019	0.00014	-	-	0.5 (l)
Endosulfan	-	-	0.056	0.0087	110	-	-	-
Endosulfan Sulfate	-	-	-	-	-	-	-	-
Endrin	-	-	0.036	0.0023	0.76	2	2	-
Endrin Aldehyde	-	-	-	-	-	-	-	-
Endrin Ketone	-	-	-	-	-	-	-	-
Heptachlor	-	-	0.0038	0.0036	0.00021	0.01	0	-
Heptachlor Epoxide	-	-	0.0038	0.0036	0.0001	0.01	0	-
Isodrin	-	-	-	-	-	-	-	-
gamma-BHC (Lindane)	-	-	-	-	0.019	0.2	0.2	-
MCPP	-	-	-	-	-	-	-	-
Methoxychlor	-	-	-	-	-	40	40	-
Petroleum Hydrocarbons and Constituents								
Total TPH	-	-	-	-	-	-	-	-
TPH (as diesel)	-	-	-	-	-	-	-	-
TPH (as gasoline)	-	-	-	-	-	-	-	-
TPH (as fuel oil)	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	1.2	1	0	-
Ethylbenzene	-	-	-	-	3,100	700	700	30 (k)
Toluene	-	-	-	-	6,800	150	-	40 (k)
Total xylenes	-	-	-	-	-	1,750	-	20 (k)
Methyl t-butyl ether (MTBE)	-	-	-	-	-	13	5	-

TABLE 3-1
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs FOR WATER AT PRESIDIO SITES (a)

Presidio of San Francisco, California

es:

Numeric values for chemical-specific ARARs and TBCs are listed in this table.

µg/L = microgram per liter
mg/L = milligram per liter

Water quality objectives for surface waters are from Table 3-3 and 3-4 of RWQCB *Water Quality Control Plan, San Francisco Bay Basin*, amended 16 April 1997 ("Basin Plan"). Values are for chronic toxicity to aquatic organisms, except for polycyclic aromatic hydrocarbon criteria which are for protection of human health, based on setting the acceptable lifetime risk for cancer to one-in-a-million.

California Toxic Rule water quality criteria listed are freshwater and saltwater aquatic toxicity standards, using 4 days of continuous exposure. Human health standards are for one-in-a-million risk for consumption of water and organisms. Values are from 40 CFR §131.38, *Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California.*

MCLs, MCLGs, and secondary MCLs are obtained from *U.S. EPA Drinking Water Standards and Health Advisories Table*, Region IX, Drinking Water Office, dated February 2001. If California MCLs are more stringent than federal MCLs, the California values are shown.

Hyphen indicates no value is provided in the reference.

Value listed is a function of hardness. Value shown is based on a hardness of 100 mg/L as calcium carbonate. Hardness concentrations at the Presidio have ranged from 93 to 772 mg/L, with an average of 325 mg/L. The use of 100 mg/L results in conservative values for these metals.

According to the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment ("OEHHA"), there is uncertainty regarding the carcinogenicity of chromium by the oral route.

Values for lead and copper are action levels that require treatment of drinking water.

U.S. EPA water quality criterion for mercury is 0.012 µg/L, which is below typical analytical method reporting limit of 0.025 µg/L. An objective of 0.012 ug/L is desirable.

Zinc value revised in 1997 amendments to RWQCB Basin Plan.

Proposed MCL.

Value corresponds to the California action level.

) Value corresponds to the RWQCB Basin Plan water quality objective for municipal supply.

TABLE 3-2
RISK-BASED SCREENING LEVELS FOR VOCS
AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	RWQCB Risk-Based Screening Levels ("RBSLs")			
	Vapor Intrusion		Groundwater Protection (Soil Leaching)	
	Residential Land Use Permitted (mg/kg); (b)	Industrial/ Commercial Land Use (mg/kg); (b)	Residential Land Use Permitted (mg/kg); (c)	Industrial/ Commercial Land Use (mg/kg); (c)
Volatile Organic Compounds				
Acetone	43	140	0.24	0.24
Bromodichloromethane	0.025	0.098	2.7	2.7
2-butanone (MEK)	- (d)	-	3.8	3.8
Carbon disulfide	-	-	-	-
Carbon tetrachloride	0.021	0.074	0.11	0.11
Chlorodibromomethane	-	-	8.3	8.3
Chloroform	0.17	0.58	0.88	0.88
Chloromethane	0.49	1.7	0.42	0.42
1,4-dichlorobenzene	0.13	0.49	0.59	0.59
1,2-dichloroethane	0.04	0.14	0.006	0.006
1,1-dichloroethene	0.018	0.062	1	1
p-Isopropyltoluene (p-cymene)	-	-	-	-
Methylene chloride	0.89	3.1	0.076	0.076
Tetrachloroethene	0.15	0.53	0.8	0.8
1,2,3-trichlorobenzene	-	-	-	-
1,2,4-trichlorobenzene	87	280	15	15
Trichloroethene	0.44	1.5	0.4	0.4
1,1,1-trichloroethane	76	220	8	8
Trichlorofluoromethane	-	-	-	-

Notes:

(a) Numeric values for volatile organic compounds ("VOCs") presented in this table are from *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater ("RBSLs")*, Regional Water Quality Control Board, San Francisco Bay Region, Interim Final, December 2001. As stated in the text, RBSLs were used only for VOCs to consider leaching to groundwater (groundwater protection) and vapor intrusion into indoor air, in addition to direct contact with soil.

mg/kg = milligram per kilogram

(b) Vapor Intrusion RBSLs represent the soil concentration corresponding to the risk due to vapor intrusion of VOCs from soil into indoor air. Values obtained from Table E-1a from Volume II of the RBSLs. The values assume coarse grain soils.

(c) Groundwater Protection RBSLs are soil cleanup levels based on protection of drinking water resources via the leaching pathway. Values were obtained from Tables A-1 and A-2 from Volume II of the RBSLs. The listed value is from the Groundwater Protection (soil leaching) column, assuming groundwater is a drinking water resource.

(d) Hyphen indicates no value is provided in the reference.

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Protection of Human Health			Protection of Ecological Receptors	Soil Cleanup Levels for Crissy Field	
	Residential (mg/kg); (b)	Maintenance (mg/kg); (b)	Recreational (mg/kg); (b)	Terrestrial Receptors (mg/kg); (b)	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)
Inorganic Chemicals						
Lead	- (c)	-	-	50	-	-
Semivolatile Organic Compounds						
Acenaphthene	-	-	-	-	-	-
Acenaphthylene	-	-	-	-	-	-
Anthracene	5,900	17,800	13,800	-	-	1,120
Benzo(a)anthracene	0.43	1.5	1	-	-	23
Benzo(a)pyrene	0.04	0.15	0.1	0.3	-	9
Benzo(b)fluoranthene	0.43	1.5	1	-	-	64
Benzo(g,h,i)perylene	620	1,700	1,400	-	-	19,500
Benzo(k)fluoranthene	0.43	1.5	1	-	-	64
Benzyl alcohol	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	-	-	-	-	-	-
Chrysene	4.3	15	10	-	-	151
Dibenzo(a,h)anthracene	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-
Fluoranthene	820	2,300	1,900	-	-	1,160
Fluorene	770	2,300	1,800	-	-	220
Indeno(1,2,3-c,d)-pyrene	-	-	-	-	-	-
2-methylnaphthalene	-	-	-	-	-	-
4-methylphenol (p-Cresol)	-	-	-	-	-	-
Naphthalene	480	2,300	1,100	-	-	140
n-doctriacontane	-	-	-	-	-	-
n-hentriacontame	-	-	-	-	-	-
n-nitrosodiphenylamine	-	-	-	-	-	-
n-triacontane	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-
Phenanthrene	600	1,700	1,400	-	-	410
Phenol	-	-	-	-	-	-
Polycyclic aromatic hydrocarbons	-	-	-	-	-	-
Pyrene	620	1,700	1,400	-	-	910

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Protection of Human Health			Protection of Ecological Receptors	Soil Cleanup Levels for Crissy Field	
	Residential (mg/kg); (b)	Maintenance (mg/kg); (b)	Recreational (mg/kg); (b)	Terrestrial Receptors (mg/kg); (b)	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)
Petroleum Hydrocarbons and Constituents						
Total TPH	-	-	-	-	-	-
TPH (as diesel)	1,380	6,700	3,200	700	15,000	1,950
TPH (as gasoline)	1,030	5,900	2,400	610	5,000	1,690
TPH (as fuel oil)	1,900	9,400	4,500	980	15,000	2,730
Benzene	0.6	5	1.5	40	140	1
Ethylbenzene	840	6,600	1,900	125	60	19
Toluene	530	12,800	1,200	270	420	14
Total xylenes	1,080	109,000	2,500	55	180	4,340
Methyl t-butyl ether (MTBE)	-	-	-	-	-	-

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Protection of Water Quality at Detectable Levels		Protection of Water Quality to Drinking Water Standards		Groundwater Quality Goals for Fuel Chemicals (µg/L); (d)
	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)	
Inorganic Chemicals					
Lead	-	-	-	-	-
Semivolatile Organic Compounds					
Acenaphthene	-	-	-	-	-
Acenaphthylene	-	-	-	-	-
Anthracene	-	0.05	-	308	770
Benzo(a)anthracene	-	0.2	-	8	2
Benzo(a)pyrene	-	0.8	-	3	0.2
Benzo(b)fluoranthene	-	0.6	-	23	2
Benzo(g,h,i)perylene	-	2	-	5,040	150
Benzo(k)fluoranthene	-	0.6	-	23	2
Benzyl alcohol	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	-	-	-	-	-
Chrysene	-	0.3	-	54	20
Dibenzo(a,h)anthracene	-	-	-	-	-
Dibenzofuran	-	-	-	-	-
Fluoranthene	-	0.05	-	316	300
Fluorene	-	0.05	-	60	300
Indeno(1,2,3-c,d)-pyrene	-	-	-	-	-
2-methylnaphthalene	-	-	-	-	-
4-methylphenol (p-Cresol)	-	-	-	-	-
Naphthalene	-	0.05	-	9	300
n-doctriacontane	-	-	-	-	-
n-hentriacontame	-	-	-	-	-
n-nitrosodiphenylamine	-	-	-	-	-
n-triacontane	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-
Phenanthrene	-	0.05	-	86	230
Phenol	-	-	-	-	-
Polycyclic aromatic hydrocarbons	-	-	-	-	-
Pyrene	-	0.09	-	241	230

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Protection of Water Quality at Detectable Levels		Protection of Water Quality to Drinking Water Standards		Groundwater Quality Goals for Fuel Chemicals (µg/L); (d)
	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)	Greater than 5 feet above Groundwater (mg/kg); (b)	Less than 5 feet above Groundwater (mg/kg); (b)	
Petroleum Hydrocarbons and Constituents					
Total TPH	-	-	-	-	-
TPH (as diesel)	15,000	7	15,000	115	880
TPH (as gasoline)	5,000	7	5,000	100	770
TPH (as fuel oil)	15,000	10	15,000	160	1,200
Benzene	140	0.005	140	0.005	1
Ethylbenzene	60	0.009	60	13	700
Toluene	420	0.005	420	1	150
Total xylenes	180	0.009	180	33	1,750
Methyl t-butyl ether (MTBE)	-	-	-	-	-

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Point of Compliance Concentration for Marine Sediment "Saltwater Ecological Protection Zone" (mg/kg); (e)	Point of Compliance Concentrations for Seawater (µg/L); (e)	Point of Compliance Concentrations for Freshwater Sediment "Freshwater Ecological Protection Zone" (mg/kg); (f)	Point of Compliance Concentration for Freshwater (µg/L); (f)
Inorganic Chemicals				
Lead	-	-	-	-
Semivolatile Organic Compounds				
Acenaphthene	-	-	-	-
Acenaphthylene	-	-	-	-
Anthracene	-	-	-	-
Benzo(a)anthracene	-	-	-	-
Benzo(a)pyrene	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-
Benzyl alcohol	-	-	-	-
Bis(2-ethylhexyl)phthalate	-	-	-	-
Chrysene	-	-	-	-
Dibenzo(a,h)anthracene	-	-	-	-
Dibenzofuran	-	-	-	-
Fluoranthene	-	-	-	-
Fluorene	-	-	-	-
Indeno(1,2,3-c,d)-pyrene	-	-	-	-
2-methylnaphthalene	-	-	-	-
4-methylphenol (p-Cresol)	-	-	-	-
Naphthalene	-	-	-	-
n-doctriacontane	-	-	-	-
n-hentriacontame	-	-	-	-
n-nitrosodiphenylamine	-	-	-	-
n-triacontane	-	-	-	-
Pentachlorophenol	-	-	-	-
Phenanthrene	-	-	-	-
Phenol	-	-	-	-
Polycyclic aromatic hydrocarbons	-	-	-	-
Pyrene	-	-	-	-

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

Potential Chemical of Concern	Point of Compliance Concentration for Marine Sediment "Saltwater Ecological Protection Zone" (mg/kg); (e)	Point of Compliance Concentrations for Seawater (µg/L); (e)	Point of Compliance Concentrations for Freshwater Sediment "Freshwater Ecological Protection Zone" (mg/kg); (f)	Point of Compliance Concentration for Freshwater (µg/L); (f)
Petroleum Hydrocarbons and Constituents				
Total TPH	-	-		
TPH (as diesel)	-	-	-	-
TPH (as gasoline)	11.6	1,200	140	443
TPH (as fuel oil)	144	2,200	-	-
Benzene	50	510	0.79	463
Ethylbenzene	5	43	15	845
Toluene	260	1,000	3	490
Total xylenes	22	130	5.7	318
Methyl t-butyl ether (MTBE)	190	4,400	-	-

TABLE 3-3
SITE CLEANUP REQUIREMENTS FOR PETROLEUM HYDROCARBONS AND RELATED CONSTITUENTS AT PRESIDIO SITES (a)

Presidio of San Francisco, California

tes:

) Numeric values for chemical-specific ARARs and TBCs are listed in this table.

µg/L = microgram per liter
mg/kg = milligram per kilogram

) Values are from Tables 1 through 5 of RWQCB Order No. 96-070, *Site Cleanup Requirements for the Cleanup of Petroleum Impacted Soils, U.S. Army, Presidio of San Francisco, California*, dated 15 May 1996.

) Hyphen indicates no value is provided in the reference.

) Values from Table E-12 of Montgomery Watson *Final Fuel Product Action Level Development Report, Presidio of San Francisco, San Francisco, California,* dated October 1995. Residential exposure scenario was used to determine groundwater cleanup levels listed.

) Values from Table 16 of IT Corporation *Petroleum Hydrocarbon Bioassay and Point-of-Compliance Concentration Determinations*, *Saltwater Ecological Protection Zone, Presidio of San Francisco, California*, dated December 1997.

) Values from Tables 5 and 6 of Montgomery Watson *Development of Point of Compliance Concentrations ("POCCs") for Gasoline in Surface Waters and Sediments of the Proposed Freshwater Stream*, dated May 1999.

4. HUMAN HEALTH RISK-BASED PRGS FOR SOIL

4. HUMAN HEALTH RISK-BASED PRGS FOR SOIL

According to U.S. EPA (1991a), under the NCP, there are two sources that can be used to establish cleanup levels that remedial actions must achieve under a Record of Decision ("ROD") or RAP. These sources consist of chemical-specific ARARs and risk-based PRGs. Chemical-specific ARARs are discussed in Section 3. In the absence of such ARARs, risk-based PRGs have been derived that take into account existing and planned uses at the Presidio. This section presents risk-based human health PRGs for PCOCs. Section 5 presents risk-based ecological PRGs for PCOCs.

4.1 PURPOSE OF RISK-BASED PRGs

U.S. EPA (1991a) defines PRGs as "concentration goals for individual chemicals for specific medium and land use combinations at CERCLA sites." In other words, PRGs are potential cleanup levels that are derived specifically for a site. PRGs take into account the PCOCs that have been identified, the media that have been impacted, most likely future land use where PCOCs have been detected, and the pathways and conditions under which exposure may occur.

Chemical-specific ARARs generally do not exist that adequately consider the scenarios under which humans may be exposed to PCOCs in soil, and ecological receptors may be exposed to PCOCs in soil and sediment at the Presidio. Consequently, site-specific PRGs for protection of human health and the environment to PCOCs in soil and sediment have been derived in this document. The methods used to derive human health and ecological PRGs incorporate comments made by DTSC (2001, 2000b, 2000d) RWQCB (verbal), and other key stakeholders.

4.2 HUMAN HEALTH PRGs FOR SOIL

Chronic exposure to PCOCs may cause non-carcinogenic and carcinogenic effects in humans. PRGs are calculated by establishing an acceptable or target risk level that will protect individuals from the non-carcinogenic and carcinogenic effects of PCOCs. The procedures and assumptions used to derive human health PRGs for soil are discussed in Sections 4.2.1 through 4.2.10.

4.2.1 Potentially Exposed Populations

Children and adults comprise the populations that may be potentially exposed to PCOCs at the Presidio. Children may be exposed through residential or recreational activities. In addition to residential and recreational activities, adults may be exposed as a result of commercial or industrial activities at the Presidio. The recreational or commercial/industrial exposure scenarios should also be protective of populations with short-term exposures, such as tourists or construction workers, respectively. For

example, subsurface utility repairs and earthwork construction typically take a few weeks to one year. Although the ingestion rate for construction and utility workers is commonly assumed to be 480 mg/day (compared with 50 mg/day assumed for the commercial/industrial population), the lifetime soil exposure is significantly lower for the construction worker because the exposure duration is so much shorter (e.g., a few weeks to one year compared with 25 years). Therefore, the PRGs developed for the commercial/industrial exposure scenario should be protective of construction workers and other workers with shorter-term exposures to soil.

Section 7.1.1 discusses the areas of the Presidio where residential, recreational, and commercial/industrial uses are likely to occur and identifies the appropriate cleanup levels based upon anticipated activity patterns that will protect the most sensitive individuals using these areas.

4.2.2 Potential Human Health Exposure Pathways

Metals and polycyclic aromatic hydrocarbons ("PAHs") are the predominant non-petroleum PCOCs in soil at chemical release sites at the Presidio. As shown on Figure 4-1 and discussed in Table 4-1, individuals that come in contact with soil at Presidio sites are likely to be exposed to PCOCs as a result of inadvertently ingesting impacted soil or absorbing chemicals from soil that becomes stuck to their skin. Inhalation of PCOCs is not considered to be a significant exposure pathway. Metals and PAHs are not volatile and inhalation of chemical-containing soil or dust is estimated to result in less than 3 percent of the potential total exposure to PCOCs when compared with the ingestion and dermal absorption pathways.[3] For VOCs, volatilization and vapor intrusion into indoor air is a potentially significant exposure pathway (i.e., for residential and commercial/industrial populations only).

Other potential exposure pathways include consumption of produce grown in gardens at the Presidio, leaching of chemicals in soil to groundwater, and ingestion, inhalation, or absorption of PCOCs that may be present in groundwater or surface water. Of these pathways, leaching to groundwater, ingestion of groundwater, and ingestion of water and fish or other organisms inhabiting surface bodies at the Presidio are considered to be a potentially significant exposure pathways.

The process of chemicals in soil leaching to groundwater is chemical-specific. Metals generally bind strongly to soil and are not prone to significant leaching unless conditions are very acidic. For petroleum compounds and related constituents (including benzene, toluene, ethylbenzene, xylenes, and PAHs), the cleanup levels established in RWQCB Order 96-070 (and as presented in Tables 3-3 and 7-5) include protection of groundwater

[3] EKI calculated the residential PRG for several compounds including and excluding the inhalation pathway. Arsenic was used as a conservative test case because it is significantly more toxic via the inhalation route compared with the oral route (i.e., slope factor of 12 $(mg/kg\text{-}day)^{-1}$ for inhalation versus 1.5 $(mg/kg\text{-}day)^{-1}$ for ingestion). Assuming a fugitive dust concentration of 0.05 mg/m^3 and breathing rates of 10 and 20 m^3/day for children and adults, respectively, the inhalation pathway accounts for 3 percent of the total exposure. For other compounds where the ingestion and inhalation slope factors are the same, the inhalation pathway comprises less than 1 percent of the exposure.

resources via the leaching pathway. Therefore, cleanup levels that consider leaching were derived for VOCs and petroleum compounds and related constituents.

As discussed in Section 7.3.4, the water ingestion and fish or other aquatic organism ingestion pathways are taken into account by adoption of chemical-specific ARARs as cleanup levels. The ARARs being used as cleanup levels include MCLs and aquatic criteria for protection of human health, where applicable. Although MCLs are not explicitly risk-based numbers like MCLGs, they are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. The aquatic criteria for protection of human health are risk-based values that include ingestion of water and consumption of aquatic organisms.

Exposure to PCOCs in homegrown produce, and dermal contact with surface water and seeps are not considered to be significant exposure pathways. Landscaping at the Presidio is maintained by the Trust, and residents and commercial tenants are not permitted to plant vegetation. Consequently, most produce grown at the Presidio would be restricted to plants in containers or in community gardens at locations specifically approved for such use by the Trust. Similarly, no appreciable dermal contact with PCOCs in surface water is expected. Swimming and wading are not allowed in Mountain Lake, Crissy Field wetlands, or Lobos Creek, and it is anticipated that these activities will be restricted in the proposed riparian corridor associated with Tennessee Hollow. Swimming and wading are prohibited in these areas because of possible damage to critical and sensitive habitats, and the need to protect potable supply in the case of Lobos Creek. Although residential and recreational users of the Presidio may have contact with water at seeps, the exposure frequency and duration are anticipated to be very limited.

4.2.3 Non-carcinogen Target Risk Level

As defined by U.S. EPA (1989a), non-carcinogenic effects are organ-specific and are manifested only after reaching a certain chemical dose. As a result, a range of exposures exists from zero to some finite value that can be tolerated with essentially no chance of adverse effects. The upper bound on this tolerance range or "safe dose" is identified as a reference dose ("RfD").

U.S. EPA (1989a) estimates the potential for non-carcinogenic effects by comparing a chronic exposure level (i.e., greater than 7 years) over a specified time period with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is called the hazard index ("HI"). Consistent with the NCP at 40 CFR §300.430(e)(2)(i)(A)(1), U.S. EPA (1991a) established the standard default non-carcinogenic target risk level to correspond to a HI of unity (i.e., 1). This target risk level is equivalent to the degree of chemical exposure from all significant exposure pathways in a given medium below which it is unlikely for even sensitive populations to experience adverse health effects. A target HI of 1 was used to derive PRGs for soil at the Presidio based upon non-carcinogenic effects.

4.2.4 Carcinogen Target Risk Level

Carcinogenesis, unlike non-carcinogenic effects, is generally thought to be a phenomenon for which risk evaluation based on presumption of a threshold is inappropriate (U.S. EPA, 1989a). For carcinogens, U.S. EPA assumes that a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation and eventually to a clinical state of disease. This hypothesized mechanism for carcinogenesis is referred to as "non-threshold" because there is not believed to be a level of exposure to such a chemical that does not pose a finite probability, however small, of generating a carcinogenic response. No dose is thought to be risk-free. Therefore, in evaluating cancer risks, a safe dose cannot be estimated.

For carcinogenic effects, U.S. EPA uses a two-part evaluation. In the first part of this evaluation, the chemical is assigned a weight-of-evidence classification, which is related to how convincingly the scientific studies demonstrate that the chemical is carcinogenic to humans. In the second part of this evaluation, a slope factor ("SF") is calculated, which is a measure of the chemical's potency. U.S. EPA (1989a) estimates risks as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This probability is defined as the incremental or excess lifetime cancer risk. The SF is the 95 percent upper confidence limit on the slope of the low-dose linear portion of the dose-response curve as estimated by the multistage linear model.

The SF directly relates the incremental risk of cancer over a lifetime (i.e., 70 years) to the degree of chemical exposure averaged over a lifetime. U.S. EPA (1991a) established the standard default carcinogenic target risk level to correspond to a one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen from all significant exposure pathways for a given medium. Consistent with the NCP at 40 CFR §300.430(e)(2)(i)(A)(2), U.S. EPA (1991c) strives for cleanup of Superfund sites that attain a 10^{-4} to 10^{-6} target risk range. A target risk of 10^{-6} was used to derive PRGs for soil at the Presidio based upon carcinogenic effects.

4.2.5 Lead Target Risk Level

Ingested or inhaled lead is distributed primarily to the blood, soft tissue (e.g., bone marrow, liver, and brain), and mineralizing tissue (e.g., bones and teeth) of the body. Lead interferes with normal cell function and with a number of physiologic processes, including damage to the central nervous system, inhibition of the body's ability to make hemoglobin, disruption of the endocrine system that may lead to impaired tooth and bone development, and damage to the kidneys (California Department of Health Services, 1997). The United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry ("ATSDR") also indicates that lead readily crosses the placenta. According to ATSDR (1995), lead not only affects the viability of the fetus, but development as well. Development consequences of prenatal exposure to low levels of lead include reduced birth weight and premature birth. Reports have shown

lead to be a teratogen and carcinogen in animals. However, studies in humans have failed to show a relationship between lead concentrations and congenital malformations, and the association of lead levels and cancer observed in humans remains uncertain (ATSDR, 1995).

Blood lead concentration is an integrated measure of internal dose resulting from the total exposure of releases of lead at a site and naturally occurring concentrations of lead in the environment. The DTSC has established that the concentration of concern for lead in blood is 10 micrograms per deciliter ("µg/dl") at the 99th percentile, i.e., a one percent chance that blood lead concentrations will be greater than 10 µg/dl (DTSC, 1996). The 99th percentile is believed to be protective because it establishes an upper bound level for lead exposure that is akin to U.S. EPA's reasonable maximum exposure ("RME") approach (U.S. EPA, 1989a).

4.2.6 Human Health Toxicity Values

Following the hierarchy established in DTSC's Preliminary Endangerment Assessment ("PEA") Guidance Manual, toxicity values used to calculate human health PRGs were obtained from the following references in the order listed:

- Carcinogenic slope factors were obtained from California Environmental Protection Agency, Office of Environmental Health Hazard Assessment ("OEHHA") website table entitled *California Cancer Potency Factors*, dated December 2000.

- U.S. EPA's computerized Integrated Risk Information System ("IRIS").

- U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July 1997.

- U.S. EPA's National Center for Environmental Assessment ("NCEA"), Draft Risk Assessment Issue Papers for individual chemicals.

OEHHA's technical documents and website represent the agency's most current stance on non-carcinogenic and carcinogenic toxicity values. U.S. EPA maintains the IRIS computerized database. Toxicity values on IRIS have undergone review and verification by U.S. EPA program offices prior to publication. Toxicity values were obtained from HEAST if none were available from OEHHA or IRIS. HEAST is not updated as regularly as IRIS and may contain interim toxicity values. NCEA was the final information source consulted. Toxicity values obtained from NCEA have not been verified by U.S. EPA and are considered provisional. The sources for chemical-specific toxicity values used to calculate human health PRGs are presented on the tables in which PRGs are calculated.

No published toxicity values were found for copper, acenaphthylene, benzo(g,h,i)perylene, 2-(4-chloro-o-to(yl)oxy)propionic acid ("MCPP"), phenanthrene,

and 2-methylnaphthalene. Consequently, human health PRGs for these PCOCs could not be calculated. For VOCs and pesticides, which have no published toxicity values, surrogates were used to calculate human health PRGs. The values for 1,2,4-trichlorbenzene were used as a surrogate for 1,2,3-trichlorbenzene, and the values for isopropyl benzene were used as a surrogate for p-isopropyltoluene (also known as p-cymene). The values for endosulfan were used as a surrogate for endosulfan sulfate, the values for endrin were used as a surrogate for endrin aldehyde and endrin ketone, the values for heptachlor were used as a surrogate for heptachlor epoxide, and the values for aldrin were used as a surrogate for isodrin because isodrin is an isomer of aldrin.

4.2.7 Calculation of Human Health PRGs for PCOCs Other than Lead in Soil

Except for lead, PRGs were calculated for PCOCs using the hazard and risk equations based on those presented in DTSC's PEA guidance. PRGs for lead were calculated as described in Section 4.2.10 due to the different toxicological behavior of lead. For other PCOCs, PRGs based on non-carcinogenic effects ("PRG_{nc}") were calculated using the following equation:

$$PRG_{nc} = \frac{RfD \times \text{Target HI of 1}}{\left(\text{Ingestion}_{child} + \text{Dermal}_{child}\right)}$$

PRGs based on carcinogenic effects ("PRG_cs") were calculated using the following equation:

$$PRG_c = \frac{\text{Target Risk Level of } 10^{-6}}{SF \times \left(\text{Ingestion}_{child} + \text{Dermal}_{child} + \text{Ingestion}_{adult} + \text{Dermal}_{adult}\right)}$$

Ingestion_{child}, Dermal_{child}, Ingestion_{adult}, and Dermal_{adult} (i.e., direct contact) are estimates of exposure that may result from swallowing and absorbing PCOCs through the skin of a child and adult, respectively. Exposure to PCOCs for various children and adult populations at the Presidio were estimated by use of the equations listed below:

where:

$$\text{Ingestion}_{child} = \frac{IR_{child} \times FI \times EF \times ED \times 10^{-6}\,kg/mg}{BW_{child} \times AT_c}$$

$$\text{Dermal}_{child} = \frac{SA_{child} \times AF_{child} \times ABS \times EF \times ED \times 10^{-6}\,kg/mg}{BW_{child} \times AT_c}$$

$$\text{Ingestion}_{adult} = \frac{IR_{adult} \times FI \times EF \times ED \times 10^{-6}\,kg/mg}{BW_{adult} \times AT_c}$$

$$\text{Dermal}_{\text{adult}} = \frac{\text{SA}_{\text{adult}} \times \text{AF}_{\text{adult}} \times \text{ABS} \times \text{EF} \times \text{ED} \times 10^{-6}\,\text{kg/mg}}{\text{BW}_{\text{adult}} \times \text{AT}_{\text{c}}}$$

Definitions of the terms or exposure parameters within the equations are presented in Table 4-2.

For VOCs under the residential and commercial/industrial exposure scenarios, the PRGs also incorporate potential risks due to vapor intrusion into indoor air. Carcinogenic and non-carcinogenic PRGs based on the vapor intrusion pathway ("$\text{PRG}_{\text{c-inh}}$" and "$\text{PRG}_{\text{nc-inh}}$") were obtained from Table E-1a of the RWQCB's RBSLs (RWQCB, 2001b).[4] For compounds that do not have tabulated RBSLs, inhalation PRGs were calculated using the Johnson and Ettinger model (Version 2.3, dated March 2001) with the default exposure assumptions and soil parameters used to calculate the RBSLs. The printouts from the Johnson and Ettinger model runs are included in Appendix E.

The PRGs accounting for the direct contact exposure pathways (i.e., dermal contact and ingestion) were combined with those for inhalation using the following equations:

$$\text{PRG}_{\text{c-combined}} = \frac{\text{PRG}_{\text{c}} \times \text{PRG}_{\text{c-inh}}}{\text{PRG}_{\text{c}} + \text{PRG}_{\text{c-inh}}}$$

$$\text{PRG}_{\text{nc-combined}} = \frac{\text{PRG}_{\text{nc}} \times \text{PRG}_{\text{nc-inh}}}{\text{PRG}_{\text{nc}} + \text{PRG}_{\text{nc-inh}}}$$

PRGs for VOCs also need to consider leaching to groundwater ("Groundwater Protection PRGs"). As discussed further in Section 4.2.9, Groundwater Protection PRGs were also obtained from the RWQCB's RBSL document (Table A-1of Volume II) (RWQCB, 2001b).

4.2.8 Human Health Exposure Parameters

In accordance with DTSC PEA Guidance Manual, the same exposure parameter values were used to calculate non-carcinogenic and carcinogenic PRGs except for the averaging time ("AT"). Regarding this parameter, DTSC (1999) states the following:

> AT is 70 yr for cancer risk, but is set equal to 6 years for non-carcinogenic hazard to be consistent with the exposure duration for non-carcinogenic hazards. Thus, all non-carcinogenic exposures are estimated for a child, which are the receptors with the greatest estimated exposures.

[4] The RBSLs generally use default values from the Johnson and Ettinger model. One exception is the indoor air exchange rate. The RBSLs use a residential air exchange rate of 2 per hour, instead of the default of 0.45 per hour, because air exchange rates are anticipated to be higher in the San Francisco Bay Area (i.e., temperate climate and houses with limited insulation). Due to the linear relationship between the calculated soil concentration and the air exchange rate, the difference is only a factor of 4.

As shown in Table 4-2, where available, exposure parameters are default factors obtained from U.S. EPA or DTSC guidance for residential, recreational, and commercial/industrial populations, or are calculated based on published values. Recreational exposure frequency is the only parameter where a default factor does not exist and professional judgement had to be used to estimate a value. The exposure frequency, or number of days per year that an individual may engage in recreational activities (e.g., sightseeing, hiking, picnicking, or participating in athletic or cultural events) at the Presidio is assumed to be 150 days per year (i.e., 3 days per week).

4.2.9 Human Health PRGs for PCOCs Other than Lead in Soil

Tables 4-3, 4-4, and 4-5 summarize the non-carcinogenic and carcinogenic PRGs for residential, recreational, and commercial/industrial exposure at the Presidio, respectively. PRGs proposed as cleanup levels are the lower values of the PRG_{nc} and PRG_c for each potential chemical of concern.

For VOCs, the non-carcinogenic and carcinogenic direct contact PRGs calculated in Tables 4-3, 4-4, and 4-5 are carried forward to Table 4-6. In Table 4-6, the indoor air exposure soil concentrations are factored into the PRG_{nc} and PRG_c using the formulas described above to account for potential risks due to vapor intrusion into indoor air. The values for $PRG_{nc\text{-}inh}$ and $PRG_{c\text{-}inh}$ (Vapor Intrusion PRGs) were obtained from Table E-1a of the RBSLs, or the Johnson and Ettinger model (Appendix E). The Combined PRGs calculated in Table 4-6 are carried forward to Table 4-7.

In Table 4-7, the Combined PRGs for VOCs are compared to the respective Groundwater Protection PRGs obtained from Tables A-1 or A-2 of the RWQCB's RBSL document (RWQCB, 2001b). The Groundwater Protection PRGs are soil cleanup levels based on protection of drinking water resources via the leaching to groundwater pathway. For VOCs for which groundwater protection numbers are not listed in the RBSL document, Groundwater Protection PRGs were calculated using formulas within the RBSL document. The lower of the Combined PRG or the Groundwater Protection PRG is retained as the human health PRG for the respective VOC for each land use.

As noted above, the Vapor Intrusion PRGs and Groundwater Protection PRGs are from the RWQCB's RBSL document and are not site-specific. Therefore, if VOCs are found at a Presidio site, VOC cleanup levels may be re-calculated to be site-specific. Site-specific factors that could affect the calculation include the type of soil, depth to groundwater, presence of buildings, and the number and types of VOCs present in soil. Any recalculation of PRGs for VOCs would be conducted in conjunction with discussions with regulatory agencies. Other identified COCs at the Presidio generally are not mobile or volatile (e.g., metals, PCBs, and pesticides); therefore, Vapor Intrusion PRGs and Groundwater Protection PRGs were not developed for these other chemical classes.

4.2.10 Human Health PRGs for Lead in Soil

PRGs for residential, recreational and commercial/industrial users of the Presidio were calculated using the DTSC Lead Spread Version 7.0 computer model. PRGs were established such that the lead concentration in the blood of these potentially exposed individuals was less than 10 µg/dl at the 99th percentile, taking into account the intake of lead from releases at Presidio sites, and lead naturally occurring in air, water, food, and soil.

DTSC default factors of 0.028 µg/m^3 and 1.1 kg food/day (at 3.1 µg lead/kg food) were used to account for lead naturally occurring in air and food, respectively, for all populations at the Presidio. The concentration of lead in tap water was established as 2.4 µg/L for residential populations at the Presidio and 15 µg/L for recreational and commercial/industrial users. A value of 2.4 µg/L is the 95 percent upper confidence limit of the average lead concentration measured in tap water at Presidio residences in 1998, 1999, and 2000. The tap water data are included in Appendix A. A value of 15 µg/L is the DTSC default factor, which is based on the Action Level for lead in drinking water.[5] The dietary source of lead assumes that residential, recreational, and commercial/industrial users will not consume produce, if any, grown at impacted sites.[6] A site-specific background concentration of 66 mg/kg of lead was assumed for soil at the Presidio. This concentration reflects the naturally occurring concentration of lead found in serpentinite soil at the Presidio. Naturally occurring or background concentrations of metals in soil and water at the Presidio are discussed in Section 6.

The frequency that residential and recreational users are exposed to naturally occurring or background concentrations of lead in air, water, and food was assumed to be equivalent to the concentrations identified above for 7 days per week. For recreational users, the exposure frequency to background concentrations of lead in soil was assumed to occur 4 days per week (i.e., when those users are assumed to be off-site). Consistent with the assumptions used to calculate PRGs for PCOCs with non-carcinogenic and carcinogenic effects, the exposure frequency to lead in soil and fugitive dust while at the Presidio was taken to be 3 days per week (i.e., 150 days per year) for recreational users and 7 days per week for residential populations. The lead PRG for commercial/industrial users was calculated assuming an exposure frequency of 5 days per week, as specified by DTSC (1996). Exposures of commercial/industrial users to background concentrations of lead in air, water, and food were assumed to be equivalent DTSC default factors. Consistent with the assumptions used to calculate PRGs for other PCOCs, the exposure frequency to lead in soil and fugitive dust while at the Presidio was taken to be 5 days per week for commercial/industrial users.

Table 4-8 summarizes the lead intakes for residential, recreational and commercial/industrial users. As shown in this table, lead concentrations of 370 mg/kg,

[5] The background level of lead in drinking water for recreational and commercial/industrial users was not established as the site-specific value of 2.4 µg/L because a significant portion of their daily drinking water may come from off-site sources.

[6] Use restrictions prohibiting the in-ground planting of home grown produce are already in place at the Presidio.

500 mg/kg and 3,500 mg/kg in soil at the Presidio potentially cause blood lead to increase to 10 µg/dl in residential, recreational, and commercial/industrial users, respectively, based upon the values of exposure parameters and frequencies assumed. Copies of computer spreadsheets used to calculate PRGs for lead in soil are included in Appendix A. Recreational and commercial/industrial PRGs have been established at 500 mg/kg and 3,500 mg/kg for lead in soil. The residential cleanup level for lead in soil has been established as a not-to-exceed value of 400 mg/kg, based on the chemical-specific ARARs discussed in Section 3.2, and a maximum average concentration of 370 mg/kg, based on the site-specific PRG.

TABLES

TABLE 4-1
EXPOSED POPULATIONS AND EXPOSURE PATHWAYS USED TO DEVELOP PRGs

Presidio of San Francisco, California

Potentially Exposed Populations and Significant Exposure Pathways	Rationale
Residential Use (Children & Adults)	
• Ingestion of Soil • Dermal Contact with Soil	Residential children and adults may be directly exposed to residual chemicals in soil in backyards and areas near houses. Thus, ingestion of soil and dermal contact with soil are considered potentially complete exposure pathways. Ingestion of chemicals in homegrown produce is not considered a significant pathway for residents because landscaping at the Presidio is maintained by the Trust. Residents are not permitted to plant vegetation. Consequently, most produce grown at the Presidio would be in community gardens at locations specifically designated by the Trust.
• Inhalation of VOCs in Indoor Air	The primary non-petroleum potential chemicals of concern ("PCOCs") at the Presidio are metals and polycyclic aromatic hydrocarbons. Inhalation of PCOCs on soil particulates accounts for only 1 to 2 percent of total exposure to PCOCs. Therefore, inhalation of chemicals is not considered to be a significant exposure pathway for non-volatile PCOCs and is not included in the development of preliminary remediation goals ("PRGs"). Inhalation of VOCs via the vapor intrusion pathway is considered a complete pathway.
• Ingestion of Water (Addressed through MCLs as Cleanup Levels)	Exposure to chemicals of concern in groundwater through drinking water is considered a potentially complete pathway and will be addressed by adopting Maximum Contaminant Levels ("MCLs") or action levels as cleanup levels. Swimming and wading are prohibited in Mountain Lake, Crissy Field wetlands, and Lobos Creek. Dermal contact with or incidental ingestion of surface water and sediment is not considered to be a significant exposure pathway for residents. Residents may have periodic contact with water at seeps; however, the exposure is anticipated to be limited because the seeps generally are small and shallow, and difficult to access. Some of the seeps are ephemeral. Contact with water at seeps is not considered to be a significant exposure pathway.

TABLE 4-1
EXPOSED POPULATIONS AND EXPOSURE PATHWAYS USED TO DEVELOP PRGs

Presidio of San Francisco, California

Potentially Exposed Populations and Complete Exposure Pathways	Rationale
Recreational Use (Children & Adults)	
• Ingestion of Soil • Dermal Contact with Soil	Children and adults recreating in open areas of the Presidio may be directly exposed to residual PCOCs. Thus, ingestion of soil and dermal contact with soil are considered potentially complete exposure pathways. The primary non-petroleum PCOCs at the Presidio are metals and polycyclic aromatic hydrocarbons. Inhalation of PCOCs on soil particulates accounts for only 1 to 2 percent of total exposure to PCOCs. Inhalation of non-volatile PCOCs is not considered to be a significant exposure pathway. In addition, recreational users of the Presidio are assumed to be primarily outdoors. Therefore, vapor intrusion of VOCs to indoor air is considered to be an incomplete pathway.
• No Significant Water Exposure Pathways Identified	Swimming and wading are prohibited in Mountain Lake, Crissy Field wetlands, and Lobos Creek. Dermal contact with or incidental ingestion of surface water and sediment is not considered to be a significant exposure pathway for recreational users. Recreational users of the Presidio may have periodic contact with water at seeps; however, the exposure is anticipated to be limited because the seeps generally are small and shallow, and difficult to access. Some of the seeps are ephemeral. Contact with water at seeps is not considered to be a significant exposure pathway.

TABLE 4-1
EXPOSED POPULATIONS AND EXPOSURE PATHWAYS USED TO DEVELOP PRGs

Presidio of San Francisco, California

Potentially Exposed Populations and Complete Exposure Pathways	Rationale
Commercial/Industrial Use (Adults)	
• Ingestion of Soil • Dermal Contact with Soil	Commercial/industrial workers may be directly exposed to residual chemicals at the Presidio. Thus, ingestion of soil and dermal contact with soil are considered potentially complete exposure pathways.
• Inhalation of VOCs in Indoor Air	Inhalation of PCOCs on soil particulates accounts for only 1 to 2 percent of total exposure to PCOCs. Therefore, inhalation of non-volatile PCOCs is not considered a significant exposure pathway. Vapor intrusion of VOCs to indoor air is also considered a complete pathway.
• Ingestion of Water (Addressed through MCLs as Cleanup Levels)	Exposure to PCOCs in groundwater through drinking water is considered a potentially complete exposure pathway and will be addressed by adopting MCLs or action levels as cleanup levels. Commercial/industrial workers are not anticipated to be contacting surface water at the Presidio. Thus, dermal contact with or incidental ingestion of surface water and sediment is not considered to be a complete exposure pathway.

TABLE 4-2
EXPOSURE FACTORS USED TO CALCULATE HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL

Presidio of San Francisco, California

Exposure Parameter	Units	Default or Assumed Value	Reference (a)
Averaging Time (AT)			
Carcinogenic	days	27,375	U.S. EPA, 1997
Non-carcinogenic			
Residential/Recreational	days	2,190	U.S. EPA, 1991; DTSC, 1996
Commercial/Industrial	days	9,125	U.S. EPA, 1991; DTSC, 1996
Exposure Frequency (EF)			
Residential	days/year	350	U.S. EPA, 1991; DTSC, 1996
Recreational	days/year	150	Professional Judgment
Commercial/Industrial	days/year	250	U.S. EPA, 1991; DTSC, 1996
Exposure Duration (ED)			
Residential/Recreational			
Carcinogenic	years	6 (child) + 24 (adult)	U.S. EPA, 1991; DTSC, 1996
Non-carcinogenic	years	6 (child)	U.S. EPA, 1991; DTSC, 1996
Commercial/Industrial			
Carcinogenic and Non-carcinogenic	years	25	U.S. EPA, 1991; DTSC, 1996
Body Weight (BW)			
Adult	kg	70	U.S. EPA, 1991; DTSC, 1996
Child	kg	15	U.S. EPA, 1991; DTSC, 1996
Soil Ingestion Rate (IR)			
Adult - Residential/Recreational	mg/day	100	U.S. EPA, 1997; DTSC, 1996
Child - Residential/Recreational	mg/day	200	U.S. EPA, 1997; DTSC, 1996
Adult - Commercial/Industrial	mg/day	50	U.S. EPA, 1997
Fraction of Soil Ingested (FI)	-	1	U.S. EPA, 1989; DTSC, 1996
Skin Surface Area			
Adult - Residential/Recreational	cm^2/day	5,800 (b)	DTSC, 1999
Child - Residential/Recreational	cm^2/day	2,900 (c)	U.S. EPA, 1998
Adult - Commercial/Industrial	cm^2/day	3,400 (d)	U.S. EPA, 1997
Soil-to-Skin Adherence Factor (AF)	-		
Adult - Residential/Recreational	mg/cm^2	0.23 (e)	U.S. EPA, 1998
Child - Residential/Recreational	mg/cm^2	0.30	U.S. EPA, 1998
Adult - Commercial/Industrial	mg/cm^2	0.12 (f)	U.S. EPA, 1998

TABLE 4-2
EXPOSURE FACTORS USED TO CALCULATE HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL

Presidio of San Francisco, California

Exposure Parameter	Units	Default or Assumed Value	Reference (a)
Skin Absorption Factor (ABS)			
Metals	-	0.01	DTSC, 1999
Arsenic	-	0.03	DTSC, 1999
Cadmium	-	0.001	DTSC, 1999
Polycyclic Aromatic Hydrocarbons	-	0.15	DTSC, 1999
Volatile Organics	-	0.10	DTSC, 1999
Polychlorinated Biphenyls	-	0.15	DTSC, 1999
Pesticides	-	0.05	DTSC, 1999

Notes:

(a) References for exposure parameter values are as follows:

- U.S. EPA. 25 March 1991. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors.* Interim Final. OSWER Directive 9285.6-03.
- U.S. EPA. December 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part A).* Interim Final. Office of Emergency and Remedial Response. EPA/540/1-89/002.
- U.S. EPA. August 1997. *Exposure Factors Handbook Volume I General Factors: Principles and Applications.* Office of Research and Development. EPA 600/P-95/002F.
- U.S. EPA. May 1998. *Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual, Supplemental Guidance Dermal Risk Assessment.* Interim Guidance. Office of Emergency Response. NCEA-W-0364.
- DTSC. August 1996. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities*.
- DTSC. June 1999. *Preliminary Endangerment Assessment Guidance Manual*. Second Printing.

(b) Average skin exposure for men and women's heads, forearms, hands, and lower legs to chemicals of concern in soil while participating in recreational activities. Exposure factor assumes residential and recreational users at the Presidio wear short-sleeved shirts and shorts.

(c) Skin exposure for children's heads, forearms, hands, lower legs, and feet to chemicals of concern in soil. Exposure factor assumes children at the Presidio wear short-sleeved shirts, shorts, and are bare footed.

(d) Average skin exposure for men and women's heads, forearms, and hands to chemicals of concern in soil while performing commercial/industrial activities. Exposure factor assumes workers at the Presidio wear short-sleeved shirts and long pants.

(e) Average of the soil-to-skin adherence factors given for rugby player in wet soil and in dry soil.

(f) Average soil-to-skin adherence factor given for grounds keeper, landscaper, irrigation installer, gardener, archaeologist construction worker, utility worker and heavy equipment operator.

TABLE 4-3
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RESIDENTIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Inorganic Chemicals								
Antimony	- (f)	-	0.0004	IRIS	0.01	-	29	29
Arsenic	1.5	OEHHA	0.0003	IRIS	0.03	0.36	20	0.36
Barium	-	-	0.07	IRIS	0.01	-	5,000	5,000
Beryllium	-	-	0.002	IRIS	0.01	-	140	140
Cadmium	0.38	OEHHA	0.0005	IRIS	0.001	1.7	37	1.7
Chromium (Cr(VI) and Cr(III))	5.3E-04	OEHHA (g)	2	IRIS	0.01	1,200	140,000	1,200
Cobalt	-	-	0.06	NCEA	0.01	-	4,000	4,000
Copper	-	-	(h)	(h)	-	-	-	-
Cyanide	-	-	0.02	IRIS	0.10	-	1,000	1,000
Lead (i)	-	-	-	-	-	-	-	400
Tetraethyl Lead	-	-	0.0000001	IRIS	0.10	-	0.0052	0.0052
Mercury	-	-	0.0003	IRIS	0.01	-	20	20
Molybdenum	-	-	0.0050	IRIS	0.01	-	360	360
Nickel	-	-	0.02	IRIS	0.01	-	1,400	1,400
Selenium	-	-	0.005	IRIS	0.01	-	360	360
Silver	-	-	0.005	IRIS	0.01	-	360	360
Thallium	-	-	0.00008	IRIS (j)	0.01	-	5.7	5.7
Vanadium	-	-	0.009	IRIS	0.01	-	650	650
Zinc	-	-	0.3	IRIS	0.01	-	22,000	22,000
Semivolatile Organic Compounds								
Acenaphthene	-	-	0.06	IRIS	0.15	-	2,700	2,700
Acenaphthylene	-	-	-	-	-	-	-	-
Anthracene	-	-	0.3	IRIS	0.15	-	14,000	14,000
Benzo(a)anthracene	1.2	OEHHA	-	-	0.15	0.27	-	0.27
Benzo(a)pyrene	12	OEHHA	-	-	0.15	0.027	-	0.027

TABLE 4-3
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RESIDENTIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Semivolatile Organic Compounds (cont.)								
Benzo(b)fluoranthene	1.2	OEHHA	-	-	0.15	0.27	-	0.27
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	1.2	OEHHA	-	-	0.15	0.27	-	0.27
Benzyl Alcohol	-	-	0.3	HEAST	0.15	-	14,000	14,000
Chrysene	0.12	OEHHA	-	-	0.15	2.7	-	2.7
Dibenzo(a,h)anthracene	4.1	OEHHA	-	-	0.15	0.078	-	0.078
Dibenzofuran	-	-	0.02	IRIS	0.15	-	910	910
Fluoranthene	-	-	0.04	IRIS	0.15	-	1,800	1,800
Fluorene	-	-	0.04	IRIS	0.15	-	1,800	1,800
Indeno(1,2,3-c,d)pyrene	1.2	OEHHA	-	-	0.15	0.27	-	0.27
2-methylnaphthalene	-	-	-	-	-	-	-	-
4-methylphenol (p-Cresol)	-	-	0.005	HEAST	0.10	-	260	260
Naphthalene	-	-	0.02	IRIS	0.15	-	910	910
n-Nitrosodiphenylamine	0.009	OEHHA	-	-	0.10	43	-	43
Pentachlorophenol	0.081	OEHHA	0.03	IRIS	0.10	5	1,600	5
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	0.6	IRIS	0.15	-	27,000	27,000
Pyrene	-	-	0.03	IRIS	0.15	-	1,400	1,400
Volatile Organic Compounds (k)								
Acetone	-	-	0.1	IRIS	0.10	-	5,200	See Table 4-6
2-butanone (MEK)	-	-	0.6	IRIS	0.10	-	31,000	See Table 4-6
Carbon disulfide	-	-	0.1	IRIS	0.10	-	5,200	See Table 4-6
1,4-dichlorobenzene	0.0054	OEHHA	0.03	HEAST	0.10	71	1,600	See Table 4-6
p-Isopropyltoluene (p-cymene)	-	-	0.1	IRIS (l)	0.1	-	5,200	See Table 4-6
Methylene Chloride	0.014	OEHHA	0.06	IRIS	0.10	27	3,100	See Table 4-6

TABLE 4-3
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RESIDENTIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Volatile Organic Compounds (cont.)								
1,2,3-trichlorobenzene	0.0036	(m)	0.01	(m)	0.1	110	520	See Table 4-6
1,2,4-trichlorobenzene	0.0036	OEHHA	0.01	IRIS	0.1	110	520	See Table 4-6
Trichlorofluoromethane	-	-	0.30	IRIS	0.10	-	16,000	See Table 4-6
1,1,1-trichloroethane	-	-	0.29	NCEA (n)	0.10	-	15,000	See Table 4-6
PCBs, Pesticides, and Herbicides								
PCBs (Aroclor 1254)	2	OEHHA (o)	0.00002	IRIS	0.15	0.16	1.0	0.16
Aldrin	17	OEHHA	0.00003	IRIS	0.05	0.029	1.8	0.029
alpha-BHC	2.7	OEHHA	-	-	0.05	0.180	-	0.18
beta-BHC	1.5	OEHHA	-	-	0.05	0.32	-	0.32
delta-BHC	2.7	(p)	-	-	0.05	0.180	-	0.18
Chlordane	1.3	OEHHA	0.0005	IRIS	0.05	0.37	31	0.37
2,4-D	-	-	0.01	IRIS	0.05	-	620	620
Dicamba	-	-	0.03	IRIS	0.05	-	1,800	1,800
4,4'-DDD	0.24	OEHHA	-	-	0.05	2.0	-	2.0
4,4'-DDE	0.34	OEHHA	-	-	0.05	1.4	-	1.4
4,4'-DDT	0.34	OEHHA	0.0005	IRIS	0.05	1.4	31	1.4
Dieldrin	16	OEHHA	0.00005	IRIS	0.05	0.030	3.1	0.030
Endosulfan	-	-	0.006	IRIS	0.05	-	370	370
Endosulfan Sulfate	-	-	0.006	(q)	0.05	-	370	370
Endrin	-	-	0.0003	IRIS	0.05	-	18	18
Endrin Aldehyde	-	-	0.0003	(q)	0.05	-	18	18
Endrin Ketone	-	-	0.0003	(q)	0.05	-	18	18
gamma-BHC (Lindane)	1.1	OEHHA	0.0003	IRIS	0.05	0.44	18	0.44
Heptachlor	4.1	OEHHA	0.0005	IRIS	0.05	0.12	31	0.12
Heptachlor Epoxide	5.5	OEHHA	0.00001	IRIS	0.05	0.088	1	0.088

TABLE 4-3
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RESIDENTIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
PCBs, Pesticides, and Herbicides (cont.)								
Isodrin	17	(r)	0.00003	(r)	0.05	0.029	-	0.029
MCPP	-	-	-	-	-	-	-	-
Methoxychlor	-	-	0.005	IRIS	0.05	-	310	310

Notes:

(a) Carcinogenic slope factors were obtained from California Environmental Protection Agency, Office of Environmental Health Hazard Assessment ("OEHHA") website table entitled *California Cancer Potency Factors*, dated March 2001. U.S. EPA Integrated Risk Information System ("IRIS") was used as a secondary reference.

(b) Chronic reference doses were obtained from IRIS, U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July 1997, and U.S. EPA's National Center for Environmental Assessment ("NCEA") Draft Risk Assessment Issue Papers for individual chemicals.

(c) Soil absorption factors obtained from California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"), *Endangerment Assessment Guidance Manual*, dated June 1999.

(d) Exposure factors used to calculate carcinogenic and non-carcinogenic preliminary remediation goals ("PRGs") are summarized in Table 4-2. PRGs are based upon a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime, and a non-carcinogenic target risk level that corresponds to a hazard index of 1.

(e) Where both carcinogenic and non-carcinogenic PRGs are available, the proposed PRG is the lesser of the two values.

(f) Hyphen indicates that a value is not available or cannot be calculated.

(g) At the Presidio, Cr(VI) comprises 0.0055 to 0.28 percent of the total chromium in serpentinite (Montgomery Watson, 1999). By analogy to the U.S. EPA PRG tables (U.S. EPA, October 2000), OEHHA's oral slope factor of 0.19 $(mg/kg\text{-}d)^{-1}$ for hexavalent chromium was reduced by a factor of 0.0028.

(h) According to HEAST, the toxicity data for copper are inadequate for calculation of an RfD.

(i) The residential cleanup level for lead in soil has been established as a not-to-exceed value of 400 mg/kg, based on chemical-specific ARARs and a maximium average concentration of 370 mg/kg, based on the site-specific PRG. Refer to text for discussion of methodology used to derive the human health PRG for lead.

(j) Reference dose for thallium chloride was used.

TABLE 4-3
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RESIDENTIAL USE

Presidio of San Francisco, California

Notes (contd):

(k) PRGs for VOCs are adjusted in Tables 4-6 and 4-7, respectively, to account for potential risks due to vapor intrusion into indoor air and potential leaching to groundwater.

(l) Oral reference dose not available for p-isopropyltoluene. The value for isopropylbenzene was used as a surrogate.

(m) Oral slope factors and reference doses not available for 1,2,3-trichlorobenzene. The values for 1,2,4-trichlorobenzene were used as a surrogate.

(n) In the absence of an oral chronic reference dose or oral slope factor, the respective inhalation value was used.

(o) OEHHA's California Cancer Potency Factor table lists a slope factor of 5 $(mg/kg\text{-}day)^{-1}$ for PCBs. However, OEHHA's Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (dated 13 September 2001) and IRIS list the oral slope factor for PCBs as 2 $(mg/kd\text{-}day)^{-1}$. Based on discussions with Laurie Monserrat and David Siegel with OEHHA, the oral slope factor of 2 $(mg/kg\text{-}day)^{-1}$ is the most current value and would be accepted in risk assessments reviewed by OEHHA.

(p) An oral slope factor was not available for delta-BHC. The respective slope factor for alpha-BHC is used.

(q) Oral reference doses were not available for Endosulfin Sulfate, Endrin Aldehyde, or Endrin Ketone. The respective reference doses for Endosulfin is used for Endosulfin Sulfate, and Endrin is used for Endrin Aldehyde and Endrin Ketone.

(r) Isodrin is an isomer of aldrin. Oral slope factor and reference dose for aldrin were used to calculate isodrin PRGs.

TABLE 4-4
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RECREATIONAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Inorganic Chemicals								
Antimony	- (f)	-	0.0004	IRIS	0.01	-	70	70
Arsenic	1.5	OEHHA	0.0003	IRIS	0.03	0.88	48	0.88
Barium	-	-	0.07	IRIS	0.01	-	12,000	12,000
Beryllium	-	-	0.002	IRIS	0.01	-	350	350
Cadmium	0.38	OEHHA	0.0005	IRIS	0.001	4.2	91	4.2
Chromium (Cr(VI) and Cr(III))	5.3E-04	OEHHA (g)	2	IRIS	0.01	2,800	350,000	2,800
Cobalt	-	-	0.06	NCEA	0.01	-	10,000	10,000
Copper	-	-	(h)	(h)	-	-	-	-
Cyanide	-	-	0.02	IRIS	0.10	-	2,500	2,500
Lead (i)	-	-	-	-	-	-	-	500
Tetraethyl Lead	-	-	0.0000001	IRIS	0.10	-	0.013	0.013
Mercury	-	-	0.0003	IRIS	0.01	-	52	52
Molybdenum	-	-	0.0050	IRIS	0.01	-	870	870
Nickel	-	-	0.02	IRIS	0.01	-	3,500	3,500
Selenium	-	-	0.005	IRIS	0.01	-	870	870
Silver	-	-	0.005	IRIS	0.01	-	870	870
Thallium	-	-	0.00008	IRIS (j)	0.01	-	14	14
Vanadium	-	-	0.009	IRIS	0.01	-	1,600	1,600
Zinc	-	-	0.3	IRIS	0.01	-	52,000	52,000
Semivolatile Organic Compounds								
Acenaphthene	-	-	0.06	IRIS	0.15	-	6,600	6,600
Acenaphthylene	-	-	-	-	-	-	-	-
Anthracene	-	-	0.3	IRIS	0.15	-	33,000	33,000
Benzo(a)anthracene	1.2	OEHHA	-	-	0.15	0.65	-	0.65
Benzo(a)pyrene	12	OEHHA	-	-	0.15	0.065	-	0.065

TABLE 4-4
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RECREATIONAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Semivolatile Organic Compounds (cont.)								
Benzo(b)fluoranthene	1.2	OEHHA	-	-	0.15	0.65	-	0.65
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	1.2	OEHHA	-	-	0.15	0.65	-	0.65
Benzyl Alcohol	-	-	0.3	HEAST	0.10	-	38,000	38,000
Chrysene	0.12	OEHHA	-	-	0.15	6.5	-	6.5
Dibenzo(a,h)anthracene	4.1	OEHHA	-	-	0.15	0.19	-	0.19
Dibenzofuran	-	-	0.02	IRIS	0.15	-	2,200	2,200
Fluoranthene	-	-	0.04	IRIS	0.15	-	4,400	4,400
Fluorene	-	-	0.04	IRIS	0.15	-	4,400	4,400
Indeno(1,2,3-c,d)pyrene	1.2	OEHHA	-	-	0.15	0.65	-	0.65
2-methylnaphthalene	-	-	-	-	-	-	-	-
4-methylphenol (p-Cresol)	-	-	0.005	HEAST	0.10	-	640	640
Naphthalene	-	-	0.02	IRIS	0.15	-	2,200	2,200
n-nitrosodiphenylamine	0.009	OEHHA	-	-	0.10	104	-	104
Pentachlorophenol	0.081	OEHHA	0.03	IRIS	0.10	12	3,800	12
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	0.60	IRIS	0.10	-	76,000	76,000
Pyrene	-	-	0.03	IRIS	0.15	-	3,300	3,300
Volatile Organic Compounds (k)								
Acetone	-	-	0.1	IRIS	0.10	-	13,000	See Table 4-6
2-butanone (MEK)	-	-	0.6	IRIS	0.10	-	76,000	See Table 4-6
Carbon disulfide	-	-	0.1	IRIS	0.10	-	13,000	See Table 4-6
1,4-dichlorobenzene	0.0054	OEHHA	0.03	HEAST	0.10	173	3,800	See Table 4-6
p-Isopropyltoluene (p-cymene)	-	-	0.1	IRIS (l)	0.1	-	13,000	See Table 4-6
Methylene Chloride	0.014	OEHHA	0.06	IRIS	0.10	67	7,600	See Table 4-6

TABLE 4-4
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RECREATIONAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Volatile Organic Compounds (cont.)								
1,2,3-trichlorobenzene	0.0036	(m)	0.01	(m)	0.1	260	1,300	See Table 4-6
1,2,4-trichlorobenzene	0.0036	OEHHA	0.01	IRIS	0.1	260	1,300	See Table 4-6
Trichlorofluoromethane	-	-	0.30	IRIS	0.10	-	38,000	See Table 4-6
1,1,1-trichloroethane	-	-	0.29	NCEA (n)	0.10	-	37,000	See Table 4-6
PCBs, Pesticides, and Herbicides								
PCBs (Aroclor 1254)	2	OEHHA (o)	0.00002	IRIS	0.15	0.39	2.2	0.39
Aldrin	17	OEHHA	0.00003	IRIS	0.05	0.07	4.5	0.07
alpha-BHC	2.7	OEHHA	-	-	0.05	0.44	-	0.44
beta-BHC	1.5	OEHHA	-	-	0.05	0.79	-	0.79
delta-BHC	2.7	(p)	-	-	0.05	0.44	-	0.44
Chlordane	1.3	OEHHA	0.0005	IRIS	0.05	0.91	75	0.91
2,4-D	-	-	0.01	IRIS	0.05	-	1,500	1,500
Dicamba	-	-	0.03	IRIS	0.05	-	4,500	4,500
4,4'-DDD	0.24	OEHHA	-	-	0.05	4.9	-	4.9
4,4'-DDE	0.34	OEHHA	-	-	0.05	3.5	-	3.5
4,4'-DDT	0.34	OEHHA	0.0005	IRIS	0.05	3.5	75	3.5
Dieldrin	16	OEHHA	0.00005	IRIS	0.05	0.074	7.5	0.074
Endosulfan	-	-	0.006	IRIS	0.05	-	900	900
Endosulfan Sulfate	-	-	0.006	(q)	0.05	-	900	900
Endrin	-	-	0.0003	IRIS	0.05	-	45	45
Endrin Aldehyde	-	-	0.0003	(q)	0.05	-	45	45
Endrin Ketone	-	-	0.0003	(q)	0.05	-	45	45
gamma-BHC (Lindane)	1.1	OEHHA	0.0003	IRIS	0.05	1.1	45	1.1
Heptachlor	4.1	OEHHA	0.0005	IRIS	0.05	0.29	75	0.29
Heptachlor Epoxide	5.5	OEHHA	0.00001	IRIS	0.05	0.21	2	0.21

TABLE 4-4
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RECREATIONAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
PCBs, Pesticides, and Herbicides (cont.)								
Isodrin	17	(r)	0.00003	(r)	0.05	0.069	4	0.069
MCPP	-	-	-	-	-	-	-	-
Methoxychlor	-	-	0.005	IRIS	0.05	-	750	750

Notes:

(a) Carcinogenic slope factors were obtained from California Environmental Protection Agency, Office of Environmental Health Hazard Assessment ("OEHHA") website table entitled *California Cancer Potency Factors*, dated March 2001. U.S. EPA Integrated Risk Information System ("IRIS") was used as a secondary reference.

(b) Chronic reference doses were obtained from IRIS, U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July 1997, and U.S. EPA's National Center for Environmental Assessment ("NCEA") Draft Risk Assessment Issue Papers for individual chemicals.

(c) Soil absorption factors obtained from California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"), *Endangerment Assessment Guidance Manual*, dated June 1999.

(d) Exposure factors used to calculate carcinogenic and non-carcinogenic preliminary remediation goals ("PRGs") are summarized in Table 4-2. PRGs are based upon a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime, and a non-carcinogenic target risk level that corresponds to a hazard index of 1.

(e) Where both carcinogenic and non-carcinogenic PRGs are available, the proposed PRG is the lesser of the two values.

(f) Hyphen indicates that a value is not available or cannot be calculated.

(g) At the Presidio, Cr(VI) comprises 0.0055 to 0.28 percent of the total chromium in serpentinite (Montgomery Watson, 1999). By analogy to the U.S. EPA PRG tables (U.S. EPA, October 2000), OEHHA's oral slope factor of 0.19 $(mg/kg\text{-}d)^{-1}$ for hexavalent chromium was reduced by a factor of 0.0028.

(h) According to HEAST, the toxicity data for copper are inadequate for calculation of an RfD.

(i) PRG calculated through use of DTSC Lead Spread Version 7.0 (beta test version) computer model.

(j) Reference dose for thallium chloride was used.

TABLE 4-4
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON RECREATIONAL USE

Presidio of San Francisco, California

Notes (contd):

(k) PRGs for VOCs are adjusted in Tables 4-6 and 4-7, respectively, to account for potential risks due to vapor intrusion into indoor air and potential leaching to groundwater.

(l) Oral reference dose not available for p-isopropyltoluene. The value for isopropylbenzene was used as a surrogate.

(m) Oral slope factors and reference doses not available for 1,2,3-trichlorobenzene. The values for 1,2,4-trichlorobenzene were used as a surrogate.

(n) In the absence of an oral chronic reference dose or oral slope factor, the respective inhalation value was used.

(o) OEHHA's California Cancer Potency Factor table lists a slope factor of 5 $(mg/kg\text{-}day)^{-1}$ for PCBs. However, OEHHA's Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (dated 13 September 2001) and IRIS list the oral slope factor for PCBs as 2 $(mg/kd\text{-}day)^{-1}$. Based on discussions with Laurie Monserrat and David Siegel with OEHHA, the oral slope factor of 2 $(mg/kg\text{-}day)^{-1}$ is the most current value and would be accepted in risk assessments reviewed by OEHHA.

(p) An oral slope factor was not available for delta-BHC. The respective slope factor for alpha-BHC is used.

(q) Oral reference doses were not available for Endosulfin Sulfate, Endrin Aldehyde, or Endrin Ketone. The respective reference doses for Endosulfin is used for Endosulfin Sulfate, and Endrin is used for Endrin Aldehyde and Endrin Ketone.

(r) Isodrin is an isomer of aldrin. Oral slope factor and reference dose for aldrin were used to calculate isodrin PRGs.

TABLE 4-5
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON COMMERCIAL/INDUSTRIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Inorganic Chemicals								
Antimony	- (f)	-	0.0004	IRIS	0.01	-	760	760
Arsenic	1.5	OEHHA	0.0003	IRIS	0.03	3.3	490	3.3
Barium	-	-	0.07	IRIS	0.01	-	130,000	130,000
Beryllium	-	-	0.002	IRIS	0.01	-	3,800	3,800
Cadmium	0.38	OEHHA	0.0005	IRIS	0.001	16	1,000	16
Chromium (Cr(VI) and Cr(III))	5.3E-04	OEHHA (g)	2	IRIS	0.01	11,000	3,800,000	11,000
Cobalt	-	-	0.06	NCEA	0.01	-	110,000	110,000
Copper	-	-	(h)	(h)	-	-	-	-
Cyanide	-	-	0.02	IRIS	0.10	-	23,000	23,000
Lead (i)	-	-	-	-	-	-	-	3,500
Tetraethyl Lead	-	-	0.0000001	IRIS	0.10	-	0.11	0.11
Mercury	-	-	0.0003	IRIS	0.01	-	570	570
Molybdenum	-	-	0.0050	IRIS	0.01	-	9,400	9,400
Nickel	-	-	0.02	IRIS	0.01	-	38,000	38,000
Selenium	-	-	0.005	IRIS	0.01	-	9,400	9,400
Silver	-	-	0.005	IRIS	0.01	-	9,400	9,400
Thallium	-	-	0.00008	IRIS (j)	0.01	-	150	150
Vanadium	-	-	0.009	IRIS	0.01	-	17,000	17,000
Zinc	-	-	0.3	IRIS	0.01	-	570,000	570,000
Semivolatile Organic Compounds								
Acenaphthene	-	-	0.06	IRIS	0.15	-	55,000	55,000
Acenaphthylene	-	-	-	-	-	-	-	-
Anthracene	-	-	0.3	IRIS	0.15	-	280,000	280,000
Benzo(a)anthracene	1.2	OEHHA	-	-	0.15	2.3	-	2.3
Benzo(a)pyrene	12	OEHHA	-	-	0.15	0.23	-	0.23

TABLE 4-5
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON COMMERCIAL/INDUSTRIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Semivolatile Organic Compounds (cont.)								
Benzo(b)fluoranthene	1.2	OEHHA	-	-	0.15	2.3	-	2.3
Benzo(g,h,i)perylene	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	1.2	OEHHA	-	-	0.15	2.3	-	2.3
Benzyl Alcohol	-	-	0.3	HEAST	0.15	-	280,000	280,000
Chrysene	0.12	OEHHA	-	-	0.15	23	-	23
Dibenzo(a,h)anthracene	4.1	OEHHA	-	-	0.15	0.67	-	0.67
Dibenzofuran	-	-	0.02	IRIS	0.15	-	18,000	18,000
Fluoranthene	-	-	0.04	IRIS	0.15	-	37,000	37,000
Fluorene	-	-	0.04	IRIS	0.15	-	37,000	37,000
Indeno(1,2,3-c,d)pyrene	1.2	OEHHA	-	-	0.15	2.3	-	2.3
2-methylnaphthalene	-	-	-	-	-	-	-	-
4-methylphenol (p-Cresol)	-	-	0.005	HEAST	0.10	-	5,600	5,600
Naphthalene	-	-	0.02	IRIS	0.15	-	18,000	18,000
n-nitrosodiphenylamine	0.009	OEHHA	-	-	0.10	380	-	380
Pentachlorophenol	0.081	OEHHA	0.03	IRIS	0.10	42	34,000	42
Phenanthrene	-	-	-	-	-	-	-	-
Phenol	-	-	0.6	IRIS	0.15	-	550,000	550,000
Pyrene	-	-	0.03	IRIS	0.15	-	28,000	28,000
Volatile Organic Compounds (k)								
Acetone	-	-	0.1	IRIS	0.10	-	110,000	See Table 4-6
2-butanone (MEK)	-	-	0.6	IRIS	0.10	-	680,000	See Table 4-6
Carbon disulfide	-	-	0.1	IRIS	0.10	-	110,000	See Table 4-6
1,4-dichlorobenzene	0.0054	OEHHA	0.03	HEAST	0.10	630	34,000	See Table 4-6
p-Isopropyltoluene (p-cymene)	-	-	0.1	IRIS (l)	0.1	-	110,000	See Table 4-6
Methylene Chloride	0.014	OEHHA	0.06	IRIS	0.10	240	68,000	See Table 4-6

TABLE 4-5
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON COMMERCIAL/INDUSTRIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
Volatile Organic Compounds (cont.)								
1,2,3-trichlorobenzene	0.0036	(m)	0.01	(m)	0.1	940	11,000	See Table 4-6
1,2,4-trichlorobenzene	0.0036	OEHHA	0.01	IRIS	0.1	940	11,000	See Table 4-6
Trichlorofluoromethane	-	-	0.30	IRIS	0.10	-	338,000	See Table 4-6
1,1,1-trichloroethane	-	-	0.29	NCEA (n)	0.10	-	330,000	See Table 4-6
PCBs, Pesticides, and Herbicides								
PCBs (Aroclor 1254)	2	OEHHA (o)	0.00002	IRIS	0.15	1.4	18	1.4
Aldrin	17	OEHHA	0.00003	IRIS	0.05	0.26	44	0.26
alpha-BHC	2.7	OEHHA	-	-	0.05	1.6	-	1.6
beta-BHC	1.5	OEHHA	-	-	0.05	2.9	-	2.9
delta-BHC	2.7	(p)	-	-	0.05	1.6	-	1.6
Chlordane	1.3	OEHHA	0.0005	IRIS	0.05	3.4	730	3.4
2,4-D	-	-	0.01	IRIS	0.05	-	15,000	15,000
Dicamba	-	-	0.03	IRIS	0.05	-	44,000	44,000
4,4'-DDD	0.24	OEHHA	-	-	0.05	18	-	18
4,4'-DDE	0.34	OEHHA	-	-	0.05	13	-	13
4,4'-DDT	0.34	OEHHA	0.0005	IRIS	0.05	13	730	13
Dieldrin	16	OEHHA	0.00005	IRIS	0.05	0.27	73	0.27
Endosulfan	-	-	0.006	IRIS	0.05	-	8,700	8,700
Endosulfan Sulfate	-	-	0.006	(q)	0.05	-	8,700	8,700
Endrin	-	-	0.0003	IRIS	0.05	-	440	440
Endrin Aldehyde	-	-	0.0003	(q)	0.05	-	440	440
Endrin Ketone	-	-	0.0003	(q)	0.05	-	440	440
gamma-BHC (Lindane)	1.1	OEHHA	0.0003	IRIS	0.05	4.0	440	4.0
Heptachlor	4.1	OEHHA	0.0005	IRIS	0.05	1.1	730	1.1
Heptachlor Epoxide	5.5	OEHHA	0.00001	IRIS	0.05	0.79	19	0.79

TABLE 4-5
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON COMMERCIAL/INDUSTRIAL USE

Presidio of San Francisco, California

Potential Chemical of Concern	Carcinogenic Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Slope Factor (a)	Non-carcinogenic Oral Reference Dose (mg/kg-day)	Reference Dose (b)	Dermal Absorption Factor (c)	Carcinogenic Risk Based PRG (mg/kg); (d)	Non-carcinogenic Risk Based PRG (mg/kg); (d)	Proposed PRG (mg/kg); (e)
PCBs, Pesticides, and Herbicides (cont.)								
Isodrin	17	(r)	0.00003	(r)	0.05	0.26	44	0.26
MCPP	-	-	-	-	-	-	-	-
Methoxychlor	-	-	0.005	IRIS	0.05	-	7,300	7,300

Notes:

(a) Carcinogenic slope factors were obtained from California Environmental Protection Agency, Office of Environmental Health Hazard Assessment ("OEHHA") website table entitled *California Cancer Potency Factors*, dated March 2001. U.S. EPA Integrated Risk Information System ("IRIS") was used as a secondary reference.

(b) Chronic reference doses were obtained from IRIS, U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July 1997, and U.S. EPA's National Center for Environmental Assessment ("NCEA") Draft Risk Assessment Issue Papers for individual chemicals.

(c) Soil absorption factors obtained from California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC"), *Endangerment Assessment Guidance Manual*, dated June 1999.

(d) Exposure factors used to calculate carcinogenic and non-carcinogenic preliminary remediation goals ("PRGs") are summarized in Table 4-2. PRGs are based upon a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime, and a non-carcinogenic target risk level that corresponds to a hazard index of 1.

(e) Where both carcinogenic and non-carcinogenic PRGs are available, the proposed PRG is the lesser of the two values.

(f) Hyphen indicates that a value is not available or cannot be calculated.

(g) At the Presidio, Cr(VI) comprises 0.0055 to 0.28 percent of the total chromium in serpentinite (Montgomery Watson, 1999). By analogy to the U.S. EPA PRG tables (U.S. EPA, October 2000), OEHHA's oral slope factor of 0.19 $(mg/kg\text{-}d)^{-1}$ for hexavalent chromium was reduced by a factor of 0.0028.

(h) According to HEAST, the toxicity data for copper are inadequate for calculation of an RfD.

(i) PRG calculated through use of DTSC Lead Spread Version 7.0 (beta test version) computer model.

(j) Reference dose for thallium chloride was used.

TABLE 4-5
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR SOIL BASED ON COMMERCIAL/INDUSTRIAL USE

Presidio of San Francisco, California

Notes (contd):

(k) PRGs for VOCs are adjusted in Tables 4-6 and 4-7, respectively, to account for potential risks due to vapor intrusion into indoor air and potential leaching to groundwater.

(l) Oral reference dose not available for p-isopropyltoluene. The value for isopropylbenzene was used as a surrogate.

(m) Oral slope factors and reference doses not available for 1,2,3-trichlorobenzene. The values for 1,2,4-trichlorobenzene were used as a surrogate.

(n) In the absence of an oral chronic reference dose or oral slope factor, the respective inhalation value was used.

(o) OEHHA's California Cancer Potency Factor table lists a slope factor of 5 $(mg/kg\text{-}day)^{-1}$ for PCBs. However, OEHHA's Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values (dated 13 September 2001) and IRIS list the oral slope factor for PCBs as 2 $(mg/kd\text{-}day)^{-1}$. Based on discussions with Laurie Monserrat and David Siegel with OEHHA, the oral slope factor of 2 $(mg/kg\text{-}day)^{-1}$ is the most current value and would be accepted in risk assessments reviewed by OEHHA.

(p) An oral slope factor was not available for delta-BHC. The respective slope factor for alpha-BHC is used.

(q) Oral reference doses were not available for Endosulfin Sulfate, Endrin Aldehyde, or Endrin Ketone. The respective reference doses for Endosulfin is used for Endosulfin Sulfate, and Endrin is used for Endrin Aldehyde and Endrin Ketone.

(r) Isodrin is an isomer of aldrin. Oral slope factor and reference dose for aldrin were used to calculate isodrin PRGs.

TABLE 4-6
DEVELOPMENT OF HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR VOLATILE ORGANIC COMPOUNDS IN SOIL AT THE PRESIDIO OF SAN FRANCISCO (INCLUDES VAPOR INTRUSION PATHWAY)

Presidio of San Francisco, California

CARCINOGENIC	Carcinogenic Direct Contact PRGs (a)			Carcinogenic Vapor Intrusion PRGs ($PRG_{c\text{-}inh}$) (b)		Combined Carcinogenic PRGs (c)		
Potential Chemical of Concern	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)
Acetone	-	-	-	-	-	-	-	-
2-butanone (MEK)	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	71	173	630	0.13	0.49	0.13	173	0.49
p-Isopropyltoluene (p-cymene)	-	-	-	-	-	-	-	-
Methylene Chloride	27	67	240	0.89	3.1	0.86	67	3.1
1,2,3-trichlorobenzene (d)	110	260	940	87	280	49	260	216
1,2,4-trichlorobenzene	110	260	940	87	280	49	260	216
Trichlorofluoromethane	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	-	-	-	-	-

NON-CARCINOGENIC	Non-carcinogenic Direct Contact PRGs (a)			Non-carcinogenic Vapor Intrusion PRGs ($PRG_{nc\text{-}inh}$) (e)		Combined Non-carcinogenic PRGs (c)		
Potential Chemical of Concern	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)
Acetone	5,200	13,000	110,000	43	140	43	13,000	140
2-butanone (MEK)	31,000	76,000	680,000	596	1,980	585	76,000	1,974
Carbon disulfide	5,200	13,000	110,000	266	676	253	13,000	672
1,4-dichlorobenzene	1,600	3,800	34,000	485	1,580	372	3,800	1,510
p-Isopropyltoluene (p-cymene)	5,200	13,000	110,000	533	848	483	13,000	842
Methylene Chloride	3,100	7,600	68,000	1,140	3,320	958	7,600	3,165
1,2,3-trichlorobenzene (d)	520	1,300	11,000	462	1,520	245	1,300	1,335
1,2,4-trichlorobenzene	520	1,300	11,000	462	1,520	245	1,300	1,335
Trichlorofluoromethane	16,000	38,000	338,000	40	116	40	38,000	116
1,1,1-trichloroethane	15,000	37,000	330,000	76	220	76	37,000	220

TABLE 4-6
DEVELOPMENT OF HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR VOLATILE ORGANIC COMPOUNDS IN SOIL AT THE PRESIDIO OF SAN FRANCISCO (INCLUDES VAPOR INTRUSION PATHWAY)

Presidio of San Francisco, California

Notes:

(a) Direct Contact Preliminary Remediation Goals ("PRGs") for volatile organic compounds ("VOCs") were calculated in Tables 4-3, 4-4, and 4-5 for residential, recreational, and commercial/industrial human health land use, respectively. The direct contact PRGs do not include potential risks due to vapor intrusion into indoor air.

(b) Carcinogenic Vapor Intrusion PRGs represent the soil concentration corresponding to a lifetime incremental cancer risk of 10^{-6} due to vapor intrusion of VOCs from soil into indoor air. Values obtained from Table E-1a from Volume II, of *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater ("RBSLs")*, Regional Water Quality Control Board, San Francisco Bay Region, Interim Final, December 2001. The value assumes coarse grained soils. Recreational populations are assumed to be outdoors; this pathway is assumed to be incomplete for recreational users.

(c) Combined carcinogenic and non-carcinogenic PRGs incorporating the Vapor Intrusion PRGs were calculated using the formula shown in the text. These values are carried forward for use in calculation of final human health PRGs in subsequent tables. Vapor intrusion of VOCs into indoor air is not anticipated for recreational land uses. Therefore, the recreational PRGs were not modified to account for vapor intrusion.

(d) Values for 1,2,4-trichlorobenzene were used as a surrogate for 1,2,3-trichlorobenzene.

(e) Non-carcinogenic Vapor Intrusion PRGs represent the soil concentration corresponding to a hazard index of 1 due to vapor intrusion of VOCs from soil into indoor air. Values obtained from Table E-1a from Volume II of the RBSLs. The value assumes coarse grained soils. RBSLs were not available for 2-butanone, carbon disulfide, 1,4-dichlorobenzene (non-carcinogenic), p-isopropyltoluene, trichloroflouromethane, and 1,2,4-trichlorobenzene (non-carcinogenic). Vapor Intrusion PRGs for these VOCs were calculated using the Johnson & Ettinger model (Version 2.3, March 2001), with the same exposure assumptions and soil parameters as used for the development of the RBSLs. Recreational populations are assumed to be outdoors; this pathway is assumed to be incomplete for recreational users.

TABLE 4-7
HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR VOLATILE ORGANIC COMPOUNDS IN SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Combined Carcinogenic PRGs (a)			Combined Non-carcinogenic PRGs (a)			Groundwater Protection PRGs for Surface Soil (b)		Proposed Human Health PRGs (c)		
	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Comm./Indust. (mg/kg)	Residential (mg/kg)	Recreational (mg/kg)	Comm./Indust. (mg/kg)
Acetone	-	-	-	43	13,000	140	0.24	0.24	0.24	0.24	0.24
2-butanone (MEK)	-	-	-	585	76,000	1,974	3.8	3.8	3.8	3.8	3.8
Carbon disulfide	-	-	-	253	13,000	672	200	200	200	200	200
1,4-dichlorobenzene	0.13	173	0.49	372	3,800	1,510	0.59	0.59	0.13	0.59	0.49
p-Isopropyltoluene (p-cymene)	-	-	-	483	13,000	842	133	133	133	133	133
Methylene Chloride	0.86	67	3.1	958	7,600	3,165	0.076	0.076	0.076	0.076	0.076
1,2,3-trichlorobenzene (d)	49	260	216	245	1,300	1,335	15	15	15	15	15
1,2,4-trichlorobenzene	49	260	216	245	1,300	1,335	15	15	15	15	15
Trichlorofluoromethane	-	-	-	40	38,000	116	80	80	40	80	80
1,1,1-trichloroethane	-	-	-	76	37,000	220	8.0	8.0	8.0	8.0	8.0

Notes:

(a) Combined carcinogenic and non-carcinogenic Preliminary Remediation Goals ("PRGs") for volatile organic compounds ("VOCs") are carried forward from Table 4-6. The PRGs for residential and commercial/industrial human health land use incorporate potential risks due to vapor intrusion into indoor air. Vapor intrusion of VOCs into indoor air is not anticipated for recreational uses.

(b) Groundwater Protection PRGs are soil cleanup levels based on protection of drinking water resources via the leaching pathway. Values were obtained from Tables A-1 and A-2 from Volume II of the *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater ("RBSLs")*, Regional Water Quality Control Board, San Francisco Bay Region, Interim Final, December 2001. The listed value is from the Groundwater Protection (soil leaching) column, assuming groundwater is a drinking water resource. Groundwater protection RBSLs were not available for carbon disulfide, p-isopropyltoluene, or trichlorofluoromethane; groundwater protection values were calculated for these compounds using formulas in the RBSL guidance. For these calculations, the common maximum contaminant level ("MCL") for trichlorofluoromethane and toluene (as a surrogate for p-isopropyltoluene) of 150 µg/L was used as the target groundwater concentration for both chemicals. The U.S. EPA tap water PRG (November 2000) was used as the target groundwater concentration for carbon disulfide (1,000 µg/L), as no target groundwater concentration is identified in Table 7-6. Because the Vapor Intrusion and Groundwater Protection PRGs are not site-specific, if VOCs are found at Presidio sites, VOC cleanup levels may be re-calculated to be site-specific. Such values would be calculated in conjunction with discussions with regulatory agencies.

(c) The proposed PRG is the more stringent (smallest) of the applicable values in each land use category. Although the RWQCB's RBSL document does not provide numbers for leaching to groundwater under a recreational land use scenario, the protection of groundwater resources in recreational areas is appropriate. Therefore, the Groundwater Protection PRGs are retained as the proposed PRGs for recreational land uses since these values are more stringent than the other human health values and are appropriate for protecting groundwater resources in recreational areas of the Presidio.

(d) Values for 1,2,4-trichlorobenzene were used as a surrogate for 1,2,3-trichlorobenzene.

TABLE 4-8
LEAD INTAKE SUMMARY FOR RESIDENTIAL, RECREATIONAL, AND COMMERCIAL/INDUSTRIAL USERS (a)

Presidio of San Francisco, California

Potentially Exposed Population	Exposure Frequency (days/week)	Exposure Media/Lead Concentration					Blood Lead (f) (µg/dl)
		Air (b) (µg/m^3)	Water (b) (µg/L)	Food Intake (c) (kg/day)	Background Soil (d) (mg/kg)	Presidio Soil (e) (mg/kg)	
Residential (child)	7 (Presidio)	0.028	2.4	1.9	0	**370**	10
Recreational (child)	7 (Background)	0.028	15	1.1	0	0	4.6
	4 (Background)	0	0	0	66	0	0.8
	3 (Presidio)	0	0	0	0	**500**	4.6
							10
Commercial/Industrial (adult)	5 (Presidio)	0.028	15	1.9	0	**3,500**	10

Notes:

(a) Lead concentration in blood calculated using California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") Lead Spread Version 7.0 (beta test version) computer model.

(b) Air, water and food intake concentrations are based on DTSC default factors, except for lead in residential tap water. A value of 2.4 ug/L is based on the 95% upper confidence limit of the average lead concentration measured in residential tap water at the Presidio in 1998, 1999, and 2000 (see data in Appendix A).

(c) Food intake is based on DTSC default factor. The lead concentration in food is assumed to be 3.1 µg/kg, which is also a DTSC default factor.

(d) Background concentrations of lead in soil at the Presidio are used for background in Lead Spread. A value of 66 mg/kg of lead corresponds to the background concentration in serpentinite, which is the maximum background concentration calculated by EKI for the four lithologies at the Presidio.

TABLE 4-8
LEAD INTAKE SUMMARY FOR RESIDENTIAL, RECREATIONAL, AND COMMERCIAL/INDUSTRIAL USERS (a)

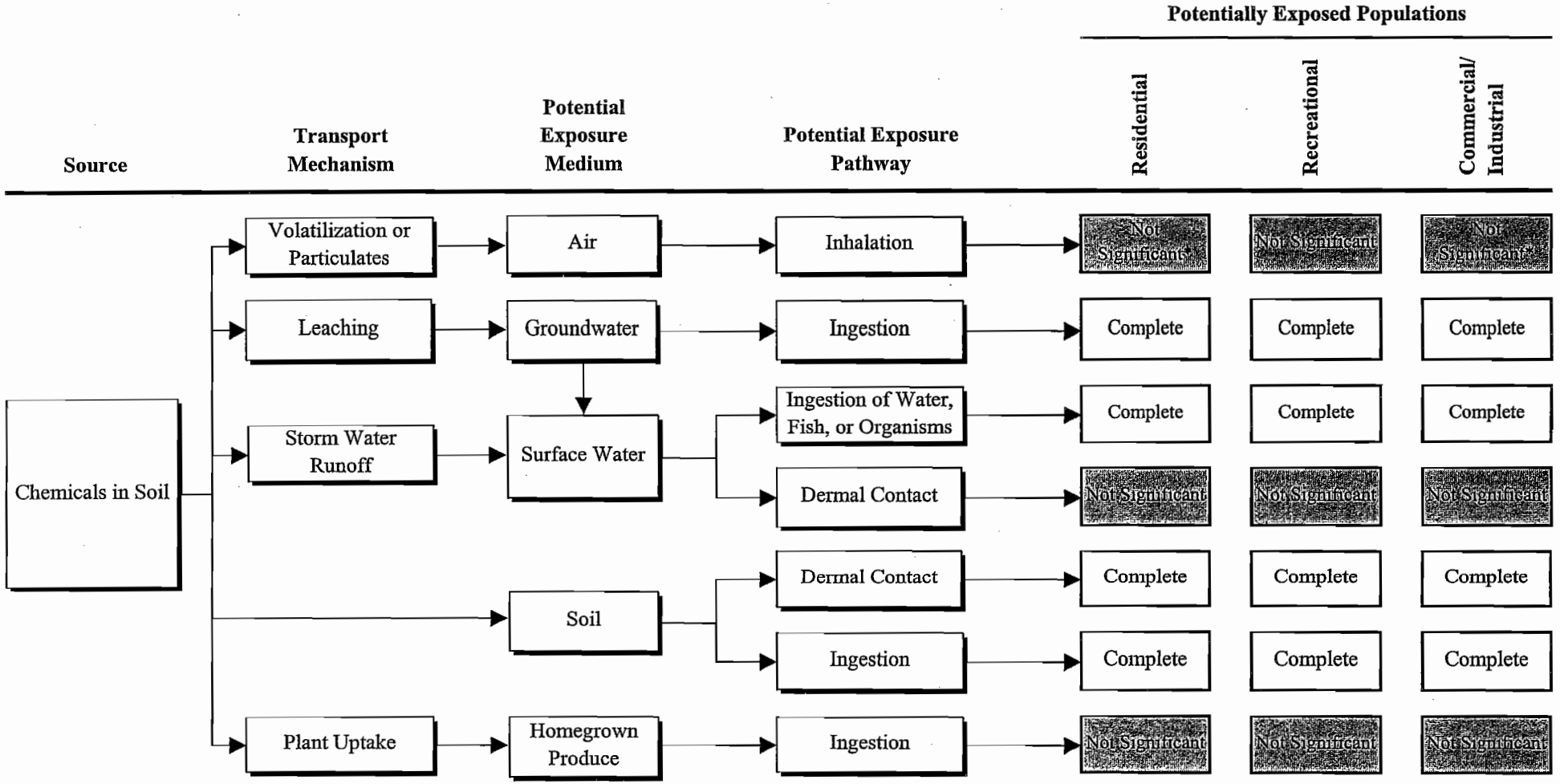
Presidio of San Francisco, California

Notes (continued):

(e) The concentration of lead in Presidio soil corresponds to the value that results in a cumulative blood lead concentration of 10 µg/dl. This value is the proposed cleanup level for the scenario indicated.

(f) See Appendix A for the computer spreadsheets in which blood lead concentration is calculated.

FIGURES



Legend

Complete — Pathway Complete or Potentially Complete. Pathway Has Been Quantitatively Evaluated.

Not Significant — Pathway Complete or Potentially Complete; Exposure is Not Considered Significant. Pathway Has Not Been Evaluated Quantitatively.

Not Complete — Pathway is Not Considered Complete.

*For volatile organic compounds, volatilization to indoor air is considered to be a complete pathway. For non-volatile compounds this pathway is not signficant.

Potential Human Health Exposure Pathways

Presidio of San Francisco, California

Erler & Kalinowski, Inc.

October 2002

Figure 4-1

5. ECOLOGICAL PRGS FOR SOIL AND SEDIMENT

5. ECOLOGICAL PRGS FOR SOIL AND SEDIMENT

Human health PRGs for PCOCs in soil were developed in Section 4. This section presents the development of ecological PRGs for PCOCs in soil and sediment. As discussed in Section 5.10, the Trust received comments from DTSC on the ecological PRGs for soil, as developed in Sections 5.1 through 5.8. These sections present the methodology used by the Trust to develop ecological PRGs for PCOCs other than lead. Section 5.10 presents the selection of the final ecological PRGs for soil based on DTSC's comments.

5.1 DERIVATION OF ECOLOGICAL PRGs FOR SOIL AND SEDIMENT

Derivation of ecological cleanup levels or performance of ecological risk assessments differ from their human health counterparts in that the objectives of ecological cleanup levels are site-specific. In contrast, the goals of human health cleanup levels are prescribed (i.e., reduce incremental carcinogenic risk to 10^{-6} to 10^{-4} and limit the non-carcinogenic HI below 1). The numerical values of human health cleanup levels change only as a result of varying activities that may be performed at a given site. Recognizing this important distinction between ecological and human health cleanup levels and risk assessments, U.S. EPA (1998b) states the following:

> The wide use and important advantages of ecological risk assessments do not mean they are the sole determinants of management decisions; risk managers consider many factors. Legal mandates and political, social, and economic considerations may lead risk managers to make decisions that are more or less protective. Reducing risk to the lowest level may be too expensive or not technically feasible. Thus, although ecological risk assessments provide critical information to risk managers, they are only part of the environmental-decision making process.

The resources to be protected and the objectives of ecological cleanup levels must be clearly established to ensure that remedial actions implemented at identified sites truly benefit the ecosystems found at the Presidio. For example, overly conservative ecological cleanup levels may cause greater harm than less stringent criteria if the cleanup levels result in remedial actions that destroy or substantially alter the habitats of the plants and wildlife that the cleanup levels are attempting to preserve. Ecological PRGs for soil and sediment at the Presidio have been derived independently of potential remedial actions to accomplish the following objectives:

- Maintain and permit enhancement of habitats as described in the *General Management Plan Amendment*, ("GMPA") (NPS, 1994), the *Vegetation Management Plan,* ("VMP") (NPS and Trust, 2001), and the *Presidio Trust*

Management Plan, Land Use Policies for Area B of the Presidio of San Francisco, ("PTMP") (Trust, 2002).

- Sustain populations of plants and soil fauna, wildlife, and aquatic life present at the Presidio.

- Protect individual plants and animals of rare, or threatened or endangered ("special status") species.

These objectives are consistent with the goals of remedial actions performed under Superfund. U.S. EPA (1999a) states the following regarding cleanup measures intended to protect the environment:

> Superfund remedial actions generally should not be designed to protect organisms on an individual basis (the exception being designated protected status resources, such as listed or candidate threatened and endangered species or treaty-protected species that could be exposed to site releases), but to protect local populations and communities of biota. Levels that are expected to protect local populations and communities can be estimated by extrapolating from effects on individuals and groups of individuals using a lines-of-evidence approach.

The Army conducted an ecological risk assessment as part of the RI (Dames & Moore, 1997b) and the results obtained were used to develop ecological PRGs for PCOCs in the FS (Dames & Moore, 1997a). Concerns expressed by regulatory agencies, organizations, and individuals regarding the manner in which the Army performed its ecological risk assessment caused the Trust to reexamine risks to ecological receptors and recalculate PRGs building upon the work completed by the Army.

Ms. Bridgette DeShields, formerly of Harding ESE and currently with Blasland, Bouck and Lee, Inc., was retained to review the Army's ecological risk assessment and to derive ecological PRGs for soil and sediment at the Presidio. The approach employed by Harding ESE to derive ecological PRGs paralleled the method used to derive PRGs in the Army's FS. For PCOCs other than lead, this method involved conducting the following two major steps:

(1) Develop toxicity benchmark values ("TBVs") that represent a range of potential adverse effects to indicator plant and wildlife species that may be exposed to PCOCs.

(2) Adopt these TBVs as acceptable concentrations or PRGs for PCOCs in soil and sediment, or use the TBVs in standard risk equations to calculate PRGs that are protective of indicator plant and wildlife species.

Multiple PRGs for PCOCs at Presidio sites were obtained because a range of TBVs was developed and more than one indicator species was considered. PRGs were further

assessed to obtain a single value for each PCOC to safeguard non-special status species and a single value for each PCOC to safeguard special status species. Non-special status species PRGs were selected to protect populations of ecological receptors, whereas special status species PRGs were chosen to protect individuals. PRGs for lead were evaluated differently because the widely varying toxicity values for lead do not lend themselves well to derivation of PRGs by the method used for other PCOCs. PRGs for lead were recalculated by use of the Monte Carlo method as was done by the Army.

Although PRGs were derived employing similar methods to those of the Army, the methods were revised to address comments made by DTSC, U.S. EPA and other regulatory agencies and organizations. Special status species were considered separately, toxicity values and exposure factors were updated to reflect more recent guidance and published literature, and errors in calculations performed by the Army were corrected. Procedures and assumptions used by Harding ESE to derive ecological PRGs for soil and sediment are discussed in Sections 5.2 through 5.9.

5.2 POTENTIALLY EXPOSED SPECIES

The Presidio has both higher quality habitat areas (e.g., native plant communities, forests, Mountain Lake, Lobos Creek, Crissy Field wetlands) and lower quality habitat areas (e.g., paved streets and parking lots or designed landscapes such as lawns and ornamental plantings). Generally, plants and animals requiring protection are associated with higher quality habitat areas. These higher quality habitat areas include both terrestrial and aquatic habitats.

5.2.1 Plants

The GMPA recognized the need for a plan to address vegetation at the Presidio. In response to this need, the Trust and NPS prepared the VMP, dated May 2001. The purpose of the VMP is to provide a management framework for protecting, enhancing, restoring, and rehabilitating native and planted vegetation at the Presidio. Members of the California Native Plant Society (Skinner and Pavlik, 1994), NPS (1995), and biologists retained by NPS (Jones & Stokes Associates, Inc., 1997) have identified the following twelve (12) native plant communities:

- Foredune
- Bluff scrub
- Coastal scrub
- Serpentine chaparral
- Live oak riparian forest
- Riparian scrub
- Dune scrub
- Coastal prairie
- Serpentine grassland
- Freshwater marsh and seep
- Arroyo willow riparian forest
- Live oak woodland

Table 5–1 summarizes special status plant species identified in the VMP as being present at the Presidio. Section 7.1.2 describes the Presidio sites where special status plant species have been observed or may be reintroduced under the VMP. Figure 7-3 identifies planned vegetation types at the Presidio, based on the VMP and PTMP.

5.2.2 Wildlife

A number of avian and mammalian species, as well as invertebrates, amphibians, and reptiles, utilize the higher quality habitat areas within the Presidio. Special status animal species considered by the Army in the RI were obtained from Jones & Stokes Associates, Inc. *Presidio of San Francisco Forest Management Plan*, dated 1994. Jones & Stokes Associates identified potential occurring special status animal species based upon the wildlife that are associated with varying types of habitats found at the Presidio. Table 5–2 summarizes special status animal species that may exist at the Presidio. Potential special status animal species are generally limited to birds.

5.2.3 Indicator Plant and Wildlife Species

Indicator species are routinely selected to conduct an ecological risk assessment. The reason for choosing a subset of potentially occurring species to determine risk at or PRGs for a site is to avoid repetition in the analysis that would make the ecological risk assessment or derivation of PRGs more difficult to perform and understand.

Indicator species are chosen to represent various ecological trophic levels (e.g., primary producer, primary consumer, and higher level consumer) to provide for complete food chain modeling. Species considered more likely to be exposed to site-related chemicals are selected over other species to represent receptors throughout the entire trophic levels. Availability of published exposure factors (e.g., body weight, surface area, dietary ingestion rate, soil ingestion rate) and toxicological information are also considered in determining indicator species. In some instances, more than one species is selected from a receptor group to adequately represent trophic levels. In the case of certain receptor groups, such as plants, soil invertebrates, aquatic plants and invertebrates, amphibians, and fish, indicator species are not identified; rather, an indicator group is selected. For example, aquatic life represents aquatic plants and invertebrates, amphibians, and fish.

5.2.3.1 Non-special Status Indicator Species

The following receptors were chosen as indicator species for non-special status species at the Presidio based on the criteria presented in Section 5.2.3, procedures followed by the Army in selecting its indicator species (Dames & Moore, 1997b), review of U.S. EPA (1992c, 1997a, 1998b) guidance, and discussions with regulatory agency staff:

- Terrestrial habitats:
  - ◊ Plants and soil fauna (e.g., soil invertebrates)
  - ◊ American robin (insectivorous bird)

- ◊ Mourning dove (herbivorous bird)
- ◊ Western harvest mouse (omnivorous mammal)
- ◊ Valley pocket gopher (herbivorous mammal)
- ◊ Raccoon (carnivorous mammal)
- ◊ Peregrine falcon (carnivorous bird that ingests birds)
- ◊ Red-tailed hawk (carnivorous bird that ingests mammals)

- Aquatic habitats:
  - ◊ Aquatic life (e.g., aquatic plants and invertebrates, amphibians, and fish)
  - ◊ Mallard duck (herbivorous, dabbling duck)
  - ◊ Western sandpiper (insectivorous, wading bird)

5.2.3.2 Special Status Indicator Species

The following receptors were chosen as indicator species for special status species at the Presidio:

- Terrestrial habitats:
  - ◊ Plants and soil fauna
  - ◊ Peregrine falcon
  - ◊ Red-tailed hawk
- Aquatic habitats:
  - ◊ Mallard duck
  - ◊ Western sandpiper

Potential ecological exposure pathways to PCOCs for both non-special status and special status species in terrestrial and aquatic habitats at Presidio sites are discussed in Section 5.3.

5.3 POTENTIAL ECOLOGICAL EXPOSURE PATHWAYS

Figures 5-1 and 5-2 illustrate the complete and potentially complete exposure pathways for each of the receptor types for terrestrial and aquatic habitats at the Presidio. Aquatic habitat includes both freshwater and marine (or estuarine) areas. Some complete or potentially complete pathways may be considered less significant due to: (1) low levels of contaminants, (2) low exposure frequency, or (3) low contribution to the overall risks in comparison to other pathways. According to U.S. EPA (1997a), complete or potentially complete exposure pathways should be evaluated quantitatively. Pathways considered less significant and that require more uncertain assumptions to be made do not warrant further evaluation.

5.3.1 Terrestrial Habitats

For plants and soil fauna (i.e., soil invertebrates), one or more complete exposure pathways are shown on Figure 5-1. Route-specific exposures shown on Figure 5-1 are not directly quantified for these species in an ecological risk assessment. Published TBVs for exposure of plants and soil fauna to PCOCs are expressed as concentrations, as opposed to doses, and generally encompass all potential exposure pathways. Therefore, exposures of plants and soil fauna to PCOCs are taken into account by use of published TBVs and not through the quantification of route-specific exposures.

For birds and mammals, pathways considered complete include ingestion of contaminated soil and food items, dermal contact with PCOCs, and inhalation of particulates and VOCs. Dermal contact and inhalation pathways are considered less significant than ingestion pathways. U.S. EPA (2000c) has examined the contributions that dermal contact of PCOCs, inhalation of particulates, and inhalation of VOCs make to chemical doses received by birds and mammals. Dermal contact and inhalation of particulate pathways have been found to contribute less than 1 percent (and often less than 0.001 percent) of the total dose. Similarly, U.S. EPA (2000c) has determined that inhalation of VOCs typically represents 1 percent of the total dose, but may contribute more under certain circumstances. Although VOCs are PCOCs at some Presidio sites, VOCs are infrequently detected at low concentrations that do not meet the conditions under which evaluation of this pathway is recommended (e.g., broadly distributed VOCs in soil and groundwater within areas where animals are burrowing). Consequently, inhalation of particulates and VOCs are not included in derivation of ecological PRGs for Presidio sites. Ecological PRGs consider ingestion of contaminated soil and food items, and dermal contact of PCOCs. The dermal contact pathway was retained, not because it is believed that this pathway contributes significantly to total dose, but due to the fact that this pathway was quantitatively evaluated in the risk assessment presented in the Army's RI (Dames & Moore, 1997b).

5.3.2 Aquatic Habitats

For aquatic life, one or more complete exposure pathways are shown on Figure 5-2. As is the case of plants and soil fauna, route-specific exposures shown on Figure 5-2 are not directly quantified for aquatic life in an ecological risk assessment; rather, risks are assessed through use of TBVs or sediment quality criteria. Exposures of wildlife to PCOCs in surface water are also not directly quantified. Aquatic life TBVs and sediment quality criteria are generally considered protective of wildlife exposures to PCOCs in surface water as well.

Ecological PRGs for birds and mammals were calculated by quantitatively evaluating ingestion of contaminated soil and food items, and dermal contact of PCOCs. Inhalation exposure pathways are not routinely assessed for aquatic habitats because VOCs do not generally bind to sediments and half-lives of these compounds are generally short in surface water. In addition, as discussed in Section 5.3.1, inhalation pathways generally do not significantly contribute to the overall risk.

5.4 ECOLOGICAL TARGET RISK LEVEL

Ecological PRGs developed for Presidio sites are intended to maintain and permit enhancement of habitats at the Presidio that will support local communities of biota. As such, the PRGs for non-special status species have been chosen to protect wildlife populations that may occur at the Presidio. While recognizing DTSC's (2000b) comment that studies of population dynamics have not been made, the objective to safeguard non-special status species populations, as opposed to individuals, is supported by U.S. EPA guidance (1999a).

Upon identifying TBVs that pose no significant risk to ecological receptors under consideration, the "safe" dose from all complete exposure pathways is the dose that results in a hazard quotient ("HQ") of unity (i.e., 1):

$$HQ = \frac{Dose}{TBV}$$

In contrast to ecological PRGs for non-special status species, ecological PRGs for special status species are intended to protect individual plants and animals of rare, or threatened or endangered species. The toxicity values for developing PRGs for both non-special status and special status species are discussed in Section 5.5.

5.5 ECOLOGICAL TOXICITY VALUES

For non-special status species, ecological PRGs for PCOCs other than lead have been derived through adoption of published TBVs and sediment quality guidelines, or calculation of risk-based concentrations that are judged to be protective of non-special status species. The ecological PRGs for lead for non-special status and special status species were derived using the Monte Carlo method, as explained in Section 5.9. Ecological PRGs for special status species were determined by evaluating reported no-observed-effects-concentrations ("NOECs") and TBV values for the indicator species and employing professional judgment to select those values that will reasonably safeguard special status species that have been observed or may exist at the Presidio.

TBVs were developed from toxicity values presented in the Army's RI, and the results of a recent literature search and the application of safety or uncertainty factors, where appropriate. The Army developed both low and high toxicity values because its review of scientific literature returned numerous toxicity values for each PCOC and indicator species evaluated.

The most conservative (i.e., lowest) value for a given chemical and indicator species was termed the TBV_{low}. TBV_{low} values are based on no-observed-adverse-effect-levels ("NOAELs") or NOEC if reported. Uncertainty factors were applied to toxicity data for

PCOCs for which NOAELs and NOECs were unavailable in an effort to estimate doses that pose no risk to individuals or populations. Exposure concentrations or doses at or below the TBV_{low} are considered to result in no significant adverse effects to the indicator species.

According to the Army, the TBV_{high} was developed to represent the upper bound of "acceptable or safe daily intakes". Where BTAG high toxicity values (PRC, 1997) were used, the TBV_{high} is considered a level of high concern to regulatory agencies and natural resource trustees. Because the TBV_{high} was often a lowest-observed-adverse-effect level ("LOAEL"), it is more correct to indicate that exposure doses below the TBV_{high} may be within the acceptable range. Exposure concentrations at or above the TBV_{high} may result in significant adverse effects on individuals or populations of ecological receptors.

The range of values between the TBV_{low} and the TBV_{high} is considered a "gray zone" where risks are possible but significant risks are unlikely. Toxicity values presented in the Army's RI were used to derive PRGs by the Trust with the following exceptions:

- Updated TBVs for plants, soil invertebrates, and aquatic life were obtained from the references consulted by the Army.
- A literature review was performed and more current TBVs were used for wildlife indicator species if warranted.
- Errors in the calculation of TBVs for wildlife, mostly due to transcription errors or misapplication of uncertainty factors, were corrected.
- Additional uncertainty factors were applied to TBVs based on studies of mortality endpoints that were used in the Army's RI.
- TBVs were developed for chemicals not considered in the Army's RI.

Summarized in Tables 5–3 and 5–4 are TBVs and uncertainty factors for chemicals not considered in the Army's RI. Revised TBV_{low} and TBV_{high} values for non-special status indicator species are listed in Table 5–5 for plants and Table 5–6 for wildlife.

5.5.1 Plants and Soil Fauna

The United States Department of Energy ("DOE") Oak Ridge National Laboratory ("ORNL") documents are the primary references consulted by both the Army and Trust for plant and invertebrate TBVs. The recommended benchmark values in the ORNL documents were used as the TBV_{low} values in the Army's RI. The lowest lowest-observed-effects-concentration ("LOEC") values in the ORNL documents were adopted as the TBV_{high} values in the Army's RI. The Trust reviewed current versions of the ORNL documents (Efroymson, 1997) and updated TBVs as appropriate. TBVs in Tables 5–5 and 5–6 that are boxed and shown in bold are updated values, or values for chemicals not considered in the Army's RI. Updated values do not vary greatly from the

original values. For example, TBV_{low} for cadmium increased from 3 to 4 mg/kg. The TBV_{low} of 5 mg/kg for chromium was chosen based on toxicity tests using different forms of chromium reported in the ORNL documents. Toxicity values for plants and invertebrates were unavailable for many PCOCs, including several chemicals not considered in the Army's RI. The majority of the chemicals without plant and invertebrate TBVs are VOCs, SVOCs, and pesticides. These chemicals are most often not highly toxic to plants. Although some VOCs, SVOCs, and pesticides have been shown to be toxic to invertebrates, risks from these chemicals are typically governed by wildlife receptors for which TBVs are generally available.

5.5.2 Wildlife

A variety of references were used to develop TBVs for wildlife species in the Army's RI including the following:

- Toxicity values listed in governmental computerized databases, such as the National Library of Medicine Toxicity Data Network ("TOXNET") and the National Institute for Occupational Safety and Health Registry of Toxic Effects of Chemical Substances ("RTECS").

- Laboratory toxicology studies for various chemicals reported by U.S. EPA and ORNL, or published in *Environmental Toxicology and Chemistry*.

- U.S. EPA's Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife: DDT, Mercury, 2,3,7,8 TCDD, and PCBs, dated 1995.

- Donker, M.H., H.E. van Capelleveen, and N.M. van Straalen. 1993. *Metal Contamination Affects Size-structure and Life-history Dynamics in Isopod Field Populations*. Ecotoxicology of Metals in Invertebrates.

- U.S. EPA Region IX Biological Technical Advisory Group ("BTAG") draft TBVs, which have since been formalized (PRC Environmental Management, 1997).

Extensive effort was put forth by the Army to gather toxicity information and to develop TBVs for wildlife. Updating TBVs for wildlife in the Army's RI involved comparing the values in the Army's RI to more recently published TBVs, correcting errors, and reevaluating the Army's values that were based upon mortality endpoints. Errors in the calculation of TBVs for wildlife, mostly due to transcription errors or misapplication of uncertainty factors, were minor and had little effect on TBV values used to calculate risk-based PRGs by the Trust. For example, using the correct uncertainty factors for the red-tailed hawk changed the TBV_{low} for mercury from 0.04 to 0.08 mg/kg-day. Uncertainty factors ("UFs") developed by the Army are shown in the table below. UFs were used to convert all toxicity endpoints to chronic NOAELs based on sensitive endpoints (e.g., growth, reproduction, development). TBV_{low} and TBV_{high} values that were based on mortality endpoints were divided by an additional uncertainty factor of 10.

TBV_{high} values derived by the Army for silver, thallium, chlordane, and gamma-BHC (i.e., lindane) were divided by this additional uncertainty factor.

Uncertainty Factors Used in the Calculation of TBV_{low} values (a)

Type of UF	UF	Comments
Study Duration	5	Converts acute to chronic
	2	Converts subchronic to chronic
Endpoint	2	Converts from less to more sensitive endpoint
	5	Converts LOAEL to NOAEL
	10	Converts LD50 to NOAEL (Army)
	10	Additional factor 10 for mortality endpoints (LD50s) was applied to both the TBV_{low} and TBV_{high} by the Trust
Intertaxon	3	Converts between species in same family, different genus
	4	Converts between species in same order, different families
	5	Converts between species in different orders
	10	Converts between species in different orders with an additional factor of 2 for special-status species (raptors)

(a) Uncertainty factors were those developed by the Army, except where noted.

TBV_{low} and TBV_{high} values were developed for chemicals not considered in the Army RI using similar methods, including application of uncertainty factors used in the Army's RI, as appropriate. Chemicals not considered in the Army's RI for which TBVs were derived consist of tetraethyl lead, 4-methylphenol, n-nitrosodiphenylamine, pentachlorophenol, phenol, acetone, 2-butanone, 1,4-dichlorobenzene, carbon disulfide, methylene chloride, 1,1,1-trichloroethane, toluene (which was used as a surrogate for p-isopropyltoluene), and methoxychlor. Additionally, mammalian data were added for heptachlor/heptachlor epoxide, which was not included in the Army's RI.

The Army also did not consider acenaphthene, acenapthylene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzofuran, benzo(k)fluoranthene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, phenanthrene, and pyrene, which are PAHs. Because only one set of toxicity values is available for PAHs, this same set was applied to each of these PAHs. Similarly, the TBV for endosulfan was used as a surrogate for endosulfan sulfate, the TBV for endrin was used

as a surrogate for endrin aldehyde and endrin ketone, the TBV for heptachlor was used as a surrogate for heptachlor epoxide, the TBV for beta-BHC was used as a surrogate for alpha- and delta-BHC, and the TBV for aldrin was used as a surrogate for isodrin because isodrin is an isomer of aldrin. Only studies on mortality endpoints were available to calculate TBV_{high} values for benzyl alcohol, aldrin, chlordane, gamma-BHC, heptachlor, heptachlor epoxide, isodrin, and methoxychlor. TBV_{high} values for these chemicals were divided by an additional uncertainty factor of 10, consistent with the revisions made to TBV_{high} values derived by the Army based upon mortality endpoints.

No published toxicity values were found for trichlorofluoromethane, 2,4-D, dicamba, and MCPP. Consequently, ecological PRGs for these PCOCs could not be calculated.

5.5.3 Aquatic Life

TBVs for aquatic life were developed for both freshwater and marine aquatic habitats. Aquatic life TBVs are based upon sediment quality guidelines. Potentially relevant sediment quality guidelines for freshwater sediments include the following:

- **Canadian Sediment Quality Guidelines**: The Canadian Council of Ministers of the Environment (1999) has issued interim sediment quality guidelines ("ISQGs") and probable effect levels ("PELs") for chemicals in sediment. These levels have been developed employing the approach that NOAA (1999) used to derive sediment criteria in its *Screening Quick Reference Tables*. Chemical concentrations in sediment below the LEL are unlikely to result in adverse effects, concentrations between the LEL and PEL may result in adverse effects, and concentrations above the PEL are likely to result in adverse effects.

- **Consensus-Based Threshold Effects Concentration ("TEC") and Probable Effects Concentration ("PEC"):** MacDonald et al. (2000) developed freshwater sediment quality guidelines for 28 chemicals. These guidelines reflect the toxicity of chemicals in sediment when they occur in mixtures with other chemicals and provide a basis for classifying sediment as potentially harmful. For each chemical considered by MacDonald et al., a TEC and PEC have been developed. Similar to the Canadian sediment quality guidelines, chemical concentrations in sediment below the TEC are unlikely to result in adverse effects, concentrations between the TEC and PEC may result in adverse effects, and concentrations above the PEC are likely to result in adverse effects.

- **U.S. EPA Sediment Quality Criteria ("SQC") and Sediment Quality Benchmarks ("SQB"):** U.S. EPA (1996a, 1995a) developed SQC and SQB values based on the equilibrium partitioning ("EqP") method. These values are considered protective of aquatic life.

Sediment quality guidelines for marine sediments include the following:

- **NOAA Effects Range Low (ER-L) and Effects-Range Median (ER-M):** NOAA (Long et al., 1995) developed effects-based screening benchmarks using data for chemical concentrations in coastal marine and estuarine environments collected throughout the United States annually. Concentrations observed or predicted from these studies associated with biological effects are ranked; the lower 10th percentile values are the ER-Ls and the median values are the ER-Ms.
- **U.S. EPA SQC and SQB**: (U.S. EPA (1996a, 1995a) developed SQC and SQB values based on the EqP method. These values are considered protective of aquatic life.

Sediment quality criteria or PRGs for aquatic life are summarized in Tables 5–7 and 5–8, respectively, for freshwater and marine habitats.

5.6 CALCULATION OF ECOLOGICAL PRGS FOR PCOCS OTHER THAN LEAD IN SOIL AND SEDIMENT

As discussed in Section 5.3, PRGs for plants, soil fauna, and aquatic life are not calculated. PRGs for these receptor groups are instead based upon published TBVs or sediment quality guidelines for the PCOCs under consideration that encompass all exposure pathways. To calculate wildlife PRGs for Presidio sites, standard risk equations were rearranged to solve for the concentration term. The general equation employed to calculate PRGs for protection of wildlife species at the Presidio is as follows:

$$PRG = \frac{\text{Target HQ of } 1 \times TBV \times BW}{Intake_{soil/sed\ ingestion} + Intake_{food\ ingestion} + Intake_{dermal}}$$

where:

HQ	=	Hazard quotient equal to 1
TBV	=	Toxicity benchmark value (mg/kg-day)
BW	=	Body weight (kg)
$Intake_i$	=	Intake (or dose) from pathway *i* (kg/day)

The intake from soil and sediment ("soil/sed") ingestion is equivalent to the total dietary ingestion rate multiplied by the fraction of soil and sediment in the diet:

$$Intake_{soil/sed\ ingestion} = DIR \times F_{soil/sed}$$

where:

DIR	=	Daily ingestion rate (kg/day)
$F_{soil/sed}$	=	Fraction of soil and sediment in diet (unitless)

The intake from food ingestion is the sum of the ingestion for each food item, which is estimated by multiplying the dietary ingestion rate by the fraction of the diet that consists of the particular food item and by the bioaccumulation factor of the food item:

$$Intake_{food\ ingestion} = \Sigma\ DIR \times F_i \times BAF_i$$

where:

F_i	=	Fraction of diet that consists of food item *i* (unitless)
BAF_i	=	Bioaccumulation factor for food item *i* (unitless)

Intake from dermal contact is expressed as follows:

$$Intake_{dermal} = SA \times AF \times ABS \times CF$$

where:

SA	=	Surface area of species (cm^2)
AF	=	Soil adherence factor (mg/cm^2)
ABS	=	Absorption factor (chemical-specific)
CF	=	Conversion factor (converts units from mg to kg)

The Army used the above general equations to create formulas for calculating PRGs for specific wildlife species. Formulas for terrestrial habitat indicator species (i.e., American robin, mourning dove, western harvest mouse, valley pocket gopher, raccoon, peregrine falcon, red-tailed hawk) and aquatic habitat indicator species (i.e., mallard duck, western sandpiper) are included in Appendix B of the Army's FS (Dames & Moore, 1997a). The formulas in Appendix B of the Army's FS were modified by the Trust to recalculate ecological PRGs for Presidio sites. Modifications to the formulas involved adjusting the ingestion of food items pathway to be consistent with the exposure pathways described in Section 5.3, and removing the area use factors ("AUFs"). The AUF is the ratio of the area of the site to the area of the home range of the species evaluated. AUFs were removed because the PRGs developed apply to all Presidio sites and do not correspond to the area of a specific site. Modified formulas used by the Trust to recalculate ecological PRGs for Presidio sites are listed in Table 5–9.

5.7 ECOLOGICAL EXPOSURE PARAMETERS

Table 5–10 summarizes the factors assumed for the exposure parameters in the formulas used to recalculate PRGs. Home ranges in Table 5–10 are presented for information only. Exposure factors are identical to those presented in the Army's FS except for adjustment to some dietary ingestion rates as noted below. When available, upper-bound (i.e., 95th percentile) values were used to be protective.

- **Body weight (BW):** 95th percentile values assumed by the Army were used. These values were compared to values in DTSC (2000a) Ecotox computerized database and were found to be comparable.

- **Surface area (SA):** 95th percentile values assumed by the Army were used.

- **Dietary ingestion rate (DIR):** 95th percentile values assumed by the Army were used except that values previously expressed on a wet weight basis (i.e., American robin, western harvest mouse, and red-tailed hawk) were converted to a dry weight basis. This conversion was necessary because all other exposure factors (e.g., fraction of soil in diet, BAF) are expressed on a dry weight basis. Dietary ingestion rates were converted using the equation $DIR_{dry} = DIR_{wet} \times (1 - \text{percent water content in food})$ and average moisture contents from Sample and Suter (1994).

Values assumed for dietary composition and bioaccumulation factors ("BAF") are discussed in Sections 5.7.1 and 5.7.2.

5.7.1 Dietary Composition

The formulas for recalculating PRGs for specific wildlife species are based upon the following dietary fractions:

- American robin: 100 percent of diet is invertebrates ($F_{inv} = 1$)

- Mourning dove: 100 percent of diet is plants ($F_{plant} = 1$)

- Western harvest mouse: 50 percent of diet is plants ($F_{plant} = 0.5$) and 50 percent is invertebrates ($F_{inv} = 0.5$)

- Valley pocket gopher: 100 percent of diet is plants ($F_{plant} = 1$)

- Raccoon: 50 percent of diet is invertebrates ($F_{inv} = 0.5$) and 50 percent is herbivorous birds ($F_{bird} = 0.5$)[7]

- Peregrine falcon: 50 percent of diet is herbivorous birds ($F_{bird1} = 0.5$) and 50 percent is insectivorous birds ($F_{bird2} = 0.5$)

- Red-tailed hawk: 50 percent of diet is herbivorous mammals ($F_{mam1} = 0.5$) and 50 percent is insectivorous mammals ($F_{mam2} = 0.5$)

[7] Although raccoons are more likely to ingest plant material and some small mammals, the use of the herbivorous bird BAF (BAF for plants times BAF for birds) is conservative and encompasses a similar magnitude of exposure.

- Mallard duck: 100 percent of diet is plants ($F_{plant} = 1$)
- Western sandpiper: 100 percent of diet is invertebrates ($F_{inv} = 1$).

5.7.2 Bioaccumulation Factors

Metals, PCBs, pesticides, and herbicides are recognized to be bioaccumulative. BAFs used by the Trust to recalculate ecological PRGs are summarized in Table 5–11. If available, BAFs for PCOCs were obtained from ORNL documents (Bechtel Jacobs Company L.L.C, 1998; Sample, et al., 1998a, 1998b). U.S. EPA generally accepts BAFs from ORNL for use in performing ecological risk assessments. ORNL BAFs for plants, soil invertebrates, and wildlife were available for most bioaccumulative PCOCs. If no BAFs from ORNL were available for PCOCs, BAFs included in the Army's RI were assumed instead. The BAF for lead was used as a surrogate for tetraethyl lead. The BAF for dieldrin was used as a surrogate for aldrin and isodrin. The BAF for heptachlor was used as a surrogate for heptachlor epoxide, and 4,4'-DDT was used as a surrogate for 4,4'-DDD and 4,4'-DDE. For pesticides and herbicides that do not have reported BAFs, assumptions were made for these values based on the magnitude of BAFs reported in literature for other pesticides and herbicides.

Plants do not bioaccumulate pesticides and herbicides to any significant extent. Therefore, the BAF was assumed to be zero for plants without pesticide and herbicide literature-reported values. Pesticide and herbicide BAFs were assumed to be 3 for invertebrates, 1 for birds, and 0.5 and 0.1 for omnivorous and herbivorous mammals based on the range of literature-reported values for chlordane, dieldrin, heptachlor, and 4,4'-DDT.

5.8 ECOLOGICAL PRGS FOR PCOCS OTHER THAN LEAD IN SOIL AND SEDIMENT

Ecological PRGs for PCOCs other than lead in soil and sediment for non-special status species and special status species are described in Sections 5.8.1 and 5.8.2. PRGs for lead in soil and sediment for non-special status species and special status species are described in Section 5.9.

5.8.1 Non-special Status Species PRGs

PRGs for soil based on TBV_{low} and TBV_{high} values are presented in Tables 5-12 and 5-13, respectively. Potential ecological PRGs for soil are compiled in Table 5-14. For each PCOC, Table 5-14 contain the PRG_{low} and PRG_{high} values for plants and soil fauna, and the lowest wildlife PRGs recalculated using the TBV_{low} from Table 5–5 and TBV_{high} from Table 5–6. The arithmetic means of the PRGs for plants and soil fauna, and the arithmetic mean PRGs for wildlife were computed for each PCOC. Selecting the lower of the arithmetic means of plants and soil fauna PRGs, and wildlife PRGs determined the soil PRG proposed to safeguard populations of non-special status species. The arithmetic

means are considered protective because they are computed from PRG_{low} and PRG_{high} values that are based on TBVs that span the range of no significant adverse effects to the upper bound of acceptable or safe daily intakes, as discussed in Section 5.5.

A similar approach to that used to develop ecological PRGs for soil was used to derive ecological PRGs for sediment. Sediment quality criteria were compared to risk-based PRGs calculated for the mallard duck and western sandpiper to determine whether sediment quality criteria or risk-based PRGs should be proposed as cleanup levels for PCOCs. Mallard duck and western sandpiper are considered representative species for both freshwater and marine aquatic areas onsite. Although mallard duck is more of a freshwater species, it is similar to diving ducks that may be present in marine aquatic areas (e.g., scoters, lesser scaup, etc.). Sediment quality criteria for aquatic life are presented in Tables 5–7 and 5–8. Potential PRGs for sediment calculated from the TBV_{low} and TBV_{high} values for the mallard duck and western sandpiper are summarized in Table 5-15. The PRGs for aquatic life, and the mallard duck, and western sandpiper were considered together to select potential sediment PRGs for each PCOC. The lowest values defining the range of PRGs developed for these indicator species (i.e., aquatic life, mallard duck, western sandpiper) of aquatic habitats are presented in Tables 5-16 and 5-17, respectively, for freshwater and marine habitats. The arithmetic mean of these lowest values was computed for each PCOC and is the proposed sediment PRG for protection of non-special status species.

5.8.2 Special Status Species PRGs

As described in Section 5.8.1, proposed PRGs in Tables 5-14, 5-16, and 5-17 are anticipated to be protective of populations of ecological receptors. However, these PRGs may not be protective of individual special status species, especially where the difference between the PRG_{low} and PRG_{high} values used to calculate the mean is great. For PCOCs where the difference between the TBV_{low} and TBV_{high} values for the species governing the level of cleanup is greater than one order of magnitude, a separate evaluation was conducted to develop alternate PRGs that are intended to safeguard special status species. For plants, special status species PRGs had to be developed for several metals. For raptors and shorebirds, which serve as wildlife indicator species for terrestrial and aquatic habitats, special status species PRGs had to be developed for several metals, as well as pesticides, and herbicides. The non-special status species PRGs for all other PCOCs and indicator species (i.e., aquatic life) are considered protective of special status species.

For plants, NOECs were compiled from the references consulted for non-special status plant species. However, the low and high values used to develop special status species PRGs encompassed the entire range of NOECs and excluded LOECs. The 5th, 10th, and 25th percentiles, and arithmetic means of the NOEC values were computed, as summarized in Table 5-18. The 25th percentile of NOECs for each metal is proposed as the alternate special status species PRG because this percentile includes NOECs obtained from studies on a variety of soil types and species, including species that are taxonomically similar to those at the Presidio.

The alternate special status species PRGs for raptors and shorebirds are established from the PRGs for the peregrine falcon and western sandpiper, respectively, because the PRGs for these birds are the lowest of the special status indicator species evaluated for terrestrial and aquatic habitats. PRG_{low} and PRG_{high} values were computed from TBVs compiled from the references consulted for non-special status wildlife species. The 5th, 10th, and 25th percentiles, and arithmetic means of the PRG_{low} and PRG_{high} values were calculated for each metal, pesticide, and herbicide that a special status species PRG needed to be derived. Tables 5-19 and 5-20 summarize these statistics and the toxicity endpoints of the studies on which the computed PRGs are founded. The following hierarchy was used to select the proposed PRG for special status raptors:

- The 5th percentile was used where the difference between PRG_{low} and PRG_{high} values for non-special status species is two orders of magnitude or greater.

- The 10th percentile was used where the difference between PRG_{low} and PRG_{high} values for non-special status species is between one and two orders of magnitude.

Except for 4,4'-DDT, no further adjustment was required to calculate special status PRGs because TBVs obtained from studies of mortality endpoints had previously been divided by an uncertainty factor of 10 to calculate PRGs for non-special status species. TBV_{low} and TBV_{high} values for 4,4'-DDT were adjusted based upon TBVs developed from studies on eggshell thinning.

Soil PRGs for special status plant (Table 5-18) and wildlife species (Table 5-19) were compared to soil PRGs proposed for non-special status plant and wildlife species (Table 5-14). This comparison is presented in Table 5-21. Special status species PRGs that are lower than non-special status PRGs are proposed as soil PRGs for special status species. Non-special status PRGs may be lower for some of the PCOCs evaluated because (1) the non-special status species evaluated may have higher exposure to chemicals than the special status species (e.g., American robin vs. peregrine falcon), or (2) the toxicity value for a non-special status species for a particular chemical is lower (e.g., mammal vs. bird toxicity values). For these PCOCs, no value is presented in Table 5-21 for the alternate PRG for special status species.

Similarly, sediment PRGs for special status wildlife species (Table 5-20) were compared to sediment PRGs proposed for non-special status aquatic life and wildlife species (Table 5-16). These comparisons are presented in Tables 5-22 and 5-23, respectively, for freshwater and marine habitats. Special status species PRGs that are lower than non-special status PRGs are proposed as sediment PRGs for special status species.

5.9 ECOLOGICAL PRGS FOR LEAD IN SOIL AND SEDIMENT

The Army evaluated separately the potential ecological risks of lead in Appendix U of the Army's RI. Available plant and wildlife toxicity information for lead varies up to five orders of magnitude. In fact, inserting U.S. EPA Region IX BTAG lead toxicity values

(PRC, 1997) in the formulas listed in Table 5–9 generates an ecological PRG that is considerably less than naturally occurring lead concentrations in Presidio soil based upon BTAG's low toxicity value, and generates an ecological PRG greater than 2,000 mg/kg based upon BTAG's high toxicity value. Therefore, establishing an ecological PRG for lead by computing the arithmetic mean of PRGs derived from TBV_{low} and TBV_{high} values may not be appropriate.

The Army used a probabilistic approach to derive a cleanup level for lead. The approach used is often termed the Monte Carlo method because of the type of computer modeling employed. The Monte Carlo method takes into account the variability of toxicity values and exposure factors. Instead of using single point estimates for TBVs and exposure factors (e.g., body weight, dietary ingestion rate), the entire distributions of values are input into a computer simulation model. The model randomly selects each of these distributions for values to be incorporated into the risk equations, thereby generating a distribution of acceptable concentrations or PRGs.

The Army performed the Monte Carlo method for plants and the American robin. Plants were selected because of the need to protect special status plant species at the Presidio. The American robin was chosen because the robin has some of the lowest PRGs of the wildlife indicator species evaluated. DTSC (2000b) provided comments to the Trust on the manner in which the Army performed the Monte Carlo method to derive PRGs for lead. In response to these comments, the Trust made the following modifications to the Monte Carlo method to recalculate ecological PRGs for lead in soil at the Presidio:

- For plants, only toxicity data for non-mortality endpoints (e.g., reduction in shoot or root growth) were used and the data were fitted to a distribution.

- For the American robin, exposure factors were revised, as discussed in Section 5.7, updated TBVs for lead from U.S. EPA Region IX BTAG were used (PRC, 1997), the gastrointestinal tract absorption of lead was changed from 10 to 26 percent, and a dermal absorption factor of 0.01 for lead was used, as suggested by DTSC (2000b).

- A total of 10,000 iterations was used in each Monte Carlo computer model simulation instead of 1,000 iterations used by the Army.

- The 50th percentile lead concentrations to safeguard plants and the American Robin were compared to determine the proposed PRG for lead in soil to protect non-special status species as opposed to the 90th percentile values used by the Army.

- The 25th percentile lead concentration to safeguard plants is proposed as the PRG for lead in soil to protect special status species.

Crystal Ball™ was used to perform the Monte Carlo method computer simulations. Copies of input parameters and Monte Carlo method output using Crystal Ball™ are included as Appendix B.

5.9.1 Non-special Status Species PRGs

The Monte Carlo method produced 50th percentile concentrations of 324 mg/kg of lead to protect plants and 297 mg/kg of lead to protect the American robin. Consequently, a PRG of 300 mg/kg for lead in soil is proposed for protection of both non-special status plant and animal species.

PRGs of 82 and 132 mg/kg for lead in sediment from freshwater and marine habitats, respectively, are proposed for protection of non-special status aquatic life and wildlife species. For freshwater habitats, this concentration is based upon the arithmetic mean of the lowest sediment quality value for aquatic life of 35.7 mg/kg and the highest sediment quality value of 128 mg/kg for lead (Table 5–7). For marine habitats, this concentration is based on the arithmetic mean of the lowest sediment quality value for aquatic life of 46.7 mg/kg and the highest sediment quality value of 218 mg/kg for lead (Table 5–8). The Monte Carlo method was not conducted for indicator wildlife species of aquatic habitats because the range of values of sediment quality value for lead varied by less than an order of magnitude and because of the fact that sediment quality value for aquatic life are generally considered protective of wildlife exposures to PCOCs in surface water as well.

5.9.2 Special Status Species PRGs

A PRG of 160 mg/kg for lead in soil is proposed for protection of both special status plant and animal species based upon the 25th percentile concentration of 157 mg/kg of lead to protect plants generated by the Monte Carlo method. The PRGs of 82 and 132 mg/kg for lead in sediment are believed to be protective of special status aquatic life and wildlife species as well as non-special status species.

5.10 DTSC REVIEW OF ECOLOGICAL PRGS FOR SOIL

The DTSC reviewed the ecological PRGs developed using the protocol described above and provided the Trust with written comments in October 2001 (DTSC, 2001) and verbal comments during the first few months of 2002. The DTSC was primarily concerned that (1) the special status species PRGs for soil developed by the Trust may not be fully protective of special status species and (2) when there was a large difference between the PRG_{low} and PRG_{high}, the arithmetic mean PRG may not be fully protective of non-special status species. Based on discussions with the DTSC, the Trust made the following changes to the ecological cleanup levels:

- The areas of the Presidio where non-special status species PRGs would be applied were renamed "buffer zone" areas because these areas are generally adjacent to

special status species areas and developed areas of the Presidio where ecological PRGs are not applicable (see Section 7.1.2 and Figure 7-2). Proposed soil PRGs for these buffer zone areas were redefined as the lowest value of (1) the special status species PRG identified in Table 5-21, (2) the arithmetic mean of the PRG_{low} and PRG_{high} for plant and soil fauna, (3) the arithmetic mean of the PRG_{low} and PRG_{high} wildlife PRGs, or (4) 5 mg/kg for pesticides or herbicides for which not enough toxicological data exists to calculate a PRG_{low} and PRG_{high} (i.e., 2,4-D, Dicamba, and MCPP).

- Special status species PRGs were redefined as the lower value of (1) the PRG_{low} for plant and soil fauna or (2) the PRG_{low} for wildlife, unless the PRG_{low} is less than the laboratory method detection limit as specified in the *Presidio-wide Quality Assurance Project Plan, Sampling and Analysis Plan* ("QAPP/SAP") (TTEMI, 2001). In such cases, the method detection limit was established as the special status species PRG. If no PRG could be calculated for pesticides or herbicides due to a lack of toxicological data (i.e., 2,4-D, Dicamba, and MCPP), the special status species PRG was established as the method detection limit. For mercury, the special status species PRG was established as two times the typical method detection limit.

These revised ecological PRGs are shown in Table 5-24, which summarizes the ecological PRGs for PCOCs in soil at the Presidio. These PRGs are incorporated into the selection of applicable cleanup levels at the Presidio, as described in Section 7.

TABLES

TABLE 5-1
SPECIAL STATUS PLANT SPECIES AT THE PRESIDIO OF SAN FRANCISCO (a)

Presidio of San Francisco, California

Common Name	Scientific Name	Basis for Special Status Listing
Coast rock cress	*Arabis blepharophylla*	List 4 Species: Plants of Limited Distribution (b)
Raven's manzanita	*Arctostaphylos hookeri* var. *ravenii*	Federal and California Endangered Species (c); (d); List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco spineflower	*Chorizanthe cuspidata* var. *cuspidata*	List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
Franciscan thistle	*Cirsium andrewsii*	Proposed List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
Presidio clarkia	*Clarkia franciscana*	Federal and California Endangered Species (c); (d); List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco wallflower	*Erysimum franciscanum*	List 4 Species: Plants of Limited Distribution (b)
Dune gilia	*Gilia capitata* ssp. *chamissonis*	Proposed List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco gum plant	*Grindelia hirsutula* var. *maritima*	List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
Marin dwarf flax	*Hesperolinon congestum*	Federal and California Threatened Species (c); (d); List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco lessingia	*Lessingia germanorum* var. *germanorum*	Federal and California Endangered Species (c); (d); List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco campion	*Silene verecunda* ssp. *verecunda*	List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
San Francisco owl's clover	*Tryphysaria floribunda*	List 1B Species: Rare, Threatened, or Endangered Species in California or Elsewhere (b)
California sea-blight	*Suaeda californica*	Federal and California Endangered Species (c)

TABLE 5-1
SPECIAL STATUS PLANT SPECIES AT THE PRESIDIO OF SAN FRANCISCO (a)

Presidio of San Francisco, California

Notes:

(a) Special status plant species identified at the Presidio of San Francisco are compiled from Department of Interior, National Park Service and Presidio Trust *Vegetation Management Plan and Environmental and Assessment Staff Report,* dated October 2000, finalized May 2001.

(b) Skinner, M.W. and B.M. Pavlik. 1994. *Inventory of Rare and Endangered Vascular Plants of California*. 5th Edition. California Native Plant Society.

(c) Title 50 of Code of Federal Regulations §17.12.

(d) California Department of Fish and Game. September 1995. *Endangered, Threatened, or Rare Plants of California*. Natural Heritage Division, Plant Conservation Program, Sacramento, California.

TABLE 5-2
POTENTIAL OCCURRING SPECIAL STATUS WILDLIFE SPECIES AT THE PRESIDIO OF SAN FRANCISCO (a)

Presidio of San Francisco, California

Common Name	Scientific Name	Basis for Special Status Listing
Double-crested cormorant	*Phalacrocorax auritus*	California Species of Concern (c)
Western snowy plover	*Charadrius alexandrius nivosus*	Federal Threatened Species (b); California Species of Concern (c)
Loggerhead shrike	*Lanius ludovicianus*	California Species of Concern (c)
Long-billed curlew	*Numenius americanus*	Federal and California Species of Concern (b); (c)
California gull	*Larus californicus*	California Species of Concern (c)
Saltmarsh common yellowthroat	*Geothylpos trichas sinuosa*	Federal and California Species of Concern (b); (c)
Elegant tern	*Sterna elegans*	California Species of Concern (c)
California least tern	*Sterna antillarum browni*	Federal and California Endangered Species (b); (c)
Vaux's swift	*Chaetura vauxi*	California Species of Concern (c)
California yellow warbler	*Dendroica petechia brewsteri*	California Species of Concern (c)
Willow flycatcher	*Empidonax trailli*	California Endangered Species (c)
White-tailed kite	*Elanus caeruleus*	California Fully Protected Species (c)
Bald eagle	*Haliaeetus leucocephalus*	Proposed Delisting from Federal Endangered Species Act (b); California Endangered and Fully Protected Species (c)
Northern harrier	*Circus cyaneus*	California Species of Concern (c)
Sharp-shinned hawk	*Accipiter striatus*	California Species of Concern (c)
Northern goshawk	*Accipiter gentilis*	California Species of Concern (c)

POTENTIAL OCCURRING SPECIAL STATUS WILDLIFE SPECIES AT THE PRESIDIO OF SAN FRANCISCO (a)

Presidio of San Francisco, California

Common Name	Scientific Name	Basis for Special Status Listing
Swainson's hawk	*Buteo swainsoni*	California Threatened Species (c)
Ferruginous hawk	*Buteo regalis*	Federal and California Species of Concern (b); (c)
Golden eagle	*Aquila chrysaetos*	California Fully Protected Species (c)
Prairie falcon	*Falco mexicanus*	California Species of Concern (c)
Cooper's hawk	*Accipiter cooperi*	California Species of Concern (c)
Merlin	*Falco columbarius*	California Species of Concern (c)
Peregrine falcon	*Falco peregrinus anatum*	Delisted from Federal Endangered Species Act (b); California Endangered Species (c)
Common loon	*Gavia inmer*	California Species of Concern (c)
American white pelican	*Pelecanus erythrorhynchos*	California Species of Concern (c)
California brown pelican	*Pelecanus occidentalis californicus*	Federal and California Endangered Species (b); (c)
Harlequin duck	*Histrionicus histrionicus*	California Species of Concern (c)
Osprey	*Pandion haliaetus*	California Species of Concern (c)
Marbled murrelet	*Brachyramphus marmoratus*	Federal Threatened Species (b); California Endangered Species (c)
Yuma myotis	*Myotis yumanensis*	Federal and California Species of Concern (b); (c)

Notes:

(a) Potential occurring special status animal species identified at the Presidio of San Francisco are compiled from Jones & Stokes Associates, Inc. *Draft Presidio of San Francisco Forest Management Plan*, dated 1994. Jones & Stokes Associates identified potential occurring special status animal species based upon the animals that are associated with varying types of habitats found at the Presidio.

(b) Title 50 of Code of Federal Regulations §1711-12

(c) California Fish and Game Code §§3511, 4700, 5050, and 3503.5.

TABLE 5-3
DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Potential Chemical of Concern	TBV-Low (mg/kg-day)	TBV-high (mg/kg-day)	Species	Study Endpoint UF	Study Duration UF	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Study Description	Reference	Comment
Inorganic Chemicals										
Beryllium	48.5	485	poultry	5	2	- (b)	485	Caused ricketts in poultry and other livestock at 0.5% of diet. Use 0.097 kg/kg-day from Wiseman (1987) to convert.	Friberg et al, 1979.	Study used in Army RI.
	21.3	42.5	rat	2	1	-	42.5	Mild weight loss, 2 year study. Estimated with 0.085 gm/gm-day (Groton, et al, 1991.)	WHO, 1999.	Long term study; clear endpoint; study used in Army RI.
Cyanide	68.7	-	rat	1	1	68.7	-	Chronic, gestation and lactation; reproduction, oral in diet.	Sample et al, 1996.	Used potassium cyanide.
Molybdenum	3.5	35.3	poultry	1	1	3.5	35.3	LOAEL reduced embryonic viability; 21 day study	Sample et al., 1996	Reproductive endpoint.
	0.26	2.6	mouse	1	1	0.26	2.6	LOAEL for reduced reproductive success; 3 generation study	Sample et al, 1996.	Long-term study.
Tetraethyl Lead	12	170	rat	1	1	12	170	NOAEL for mortality and growth.	Azar et al, 1973.	Study used in Army RI.
	1.13	11.3	quail	1	1	1.13	11.3	Egg hatching success.	Sample et al, 1996.	Long-term study.

DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Potential Chemical of Concern	TBV-Low (mg/kg-day)	TBV-high (mg/kg-day)	Species	Study Endpoint UF	Study Duration UF	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Study Description	Reference	Comment
Semi Volatile Oragnic Compounds										
Benzyl Alcohol	2	100	bird	10	5	-	100	LD_{50} study.	RTECS, 1996.	Study used in Army RI.
	20.8	1,040	rabbit	10	5	-	1,040	LD_{50} study.	RTECS, 1996.	Study used in Army RI.
4-methylphenol (p-Cresol)	219.2	-	mink	1	1	219.2	-	6 months, reproduction, oral in diet.	Sample et al, 1996.	Used o-cresol.
n-nitrosodiphenylamine	200	-	rat	1	1	200	-	100 week, systemic.	ATSDR, 1999.	
Pentachlorophenol	0.24	2.4	rat	1	1	-	-	Reduction in survival and growth during gestation.	Sample et al, 1996.	Study used in Army RI.
Phenol	30	-	rat	2	1	60	-	NOAEL, chronic, oral study demonstrating decreased fetal weight.	U.S. EPA, 2000.	
Volatile Organic Compounds										
Acetone	100	500	rat	1	1	100	500	90 day NOAEL & LOAEL; liver & kidney damage; oral intubation.	Sample et al, 1996.	Study used in Army RI.
2-butanone (MEK)	50	100	rat	1	1	50	-	NOAEL for methyl isobutyl ketone for body weight, food consumption, organ weight, histopathology, morbidity, clinical chemistry, hematology for 13 week study.	WHO, 1990.	Study used in Army RI.

TABLE 5-3
DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Potential Chemical of Concern	TBV-Low (mg/kg-day)	TBV-high (mg/kg-day)	Species	Study Endpoint UF	Study Duration UF	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Study Description	Reference	Comment
Volatile Organic Compounds (cont.)										
Carbon disulfide	11	110	rat	1	1	11	110	NOAEL for fetal toxicty/malformations; entire gesation period (22 days).	IRIS, 2001.	Calculated from oral dose.
1,4-dichlorobenzene	25	50	mouse, rat	1	1	25	50	NOEL, subchronic oral study, endpoints of body weight, survival, histopathology, hematology, organ weight range from 25-125 mg/kg bw/d.	CEPA, 1993.	Less extrapolation than using the inhalation study from Army RI.
Methylene Chloride	5.85	50	rat	1	1	5.85	50	Histological effects on liver.	Sample et al, 1996.	
Toluene (as a surrogate for p-isopropyltoluene)	26	260	mouse	1	1	26	260	LOAEL for reduced fetal weights; dosed during	Sample et al, 1996.	
1,1,1-trichloroethane	114	5,700	rabbit, rat, guinea pig	10	5	-	5,700	LD_{50} study.	CEPA, 1993.	Study used in Army RI.
PCBs, Pesticides, and Herbicides										
Aldrin	0.5	5	mallard duck	5	2	-	5	LOAEL for mortality in a 30-day study.	Hudson et al, 1984.	Study used in Army RI.
	0.2	1	rat	1	1	0.2	1	Reproduction, duration less than 1year, oral in diet.	Sample et al, 1996.	Study used in Army RI.
alpha-BHC	0.563	2.25	japanese quail	1	1	0.563	2.25	Chronic, 90-day, reproduction, oral in diet	Sample et al, 1996.	Used beta-BHC.

TABLE 5-3
DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Potential Chemical of Concern	TBV-Low (mg/kg-day)	TBV-high (mg/kg-day)	Species	Study Endpoint UF	Study Duration UF	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Study Description	Reference	Comment
PCBs, Pesticides, and Herbicides (cont.)										
alpha-BHC	4	20	rat	1	1	4	20	13 weeks; growth, blood chemistry, organ histology, oral in diet.	Sample et al, 1996.	Used beta-BHC.
beta-BHC	0.563	2.25	japanese quail	1	1	0.563	2.25	Chronic, 90-day, reproduction, oral in diet	Sample et al, 1996.	Study used in Army RI.
	4	20	rat	1	1	4	20	13 weeks (subchronic); growth, blood chemistry, organ histology, oral in diet.	Sample et al, 1996.	Study used in Army RI.
delta-BHC	0.563	2.25	japanese quail	1	1	0.563	2.25	Chronic, 90-day, reproduction, oral in diet.	Sample et al, 1996.	Used beta-BHC.
	4	20	rat	1	1	4	20	13 weeks; growth, blood chemistry, organ histology, oral in diet.	Sample et al, 1996.	Used beta-BHC.
Endosulfan / Endosulfan Sulfate	10	-	gray partridge	1	1	10	-	4 weeks, chronic; reproduction; oral in diet.	Sample et al, 1996.	Study used in Army RI.
	1.5	-	rat	1	1	1.5	-	30 days; reproduction, blood chemistry; oral intubation.	Sample et al, 1996.	Study used in Army RI.

TABLE 5-3
DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Potential Chemical of Concern	TBV-Low (mg/kg-day)	TBV-high (mg/kg-day)	Species	Study Endpoint UF	Study Duration UF	NOAEL (mg/kg-day)	LOAEL (mg/kg-day)	Study Description	Reference	Comment
PCBs, Pesticides, and Herbicides (cont.)										
Endrin / Endrin Aldehyde / Endrin Ketone	0.032	0.2	mallard duck	1	1	0.0315	0.189	NOAEL for reproductive effects in a 12 week study; dietary level 0.5 ppm. 3 ppm decreased embryo survival, and decreased male body weight by 4.5%; convert with 0.063 g/g -day from U.S. EPA (1993).	Roylance et al, 1985.	Long term study; relates to assessment endpoints; study used in Army RI.
	0.184	0.92	mouse	5	1	-	0.92	120 days, chronic; reproduction; oral in diet.	Sample et al, 1996.	Study used in Army RI.
Heptachlor / Heptachlor Epoxide	0.2	1	mink	5	1	-	1	181 days, chronic; reproduction; oral in diet.	Sample et al, 1996.	Mammal data.
Isodrin	0.5	5	mallard duck	5	2	-	5	LOAEL for mortality in a 30-day study.	Hudson et al., 1984	Used aldrin.
	0.2	1	rat	1	1	0.2	1	Reproduction, duration less than 1year, oral in diet.	Sample et al, 1996.	Used aldrin.
Methoxychlor	40	2,000	mallard duck, sharp tailed grouse, California quail	10	5	-	200	LD_{50} exceeded 2,000 mg/kg bw for all species.	Hudson et al., 1984	
	4	8	rat	1	1	4	8	11 month, chronic, reproduction; oral in diet.	Sample et al, 1996.	Study used in Army RI.

DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Notes:

(a) Abbreviations used in this table are as follows:

ATSDR	Agency for Toxic Substances and Disease Registry
CEPA	Canada Environmental Protection Agency
IRIS	Integrated Risk Information System
LOAEL	lowest-observed-adverse-effect-level
mg/kg-day	milligrams per kilogram body weight per day
NOAEL	no-observed-adverse-effect-level
ORNL	Oak Ridge National Laboratory
RI	Remedial Investigation
RTECS	Registry of Toxic Effects of Chemical Substances
TBV	toxicity benchmark value
UF	uncertainty factor
U.S. EPA	United States Environmental Protection Agency
WHO	World Health Organization

(b) Hyphen indicates information was not available.

(c) References listed in this table are as follows:

- Azar, A., H.J. Trochimowicz, and M.E. Maxfield. 1973. *Review of Lead Studies in Animals Carried Out at Haskell Laboratory - Two-Year Feeding Study and Response to Hemorrhage Study.* International Symposium. Environmental Health Aspects of Lead.
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- Hudson, R., R.K. Tucker, and M.A. Haegele. 1984. *Handbook of Toxicity of Pesticides to Wildlife (2nd ed.)*. United States Fish and Wildlife Service. Res. Publ. 153.
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- Sample, B.E., D.M. Opresko, and G.W. Suter I.I. June 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. Oak Ridge National Laboratory.

TABLE 5-3
DEVELOPMENT OF TOXICITY BENCHMARK VALUES FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION (a)

Presidio of San Francisco, California

Notes:

- United States Department of Health and Human Services. 1999. *Toxicological Profile for N-Nitrosodiphenylamine*. Agency for Toxic Substances and Disease Registry.
- U.S. EPA. 2000. Integrated Risk Information System Computerized Database. www.epa.gov/ngispgm3/iris/subst/.
- U.S. EPA. 1993. *Wildlife Exposure Factors Handbook, Volumes I and II*. Office of Research and Development. EPA/600/R-93/187 (a and b).
- Wiseman, J. 1987. *Feeding of Non-Ruminant Livestock*. Butterworths
- World Health Organization. 1999. *Beryllium; Environmental Health Criteria 106*. Geneva, Switzerland.

TABLE 5-4

UNCERTAINTY FACTORS USED FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION

Presidio of San Francisco, California

Potential Chemical of Concern	Toxicity Data (a)			Uncertainty Factors (Dimensionless); (a)								
	Species Data are Based	TBV_{low} (mg/kg-day)	TBV_{high} (mg/kg-day)	American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Inorganic Chemicals												
Beryllium	poultry	48.5	485	5	5	- (b)	-	-	10	5	5	5
	rat	21.3	42.5	-	-	3	4	5	-	-	-	-
Cyanide	rat	68.7	68.7	-	-	3	4	5	-	-	-	-
Molybdenum	poultry	3.5	35.3	5	5	10	5	5	5	-	-	-
	mouse	0.26	2.6	-	-	-	-	-	-	3	4	5
Tetraethyl Lead	rat	12	170	-	-	3	4	5	-	-	-	-
	quail	1.13	11.3	5	5	-	-	-	10	5	5	5
Semivolatile Organic Compounds												
Benzyl Alcohol	bird	2	100	5	5	-	-	-	10	5	5	5
	rabbit	20.8	1,040	-	-	5	5	5	-	-	-	-
4-methylphenol (p-Cresol)	mink	219.2	219.2	-	-	5	5	4	-	-	-	-
n-nitrosodiphenylamine	rat	200	200	-	-	3	4	5	-	-	-	-
Pentachlorophenol	rat	0.24	2.4	-	-	3	4	5	-	-	-	-
Phenol	rat	30	30	-	-	3	4	5	-	-	-	-
Volatile Organic Compounds												
Acetone	rat	100	500	-	-	3	4	5	-	-	-	-
2-butanone (MEK)	rat	50	100	-	-	3	4	5	-	-	-	-

TABLE 5-4
UNCERTAINTY FACTORS USED FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION

Presidio of San Francisco, California

Potential Chemical of Concern	Toxicity Data (a)			Uncertainty Factors (Dimensionless); (a)								
	Species Data are Based	TBV_{low} (mg/kg-day)	TBV_{high} (mg/kg-day)	American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Volatile Organic Compounds (cont.)												
1,4-dichlorobenzene	mouse, rat	25	50	-	-	3	4	5	-	-	-	-
Carbon disulfide	rat	11	110	-	-	3	4	5	-	-	-	-
Methylene Chloride	rat	5.85	50	-	-	3	4	5	-	-	-	-
Toluene (as a surrogate for p-isopropyltoluene)	mouse	26	260	-	-	3	4	5	-	-	-	-
1,1,1-trichlorothane	rabbit rat, guinea pig	114	5,700	-	-	3	4	5	-	-	-	-
PCBs, Pesticides, and Herbicides												
Aldrin	mallard duck	0.5	5	5	5	-	-	-	10	5	1	5
	rat	0.2	1	-	-	3	4	5	-	-	-	-
alpha-BHC	japanese quail	0.563	2.25	5	5	-	-	-	10	5	5	5
	rat	4	20	-	-	3	4	5	-	-	-	-
beta-BHC	japanese quail	0.563	2.25	5	5	-	-	-	10	5	5	5
	rat	4	20	-	-	3	4	5	-	-	-	-

TABLE 5-4
UNCERTAINTY FACTORS USED FOR CHEMICALS NOT INCLUDED IN ARMY REMEDIAL INVESTIGATION

Presidio of San Francisco, California

Potential Chemical of Concern	Toxicity Data (a)			Uncertainty Factors (Dimensionless); (a)								
	Species Data are Based	TBV_{low} (mg/kg-day)	TBV_{high} (mg/kg-day)	American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
PCBs, Pesticides, and Herbicides (cont.)												
delta-BHC	japanese quail	0.563	2.25	5	5	-	-	-	10	5	5	5
	rat	4	20	-	-	3	4	5	-	-	-	-
	rat	1.5	1.5	-	-	3	4	5	-	-	-	-
Endrin / Endrin Aldehyde / Endrin Ketone	mallard duck	0.032	0.2	5	5	-	-	-	10	5	1	5
	mouse	0.184	0.92	-	-	3	4	5	-	-	-	-
Heptachlor/Heptachlor Epoxide	mink	0.2	0.5	-	-	5	5	4	-	-	-	-
Isodrin	mallard duck	0.5	5	5	5	-	-	-	10	5	1	5
	rat	0.2	1	-	-	3	4	5	-	-	-	-
Methoxychlor	mallard duck, sharp tailed grouse, California quail	40	2,000	5	5	-	-	-	10	5	1	5
	rat	4	8	-	-	3	4	5	-	-	-	-

Notes:

(a) Toxicity values are obtained from studies described in Table 5-3; uncertainty factors are discussed in Section 5.5.

(b) Hyphen indicates information was not available.

TABLE 5-5
LOW TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{low} (mg/kg)	Wildlife TBV_{low} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Inorganic Chemicals										
Antimony	5	- (b)	-	0.59	0.45	0.36	-	-	-	-
Arsenic	10	2.8	2.8	1.27	0.95	0.76	1.4	2.8	14	2.8
Barium	500	19.4	19.4	11.9	8.9	7.12	9.7	19.4	19.4	19.4
Beryllium	**10**	**9.7**	**9.7**	**7.1**	**5.33**	**4.26**	**4.85**	**9.7**	**9.7**	**9.7**
Cadmium	**4**	0.08	0.08	0.06	0.06	0.06	0.04	0.08	0.4	0.08
Chromium	**5**	0.26	0.26	4	4	5	0.13	0.26	0.26	0.32
Cobalt	20	101	101	0.8	0.6	0.48	50.4	101	252	101
Copper	50	11.1	11.1	26.7	26.7	1.97	5.53	11.1	11.1	11.1
Cyanide	-	-	-	**22.9**	**17.2**	**13.7**	-	-	-	-
Lead (c)										
Tetraethyl Lead	-	**0.23**	**0.23**	**4**	**3**	**19.8**	**0.11**	**0.23**	**0.23**	**0.23**
Mercury	0.3	0.0	0.0	0.26	0.2	0.16	0.04	**0.1**	**0.1**	**0.1**
Molybdenum	-	**0.7**	**0.7**	**0.087**	**0.065**	**0.052**	**0.35**	**0.7**	**0.7**	**0.7**
Nickel	**30**	3.49	3.49	10.5	7.9	3	1.75	3.49	3.49	3.49
Selenium	1	0.13	0.13	0.04	0.03	0.02	0.07	0.13	0.13	0.13
Silver	2	**0.349**	**0.349**	21.7	16.3	13	**0.175**	**0.349**	**0.349**	**0.349**
Thallium	1	**0.009**	**0.009**	0.1	0.08	0.06	**0.005**	**0.009**	**0.009**	**0.009**
Vanadium	2	0.1	0.1	0.02	0.01	0.01	0.05	0.1	0.1	0.1
Zinc	50	7.56	7.56	56.7	42.5	34	3.78	7.56	37.8	7.56

TABLE 5-5

LOW TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{low} (mg/kg)	Wildlife TBV_{low} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Semivolatile Organic Compounds										
Acenaphthene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Acenaphthylene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Anthracene	30	-	-	0.33	0.25	0.2	-	-	-	-
Benzo(a)anthracene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Benzo(a)pyrene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Benzo(b)fluoranthene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Benzo(g,h,i)perylene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Benzo(k)fluoranthene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Benzyl Alcohol	-	**0.04**	**0.04**	**0.416**	**0.416**	**0.416**	**0.02**	**0.04**	**0.04**	**0.04**
Chrysene	30	-	-	0.33	0.25	0.2	-	-	-	-
Dibenzo(a,h)anthrancene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-	-
Fluoranthene	30	-	-	0.33	0.25	0.2	-	-	-	-
Fluorene	30	-	-	0.33	0.25	0.2	-	-	-	-
Ideno(1,2,3-cd)pyrene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
2-methylnaphthalene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
4-methylphenol (p-Cresol)	**50**	-	-	**43.8**	**43.8**	**54.8**	-	-	-	-
Naphthalene	30	-	-	0.33	0.25	0.2	-	-	-	-
n-nitrosodiphenylamine	**20**	-	-	**66.7**	**50**	**40**	-	-	-	-
Pentachlorophenol	**3**	-	-	**0.08**	**0.06**	**0.05**	-	-	-	-
Phenanthrene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-
Phenol	**30**	-	-	**10**	**7.5**	**6**	-	-	-	-
Pyrene	**30**	-	-	**0.33**	**0.25**	**0.20**	-	-	-	-

TABLE 5-5
LOW TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{low} (mg/kg)	Wildlife TBV_{low} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Volatile Organic Compounds										
Acetone	-	-	-	**33.3**	**25**	**20**	-	-	-	-
2-Butanone (MEK)	-	-	-	**16.7**	**12.5**	**10**	-	-	-	-
Carbon disulfide	-	-	-	**3.67**	**2.75**	**2.20**	-	-	-	-
1,4-dichlorobenzene	**20**	-	-	**8.33**	**6.25**	**5**	-	-	-	-
p-isopropyltoluene (p-cymene) (d)	**200**	-	-	**8.7**	**6.5**	**5.20**	-	-	-	-
Methylene Chloride	-	-	-	**1.67**	**1.25**	**1.00**	-	-	-	-
1,2,3-trichlorobenzene	**20**	-	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	**20**	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	**38**	**28.5**	**22.8**	-	-	-	-
PCBs, Pesticides, and Herbicides										
PCBs (Aroclor 1254)	40	0.04	0.04	0.11	0.09	0.07	0.02	0.04	0.04	0.04
Aldrin	-	**0.01**	**0.01**	**0.07**	**0.05**	**0.04**	**0.005**	**0.01**	**0.05**	**0.01**
alpha-BHC	-	**0.113**	**0.113**	**1.33**	**1**	**0.8**	**0.0563**	**0.113**	**0.113**	**0.113**
beta-BHC	-	**0.113**	**0.113**	**1.33**	**1**	**0.8**	**0.0563**	**0.113**	**0.113**	**0.113**
delta-BHC	-	**0.113**	**0.113**	**1.33**	**1**	**0.8**	**0.0563**	**0.113**	**0.113**	**0.113**
Chlordane	-	**0.027**	**0.021**	0.24	0.24	0.24	**0.011**	**0.021**	**0.021**	**0.021**
2,4-D	-	-	-	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-	-	-
4,4'-DDD	40	0.06	0.06	2.83	2.13	1.7	0.04	0.1	0.06	0.06
4,4'-DDE	40	0.12	0.12	2.83	2.13	1.7	0.06	0.12	0.12	0.12
4,4'-DDT	40	0.01	0.01	2.83	2.13	1.7	**0.04**	**0.1**	**0.06**	**0.06**
Dieldrin	50	0.1	0.1	0.09	0.07	0.01	0.05	0.1	0.1	0.1
Endosulfan	-	**2**	**2**	**0.5**	**0.375**	**0.3**	**1**	**2**	**2**	**2**
Endosulfan Sulfate (e)	-	**2**	**2**	**0.5**	**0.375**	**0.3**	**1**	**2**	**2**	**2**

LOW TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{low} (mg/kg)	Wildlife TBV_{low} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
PCBs, Pesticides, and Herbicides (cont.)										
Endrin	-	**0.0064**	**0.0064**	**0.06**	**0.046**	**0.0368**	**0.0032**	**0.0064**	**0.032**	**0.0064**
Endrin Aldehyde (e)	-	**0.0064**	**0.0064**	**0.06**	**0.046**	**0.0368**	**0.0032**	**0.0064**	**0.032**	**0.0064**
Endrin Ketone (e)	-	**0.0064**	**0.0064**	**0.06**	**0.046**	**0.0368**	**0.0032**	**0.0064**	**0.032**	**0.0064**
gamma-BHC (Lindane)	-	**0.019**	**0.019**	**2.7**	**2.0**	**1.6**	**0.01**	**0.019**	**0.019**	**0.019**
Heptachlor	-	**0.019**	**0.019**	**0.04**	**0.04**	**0.05**	**0.01**	**0.019**	**0.019**	**0.019**
Heptachlor Epoxide	-	**0.019**	**0.019**	**0.04**	**0.04**	**0.05**	**0.01**	**0.019**	**0.019**	**0.019**
Isodrin (f)	-	**0.01**	**0.01**	**0.067**	**0.05**	**0.04**	**0.005**	**0.01**	**0.05**	**0.01**
MCPP	-	-	-	-	-	-	-	-	-	-
Methoxychlor	-	**0.8**	**0.8**	**1.33**	**1**	**0.8**	**0.4**	**0.8**	**4**	**0.8**

Notes:

(a) Toxicity values that are boxed and shown in bold have been updated and differ from those assumed by the Army in Dames & Moore, *Final Feasibility Study Report, Presidio Main Installation*, dated May 1997. Updated values have been obtained from United States Department of Energy Oak Ridge National Laboratory documents prepared by R.A. Efroymson, M.E. Will, G.W. Suter II, and A.C. Wooten entitled T*oxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants, 1997 Revision*, dated November 1997. Low toxicity values incorporate uncertainty factors, as discussed in Section 5.5.

(b) Hyphen indicates information was not available.

(c) United States Environmental Protection Agency Region IX Biological Technical Advisory Group toxicity benchmark values for lead vary up to five orders of magnitude. As described in the text, the Preliminary Remediation Goals for lead in soil were developed by use of the Monte Carlo method.

(d) Values for toluene were used for isopropyltoluene.

(e) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(f) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-6
HIGH TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{high} (mg/kg)	Wildlife TBV_{high} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Inorganic Chemicals										
Antimony	5	- (b)	-	1.78	1.78	1.78	-	-	-	-
Arsenic	224	42	42	22.5	22.5	22.5	42	42	42	42
Barium	500	194	194	71.2	71.2	71.2	194	194	194	194
Beryllium	**10**	**485**	**485**	**42.5**	**42.5**	**42.5**	**485**	**485**	**485**	**485**
Cadmium	100	2	2	24.3	24.3	24.3	2	2	2	2
Chromium	200	2.56	2.56	40	40	40	2.56	2.56	2.56	2.56
Cobalt	75	2,520	2,520	12	12	12	2,520	2,520	2,520	2,520
Copper	400	72.7	72.7	40	40	13	72.7	72.7	72.7	72.7
Cyanide	-	-	-	**68.7**	**68.7**	**68.7**	-	-	-	-
Lead (c)										
Tetraethyl Lead	-	**11.3**	**11.3**	**170**	**170**	**170**	**11.3**	**11.3**	**11.3**	**11.3**
Mercury	10	12.5	12.5	3.9	3.9	3.9	12.5	12.5	12.5	12.5
Molybdenum	-	**35.3**	**35.3**	**2.6**	**2.6**	**2.6**	**35.3**	**35.3**	**35.3**	**35.3**
Nickel	500	87.3	87.3	158	158	158	87.3	87.3	87.3	87.3
Selenium	70	1.32	1.32	0.57	0.57	0.57	1.32	1.32	1.32	1.32
Silver	2	**8.73**	**8.73**	130	130	130	**8.73**	**8.73**	**8.73**	**8.73**
Thallium	1	**2.37**	**2.37**	3	3	3	**2.37**	**2.37**	**2.37**	**2.37**
Vanadium	20	0.485	0.485	20	20	20	0.485	0.485	0.485	0.485
Zinc	864	189	189	340	340	340	189	189	189	189

TABLE 5-6
HIGH TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{high} (mg/kg)	Wildlife TBV_{high} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Semivolatile Organic Compounds										
Acenaphthene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Acenaphthylene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Anthracene	50	-	-	10	10	10	-	-	-	-
Benzo(a)anthracene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Benzo(a)pyrene	50	-	-	10	10	10	-	-	-	-
Benzo(b)fluoranthene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Benzo(g,h,i)perylene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Benzo(k)fluoranthene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Benzyl Alcohol	-	**10**	**10**	**104**	**104**	**104**	**10**	**10**	**10**	**10**
Chrysene	50	-	-	10	10	10	-	-	-	-
Dibenzo(a,h)anthrancene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-	-
Fluoranthene	50	-	-	10	10	10	-	-	-	-
Fluorene	50	-	-	10	10	10	-	-	-	-
Indeno(1,2,3-cd)pyrene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
2-methylnaphthalene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
4-methylphenol (p-Cresol)	**50**	-	-	**219**	**219**	**219**	-	-	-	-
Naphthalene	50	-	-	10	10	10	-	-	-	-
n-nitrosodiphenylamine	**109**	-	-	**200**	**200**	**200**	-	-	-	-
Pentachlorophenol	**4**	-	-	**2.4**	**2.4**	**2.4**	-	-	-	-
Phenanthrene	**50**	-	-	**10**	**10**	**10**	-	-	-	-
Phenol	**188**	-	-	**30**	**30**	**30**	-	-	-	-
Pyrene	**50**	-	-	**10**	**10**	**10**	-	-	-	-

TABLE 5-6
HIGH TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{high} (mg/kg)	Wildlife TBV_{high} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
Volatile Organic Compounds										
Acetone	-	-	-	**500**	**500**	**500**	-	-	-	-
2-Butanone (MEK)	-	-	-	**100**	**100**	**100**	-	-	-	-
Carbon disulfide	-	-	-	**110**	**110**	**110**	-	-	-	-
1,4-dichlorobenzene	**128**	-	-	**50**	**50**	**50**	-	-	-	-
p-isopropyltoluene (p-cymene) (d)	**1,000**	-	-	**87**	**65**	**52**	-	-	-	-
Methylene Chloride	-	-	-	**125**	**125**	**125**	-	-	-	-
1,2,3-trichlorobenzene	**115**	-	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	**127**	-	-	-	-	-	-	-	-	-
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	**5,700**	**5,700**	**5,700**	-	-	-	-
PCBs, Pesticides, and Herbicides										
PCBs (Aroclor 1254)	240	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.8	1.8
Aldrin	-	**0.5**	**0.5**	**1**	**1**	**1**	**0.5**	**0.5**	**0.5**	**0.5**
alpha-BHC	-	**20**	**20**	**2.25**	**2.25**	**2.25**	**20**	**20**	**20**	**20**
beta-BHC	-	**20**	**20**	**2.25**	**2.25**	**2.25**	**20**	**20**	**20**	**20**
delta-BHC	-	**20**	**20**	**2.25**	**2.25**	**2.25**	**20**	**20**	**20**	**20**
Chlordane	-	**0.213**	**0.213**	10.4	10.4	10.4	**0.213**	**0.213**	**0.213**	**0.213**
2,4-D	-	-	-	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-	-	-
4,4'-DDD	200	3	3	43	43	43	**3**	3	3	3
4,4'-DDE	200	3	3	43	43	43	3	3	3	3
4,4'-DDT	200	3	3	43	43	43	**3**	3	3	3
Dieldrin	100	1.25	1.25	0.31	0.31	2.6	1.25	1.25	1.25	1.25
Endosulfan	-	**10**	**10**	**1.5**	**1.5**	**1.5**	**10**	**10**	**10**	**10**
Endosulfan Sulfate (e)	-	**10**	**10**	**1.5**	**1.5**	**1.5**	**10**	**10**	**10**	**10**

TABLE 5-6

HIGH TOXICITY BENCHMARK VALUES FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna TBV_{high} (mg/kg)	Wildlife TBV_{high} (mg/kg-day); (a)								
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Mallard Duck	Western Sandpiper
PCBs, Pesticides, and Herbicides (cont.)										
Endrin	-	**0.92**	**0.92**	**2**	**2**	**2**	**0.92**	**0.92**	**0.92**	**0.92**
Endrin Aldehyde (e)	-	**0.92**	**0.92**	**2**	**2**	**2**	**0.92**	**0.92**	**0.92**	**0.92**
Endrin Ketone (e)	-	**0.92**	**0.92**	**2**	**2**	**2**	**0.92**	**0.92**	**0.92**	**0.92**
gamma-BHC (Lindane)	-	**3**	**3**	**8**	**8**	**8**	**3**	**3**	**3**	**3**
Heptachlor	-	**208**	**208**	**1**	**1**	**1**	**208**	**208**	**208**	**208**
Heptachlor Epoxide	-	**208**	**208**	**1**	**1**	**1**	**208**	**208**	**208**	**208**
Isodrin (f)	-	**0.5**	**0.5**	**1**	**1**	**1**	**0.5**	**0.5**	**0.5**	**0.5**
MCPP	-	-	-	-	-	-	-	-	-	-
Methoxychlor	-	**200**	**200**	**8**	**8**	**8**	**200**	**200**	**200**	**200**

Notes:

(a) Toxicity values that are boxed and shown in bold have been updated and differ from those assumed by the Army in Dames & Moore, *Final Feasibility Report, Presidio Main Installation*, dated May 1997. Updated values have been obtained from United States Department of Energy Oak Ridge National Laboratory documents prepared by R.A. Efroymson, M.E. Will, G.W. Suter II, and A.C. Wooten entitled T*oxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants, 1997 Revision*, dated November 1997.
With the exception of the factor of 10 used for toxicity values based on mortality endpoints, high toxicity values do not incorporate the use of uncertainty factors (see Section 5.5).

(b) Hyphen indicates information was not available.

(c) United States Environmental Protection Agency Region IX Biological Technical Advisory Group toxicity benchmark values vary up to five orders of magnitude. As described in the text, the Preliminary Remediation Goals for lead in soil were developed by use of the Monte Carlo method.

(d) Values for toluene were used for isopropyltoluene.

(e) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(f) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-7
SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)							
	CCME ISQG (a)	CCME PEL (a)	Consensus Based TEC (b)	Consensus Based PEC (b)	U.S. EPA SQC (c)	U.S. EPA SQB (c)	Lowest Criterion	Highest Criterion
Inorganic Chemicals								
Antimony	- (d)	-	-	-	-	-	-	-
Arsenic	5.9	17	9.79	33	-	-	5.9	33
Barium	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-
Cadmium	0.6	3.5	0.99	4.98	-	-	0.6	4.98
Chromium	37.3	90	43.4	111	-	-	37.3	111
Cobalt	50 (e)	-	-	-	-	-	50	50
Copper	35.7	197	31.6	149	-	-	31.6	197
Cyanide	0.0001 (e)	-	-	-	-	-	0.0001	0.0001
Lead	35.7	91.3	35.8	128	-	-	35.7	128
Tetraethyl Lead	-	-	-	-	-	-	-	-
Mercury	0.17	0.486	0.18	1.06	-	-	0.17	1.06
Molybdenum	-	-	-	-	-	-	-	-
Nickel	16 (e)	75 (e)	22.7	48.6	-	-	16	75
Selenium	-	-	-	-	-	-	-	-
Silver	0.5 (e)	-	-	-	-	-	0.5	0.5
Thallium	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-
Zinc	123	315	121	459	-	-	121	459

TABLE 5-7

SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)							
	CCME ISQG (a)	CCME PEL (a)	Consensus Based TEC (b)	Consensus Based PEC (b)	U.S. EPA SQC (c)	U.S. EPA SQB (c)	Lowest Criterion	Highest Criterion
Semivolatile Organic Compounds								
Acenaphthene	0.00671	0.0889	-	-	0.62	-	0.00671	0.62
Acenaphthylene	0.00587	0.128	-	-	-	-	0.00587	0.128
Anthracene	0.0469	0.245	0.0572	0.845	-	-	0.0469	0.845
Benzo(a)anthracene	0.0317	0.385	0.108	1.05	-	-	0.0317	1.05
Benzo(a)pyrene	0.0319	0.782	0.15	1.45	-	-	0.0319	1.45
Benzo(b)fluoranthene	0.24 (e,f)	1.34 (e,f)	-	-	-	-	0.24	1.34
Benzo(g,h,i)perylene	0.17 (e)	0.32 (e)	-	-	-	-	0.17	0.32
Benzo(k)fluoranthene	0.24 (f)	1.34 (f)	-	-	-	-	0.24	1.34
Benzyl Alcohol	-	-	-	-	-	-	-	-
Chrysene	0.0571	0.862	0.166	1.29	-	-	0.0571	1.29
Dibenzo(a,h)anthrancene	0.00622	0.135	0.033	-	-	-	0.00622	0.135
Dibenzofuran	-	-	-	-	-	2	2	2
Fluoranthene	0.111	2.355	0.423	2.23	2.9	-	0.111	2.9
Fluorene	0.0212	0.144	0.0774	0.536	-	0.54	0.0212	0.54
Indeno(1,2,3-cd)pyrene	0.2	0.32	-	-	-	-	0.2	0.32
2-methylnaphthalene	0.0202	0.201	-	-	-	-	0.0202	0.201
4-methylphenol (p-Cresol)	-	-	-	-	-	-	-	-
Naphthalene	0.0346	0.391	0.176	0.561	-	0.48	0.0346	0.561
n-nitrosodiphenylamine	-	-	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-	-	-
Phenanthrene	0.0419	0.515	0.204	1.17	0.85	-	0.0419	1.17
Phenol	-	-	-	-	-	-	-	-
Pyrene	0.053	0.875	0.195	1.52	-	-	0.053	1.52

TABLE 5-7
SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)							
	CCME ISQG (a)	CCME PEL (a)	Consensus Based TEC (b)	Consensus Based PEC (b)	U.S. EPA SQC (c)	U.S. EPA SQB (c)	Lowest Criterion	Highest Criterion
Volatile Organic Compounds								
Acetone	-	-	-	-	-	-	-	-
2-Butanone (MEK)	-	-	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-	-	-
p-isopropyltoluene (p-cymene)	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	-	-	-	-	-	0.35	0.35	0.35
Methylene Chloride	-	-	-	-	-	-	-	-
1,2,3-trichlorobenzene	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	-	-	-	-	-	-	-	-
Trichlorofluormethane	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	-	-	0.17	0.17	0.17
PCBs, Pesticides, and Herbicides								
PCBs (Arochlor 1254)	0.06	0.34	0.0598	0.676	-	-	0.0598	0.676
Aldrin	0.002 (e)	0.008 (e)	-	-	-	-	0.002	0.008
alpha-BHC	0.006 (e)	0.01 (e)	-	-	-	-	0.006	0.01
beta-BHC	0.005 (e)	0.021 (e)	-	-	-	-	0.005	0.021
delta-BHC	0.003 (e)	0.012 (e)	-	-	-	-	0.003	0.012
Chlordane	0.0045	0.00887	0.00324	0.0176	-	-	0.00324	0.0176
2,4-D	-	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-
4,4'-DDD	0.00354	0.00851	0.00488	0.028	-	-	0.00354	0.028
4,4'-DDE	0.00142	0.00675	0.00316	0.0313	-	-	0.00142	0.0313
4,4'-DDT	0.00119	0.00477	0.00416	0.0629	-	-	0.00119	0.0629
Dieldrin	0.00285	0.00667	0.0019	0.0618	0.052	-	0.0019	0.0618
Endosulfan	-	-	-	-	-	0.0054	0.0054	0.0054
Endosulfan Sulfate (g)	-	-	-	-	-	0.0054	0.0054	0.0054

SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)							
	CCME ISQG (a)	CCME PEL (a)	Consensus Based TEC (b)	Consensus Based PEC (b)	U.S. EPA SQC (c)	U.S. EPA SQB (c)	Lowest Criterion	Highest Criterion
PCBs, Pesticides, and Herbicides (cont.)								
Endrin	0.00267	0.0624	0.00222	0.207	0.02	-	0.00222	0.207
Endrin Aldehyde (g)	0.00267	0.0624	0.00222	0.207	0.02	-	0.00222	0.207
Endrin Ketone (g)	0.00267	0.0624	0.00222	0.207	0.02	-	0.00222	0.207
gamma-BHC (Lindane)	0.00094	0.00138	0.00237	0.00499	-	0.0037	0.00094	0.00499
Heptachlor	0.0006	0.00274	0.00247	0.016	-	-	0.0006	0.016
Heptachlor Epoxide	0.0006	0.00274	0.00247	0.016	-	-	0.0006	0.016
Isodrin	0.002 (h)	0.008 (h)	-	-	-	-	0.002	0.008
MCPP	-	-	-	-	-	-	-	-
Methoxychlor	-	-	-	-	-	0.019	0.019	0.019

Notes:

(a) Unless otherwise noted, interim sediment quality guidelines ("ISQG") and probable effect levels ("PELs") obtained from Canadian Council of Ministers of the Environment *Canadian Sediment Quality Guidelines for the Protection of Aquatic Life*, dated 1999.

(b) Consensus-based threshold effects concentrations ("TECs") and probable effects concentrations ("PECs") obtained from MacDonald, D.M., C.G. Ingersoll, and T.A. Berger *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, dated 2000.

(c) Sediment quality criteria ("SQC") and sediment quality benchmarks ("SQB") obtained from U.S. EPA *Ecotox Thresholds*, dated 1996 and U.S. EPA. *Ecological Screening Values*, dated 1995.

(d) Hyphen indicates sediment quality criterion not found.

(e) Value from Persuad, D., R. Jaagumagi, and A. Hayton *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*, dated August 1993 or U.S. EPA (1996).

(f) Value for benzo(k)fluoroanthene obtained from Persuad, et al (1993). Value for benzo(k)fluoroanthene used for benzo(b)fluoroanthene.

(g) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(h) Isodrin is an isomer of aldrin. Value listed is for aldrin.

TABLE 5-8
SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)					
	ER-L (a)	ER-M (a)	U.S. EPA SQC (b)	U.S. EPA SQB (b)	Lowest Criterion	Highest Criterion
Inorganic Chemicals						
Antimony	2	25	- (c)	-	2	25
Arsenic	8.2	70	-	-	8.2	70
Barium	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-
Cadmium	1.2	9.6	-	-	1.2	9.6
Chromium	81	370	-	-	81	370
Cobalt	-	-	-	-	-	-
Copper	34	270	-	-	34	270
Cyanide	-	-	-	-	-	-
Lead	46.7	218	-	-	46.7	218
Tetraethyl Lead	-	-	-	-	-	-
Mercury	0.15	0.71	-	-	0.15	0.71
Molybdenum	-	-	-	-	-	-
Nickel	20.9	51.6	-	-	20.9	51.6
Selenium	-	-	-	-	-	-
Silver	1	3.7	-	-	1	3.7
Thallium	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-
Zinc	150	410	-	-	150	410

TABLE 5-8

SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)					
	ER-L (a)	ER-M (a)	U.S. EPA SQC (b)	U.S. EPA SQB (b)	Lowest Criterion	Highest Criterion
Semivolatile Organic Compounds						
Acenaphthene	0.016	0.5	0.62	-	0.016	0.62
Acenaphthylene	0.044	0.64	-	-	0.044	0.64
Anthracene	0.0853	1.1	-	-	0.0853	1.1
Benzo(a)anthracene	0.261	1.6	-	-	0.261	1.6
Benzo(a)pyrene	0.43	1.6	-	-	0.43	1.6
Benzo(b)fluoranthene	-	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-
Benzyl Alcohol	-	-	-	-	-	-
Chrysene	0.384	2.8	-	-	0.384	2.8
Dibenzo(a,h)anthrancene	0.0634	0.26	-	-	0.0634	0.26
Dibenzofuran	-	-	-	2	2	2
Fluoranthene	0.6	5.1	2.9	-	0.6	5.1
Fluorene	0.019	0.54	-	0.54	0.019	0.54
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-
2-methylnaphthalene	0.07	0.67	-	-	0.07	0.67
4-methylphenol (p-Cresol)	-	-	-	-	-	-
Naphthalene	0.16	2.1	-	0.48	0.16	2.1
n-nitrosodiphenylamine	-	-	-	-	-	-
Pentachlorophenol	-	-	-	-	-	-
Phenanthrene	0.24	1.5	0.85	-	0.24	1.5
Phenol	-	-	-	-	-	-
Pyrene	0.665	2.6	-	-	0.665	2.6

TABLE 5-8
SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)					
	ER-L (a)	ER-M (a)	U.S. EPA SQC (b)	U.S. EPA SQB (b)	Lowest Criterion	Highest Criterion
Volatile Organic Compounds						
Acetone	-	-	-	-	-	-
2-Butanone (MEK)	-	-	-	-	-	-
Carbon disulfide	-	-	-	-	-	-
1,4-dichlorobenzene	-	-	-	0.35	0.35	0.35
p-isopropyltoluene (p-cymene) (d)	-	-	-	0.67	0.67	0.67
Methylene Chloride	-	-	-	-	-	-
1,2,3-trichlorobenzene (e)	-	-	-	9.2	9.2	9.2
1,2,4-trichlorobenzene	-	-	-	9.2	9.2	9.2
Trichlorofluormethane	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	0.17	0.17	0.17
PCBs, Pesticides, and Herbicides						
PCBs (Arochlor 1254)	0.0227 (f)	0.18 (f)	-	-	0.0227	0.18
Aldrin	-	-	-	-	-	-
alpha-BHC	0.00032 (g,h)	0.00099 (g,h)	-	-	0.00032	0.00099
beta-BHC	0.00032 (g,h)	0.00099 (g,h)	-	-	0.00032	0.00099
delta-BHC	0.00032 (g,h)	0.00099 (g,h)	-	-	0.00032	0.00099
Chlordane	0.0005	0.006	-	-	0.0005	0.006
2,4-D	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-
4,4'-DDD	0.002	0.02	-	-	0.002	0.02
4,4'-DDE	0.0022	0.027	-	-	0.0022	0.027
4,4'-DDT	0.001	0.007	-	-	0.001	0.007
Dieldrin	0.00002	0.008	0.052	-	0.00002	0.052
Endosulfan	-	-	-	0.0054	0.0054	0.0054
Endosulfan Sulfate (i)	-	-	-	0.0054	0.0054	0.0054

TABLE 5-8
SEDIMENT QUALITY CRITERIA FOR AQUATIC LIFE (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment Quality Criteria (mg/kg)					
	ER-L (a)	ER-M (a)	U.S. EPA SQC (b)	U.S. EPA SQB (b)	Lowest Criterion	Highest Criterion
PCBs, Pesticides, and Herbicides (cont.)						
Endrin	0.00002	0.045	0.02	-	0.00002	0.045
Endrin Aldehyde (i)	0.00002	0.045	0.02	-	0.00002	0.045
Endrin Ketone (i)	0.00002	0.045	0.02	-	0.00002	0.045
gamma-BHC (Lindane)	0.00032 (g)	0.00099 (g)	-	0.0037	0.00032	0.0037
Heptachlor	-	-	-	-	-	-
Heptachlor Epoxide	-	-	-	-	-	-
Isodrin	-	-	-	-	-	-
MCPP	-	-	-	-	-	-
Methoxychlor	0.019	-	-	0.019	0.019	0.019

Notes:

(a) Effects Range-Low ("ER-L") and Effects Range-Medium ("ER-M") obtained from U.S. EPA *Sediment Classification Methods Compendium*, dated 1992; except where noted.

(b) Sediment quality criteria ("SQC") and sediment quality benchmarks ("SQB") obtained from U.S. EPA *Ecotox Thresholds*, dated *1996 and U.S. EPA. Ecological Screening Values*, dated 1995.

(c) Hyphen indicates sediment quality criterion not found.

(d) Values for toluene were used for isopropyltoluene.

(e) Values for 1,2,4-trichlorobenzene were used for 1,2,3-trichlorobenzene.

(f) Value listed is for total PCBs.

(g) Florida Department of Environmental Protection Threshold Effects Level (TEL) and Probable Effects Level (PEL) (MacDonald, 1994). dated 1990 and normalized to 1 percent total organic carbon.

(h) Value listed is for gamma-BHC.

(i) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

TABLE 5-9
FORMULAS FOR CALCULATION OF WILDLIFE PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

$$PRG_{\text{American robin}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (BAF_{inv} \times DIR)}$$

$$PRG_{\text{Mourning dove}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (BAF_{pl} \times DIR)}$$

$$PRG_{\text{Western harvest mouse}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (((BAF_{pl} \times 0.5) + (BAF_{inv} \times 0.5)) \times DIR)}$$

$$PRG_{\text{Pocket gopher}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (BAF_{pl} \times DIR)}$$

$$PRG_{\text{Red-tailed hawk}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + ((BAF_{mam} \times BAF_{pl} \times 0.5) + (BAF_{mam} \times BAF_{inv} \times 0.5)) \times DIR)}$$

TABLE 5-9
FORMULAS FOR CALCULATION OF WILDLIFE PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

$$PRG_{\text{Peregrine falcon}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (((BAF_{bird} \times BAF_{pl} \times 0.5) + (BAF_{bird} \times BAF_{inv} \times 0.5)) \times DIR)}$$

$$PRG_{\text{Raccoon}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (((BAF_{bird} \times BAF_{pl} \times 0.5) + (BAF_{inv} \times BAF_{inv} \times 0.5)) \times DIR)}$$

$$PRG_{\text{Mallard duck}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (BAF_{pl} \times DIR)}$$

$$PRG_{\text{Western sandpiper}} = \frac{HQ \times TBV \times BW}{(F_{soil/sed} \times DIR) + (CF \times SA \times AF \times ABS) + (BAF_{inv} \times DIR)}$$

TABLE 5-9
FORMULAS FOR CALCULATION OF WILDLIFE PRELIMINARY REMEDIATION GOALS FOR SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

where:

ABS = Absorption factor (chemical-specific)

AF = Soil adherence factor (mg/cm^2)

BAF_{inv} = Bioaccumulation factor for invertebrates (unitless)

BAF_{pl} = Bioaccumulation factor for plants (unitless)

BW = Body weight (kg)

CF = Conversion factor (converts units from mg to kg)

DIR = Dietary ingestion rate (kg/day)

$F_{soil/sed}$ = Fraction of soil and sediment in diet (unitless)

HQ = Hazard quotient equal to 1

PRG = Preliminary remediation goal

SA = Surface area (cm^2)

TBV = Toxicity benchmark value (mg/kg-day)

TABLE 5-10
WILDLIFE EXPOSURE FACTORS (a)

Presidio of San Francisco, California

Receptor	Surface Area (cm^2)	Body Weight (kg)	Normalized Dietary Ingestion Rate (kg/kg-day)	Dietary Ingestion Rate (kg/day)	Basis of Dietary Ingestion Rate	Converted Dietary Ingestion Rate (kg/day); (b)	Soil Ingestion (Fraction of Diet)	Soil Ingestion Rate (kg/day)	Home Range (hectares)
American Robin	206	0.085	1.457	0.1235	weight weight	0.0499	0.103	0.00514	0.4
Mourning Dove	385	0.166	0.200	0.0332	dry weight	0.0332	0.103	0.00342	0.24
Western Harvest Mouse	93	0.029	0.372	0.0108	weight weight	0.0044	0.024	0.00010	0.4
Valley Pocket Gopher	161	0.306	0.061	0.0187	dry weight	0.0187	0.024	0.00044	0.1
Raccoon	3979	7.264	0.017	0.1235	dry weight	0.1235	0.094	0.01161	2122
Peregrine Falcon	279	0.135	0.290	0.0392	dry weight	0.0392	0.028	0.00110	192
Red-tailed Hawk	1208	1.231	0.109	0.1342	weight weight	0.0426	0.028	0.00119	1663
Mallard Duck	1205	1.243	0.053	0.0659	dry weight	0.0659	0.033	0.00217	608
Western Sandpiper	140	0.047	0.122	0.0057	dry weight	0.0057	0.282	0.00160	0.25

Notes:

(a) Unless otherwise noted, wildlife exposure factors are the same as those assumed by the Army in Dames & Moore, *Final Feasibility Study Report, Presidio Main Installation*, dated May 1997.

(b) Dietary ingestion rates were converted to a dry weight basis using the equation DIRdry = DIRwet x (1 - percent water in food) and average moisture contents from Sample, B.E. and G.W. Suter, I.I. 1994. *Estimating Exposure of Terrestrial Wildlife to Contaminants*. Oak Ridge National Laboratory, United States Department of Energy. ES/ER/TM-125.

TABLE 5-11
PLANT AND WILDLIFE BIOACCUMULATION FACTORS

Presidio of San Francisco, California

Potential Chemical of Concern	Bioaccumulation Factor (unitless); (a)				
	Plant	Soil Invertebrate	Bird	Mammal	
				Omnivore	Herbivore
Inorganic Chemicals					
Cadmium	**0.586**	**7.708**	0.002	**0.1217**	**0.1258**
Copper	**0.124**	**0.515**	0.001	**0.1272**	**0.1086**
Lead	**0.0389**	**0.266**	0.0003	**0.0659**	**0.0522**
Mercury	**0.652**	**1.693**	1.214	**0.0543**	**0.0239**
Selenium	**0.672**	**0.985**	0.013	**0.2062**	**0.155**
Zinc	**0.366**	**3.201**	0.001	0.55772	**0.50429**
Semivolatile Organic Compounds					
Polycyclic Aromtaic Hydrocarbons	0	0	0	0	0
PCBs, Pesticides, and Herbicides					
PCBs	0.01	**6.667**	0.227	1.43	1.43
Aldrin	**0.03**	**4.29**	**0.477**	**0.02**	**0.02**
alpha-BHC (b)	**0**	**3**	**1**	**0.5**	**0.1**
beta-BHC (b)	**0**	**3**	**1**	**0.5**	**0.1**
delta-BHC (b)	**0**	**3**	**1**	**0.5**	**0.1**
Chlordane	0.02	5	0.352	0.04	0.04
Dicamba (b)	**0**	**3**	**1**	**0.5**	**0.1**
4,4'-DDD	**0.01**	**1.98**	**0.905**	**0.45**	**0.45**
4,4'-DDE	**0.01**	**1.98**	**0.905**	**0.45**	**0.45**
4,4'-DDT	0.01	1.98	0.905	0.45	0.45
Dieldrin	0.03	4.29	0.477	0.02	0.02
Endosulfan (b)	**0**	**3**	**1**	**0.5**	**0.1**
Endosulfan Sulfate (b)	**0**	**3**	**1**	**0.5**	**0.1**
Endrin (b)	**0**	**3**	**1**	**0.5**	**0.1**
Endrin Aldehyde (b)	**0**	**3**	**1**	**0.5**	**0.1**
Endrin Ketone (b)	**0**	**3**	**1**	**0.5**	**0.1**
gamma-BHC (b)	**0**	**3**	**1**	**0.5**	**0.1**
Heptachlor	0.086	1.67	2.25	0.11	0.11
Heptachlor Epoxide	**0.086**	**1.67**	**2.25**	**0.11**	**0.11**
Isodrin (c)	**0.03**	**4.29**	**0.477**	**0.02**	**0.02**
MCPP (b)	**0**	**3**	**1**	**0.5**	**0.1**
Methoxychlor (b)	**0**	**3**	**1**	**0.5**	**0.1**

TABLE 5-11
PLANT AND WILDLIFE BIOACCUMULATION FACTORS

Presidio of San Francisco, California

ıtes:

) Unless otherwise noted, bioaccumulation factors that are boxed and shown in bold have been updated and differ from those assumed by the Army in Dames & Moore, *Final Feasibility Study Report, Presidio Main Installation*, dated May 1997. Updated values have been obtained from the following United States Department of Energy Oak Ridge National Laboratory documents:

- Bechtel Jacobs Company L.L.C. September 1998. *Empirical Models for Uptake of Inorganic Chemicals from Soil to Plants.* United States Department of Energy Oak Ridge National Laboratory. BJC/OR-133.
- Sample, B.E., et al. February 1998. *Development and Validation of Bioaccumulation Models for Earthworms*. Energy. ES/ER/TM-220.
- Sample, B.E., et al. February 1998. *Development and Validation of Bioaccumulation Models for Small Mammals*. United States Department of United States Department of Energy ES/ER/TM-219.

Calculation of BAFs for chemicals without literature based BAFs

Potential Chemical of Concern	Bioaccumulation Factor (unitless)				
	Plant	Soil Invertebrate	Bird	Mammal	
				Omnivore	Herbivore
Pesticides/herbicides with BAFs					
Dieldrin	0.03	4.29	0.477	0.02	0.02
Chlordane	0.02	5	0.352	0.04	0.04
4,4'-DDT	0.01	1.98	0.905	0.45	0.45
Heptachlor	0.086	1.67	2.25	0.11	0.11
Statistics					
Range	0.01-0.09	1.67-5	0.35-2.25	0.02-0.45	0.02-0.45
Median	0.025	3.135	0.691	0.075	0.075
Assumed BAFs (for chemicals with no literature BAF)	**0 (a)**	**3 (b)**	**1 (c)**	**0.5 (d)**	**0.1 (e)**

(a) Assumed to be 0 based on BAFs for other pesticides all below 0.1.
(b) Assumed to be 3 based on median BAF for other pesticides of 3.1.
(c) Assumed to be 1 based on median BAF for other pesticides of 0.7.
(d) Assumed to be 0.5 based on median BAF for other pesticides of 0.075 and conservative assumption that omnivores should have a higher BAF.
(e) Assumed to be 0.1 based on median BAF for other pesticides of 0.075.

) No literature-reported bioaccumulation factors were found. Bioaccumulation factors listed for potential chemical of concern are assumed values based on the range of literature-reported values for chlordane, dieldrin, heptachlor, and 4,4'-DDT.

) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-12
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON LOW TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{low} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Inorganic Chemicals									
Antimony	5	- (a)	-	162	309	225	-	-	162
Arsenic	10	46	135	343	647	471	171	2,804	46
Barium	500	320	940	3,264	6,109	4,440	1,192	19,819	320
Beryllium	10	160	470	1,953	3,655	2,657	596	9,910	160
Cadmium	4	0.017	0.58	0.1	2	0.89	4	4	0.017
Chromium	5	4	13	1,100	2,746	3,118	16	266	4
Cobalt	20	1,663	4,886	220	412	299	6,191	102,977	220
Copper	50	30	243	517	2,957	329	672	4,715	30
Cyanide	-	-	-	6,298	11,789	8,569	-	-	6,298
Lead (b)	-	-	-	-	-	-	-	-	-
Tetraethyl Lead	-	1	8	151	783	5,111	13	175	1
Mercury	0.3	0.038	0.26	1.45	4.85	7.04	0.095	28.18	0.038
Molybdenum	-	12	34	24	44	32	43	701	12
Nickel	30	58	169	2,896	5,422	1,871	215	3,565	58
Selenium	1	0.2	0.84	0.31	0.71	2	6	21	0.2
Silver	2	6	17	5,960	11,154	8,107	21	357	6
Thallium	1	0.15	0.44	28	55	37	1	9	0.15
Vanadium	2	2	5	6	7	6	6	102	2
Zinc	50	4	81	209	1,787	1,180	437	216	4

TABLE 5-12

SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON LOW TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{low} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Semivolatile Organic Compounds									
Acenaphthene	30	-	-	84	166	121	-	-	84
Acenaphthylene	30	-	-	84	166	121	-	-	84
Anthracene	30	-	-	84	166	121	-	-	84
Benzo(a)anthracene	30	-	-	84	166	121	-	-	84
Benzo(a)pyrene	30	-	-	84	166	121	-	-	84
Benzo(b)fluoranthene	30	-	-	84	166	121	-	-	84
Benzo(g,h,i)perylene	30	-	-	84	166	121	-	-	84
Benzo(k)fluoranthene	30	-	-	84	166	121	-	-	84
Benzyl Alcohol	-	0.66	2	106	277	252	2	37	0.66
Chrysene	30	-	-	84	166	121	-	-	84
Dibenzo(a,h)anthrancene	30	-	-	84	166	121	-	-	84
Dibenzofuran	-	-	-	-	-	-	-	-	-
Fluoranthene	30	-	-	84	166	121	-	-	84
Fluorene	30	-	-	84	166	121	-	-	84
Indeno(1,2,3-cd)pyrene	30	-	-	84	166	121	-	-	84
2-methylnaphthalene	30	-	-	84	166	121	-	-	84
4-methylphenol (p-Cresol)	50	-	-	11,167	29,145	33,156	-	-	11,167
Naphthalene	30	-	-	84	166	121	-	-	84
n-nitrosodiphenylamine	20	-	-	16,981	33,240	24,202	-	-	16,981
Pentachlorophenol	3	-	-	22	41	30	-	-	22
Phenanthrene	30	-	-	84	166	121	-	-	84
Phenol	30	-	-	2,547	4,986	3,630	-	-	2,547
Pyrene	30	-	-	84	166	121	-	-	84

TABLE 5-12
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON LOW TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{low} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Volatile Organic Compounds									
Acetone	-	-	-	8,490	16,620	12,101	-	-	8,490
2-Butanone (MEK)	-	-	-	4,245	8,310	6,050	-	-	4,245
Carbon disulfide	-	-	-	934	1,828	1,331	-	-	934
1,4-dichlorobenzene	20	-	-	2,123	4,155	3,025	-	-	2,123
p-isopropyltoluene (p-cymene) (d)	200	-	-	2,207	4,321	3,146	-	-	2,207
Methylene Chloride	-	-	-	459	858	624	-	-	459
1,2,3-trichlorobenzene	20	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	20	-	-	-	-	-	-	-	-
Trichlorfluoromethane	-	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	9,679	18,947	13,795	-	-	9,679
PCBs, Pesticides, and Herbicides									
PCBs (Aroclor 1254)	40	0.01	2	0.22	43	1	0.09	0.24	0.01
Aldrin	-	0.004	0.37	0.2	15	1	0.02	4	0.004
alpha-BHC	-	0.062	5	6	665	29	0.13	18	0.062
beta-BHC	-	0.062	5	6	665	29	0.13	18	0.062
delta-BHC	-	0.062	5	6	665	29	0.13	18	0.062
Chlordane	-	0.009	0.85	0.63	88	5	0.04	5	0.009
2,4-D	-	-	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-	-
4,4'-DDD	40	0.049	3	18	1,007	92	0.14	6	0.049
4,4'-DDE	40	0.098	5	18	1,007	92	0.22	7	0.098
4,4'-DDT	40	0.008	0.44	18	1,007	92	0.14	6	0.008
Dieldrin	50	0.039	4	0.27	21	0.26	0.16	39	0.039
Endosulfan	-	1.1	96	2	249	11	2	320	1.1
Endosulfan Sulfate (d)	-	1.1	96	2	249	11	2	320	1.1

TABLE 5-12

SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON LOW TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{low} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
PCBs, Pesticides, and Herbicides (cont.)									
Endrin	-	0.004	0.31	0.3	31	1	0.007	1	0.004
Endrin Aldehyde (d)	-	0.004	0.31	0.3	31	1	0.007	1	0.004
Endrin Ketone (d)	-	0.004	0.31	0.3	31	1	0.007	1	0.004
gamma-BHC (Lindane)	-	0.010	0.91	12	1,330	59	0.023	3	0.010
Heptachlor	-	0.018	0.50	0.29	6	3	0.017	4	0.017
Heptachlor Epoxide	-	0.018	0.5	0.29	6	3	0.017	4	0.017
Isodrin	-	0.004	0.37	0.2	15	1	0.016	4	0.004
MCPP	-	-	-	-	-	-	-	-	-
Methoxychlor	-	0.44	38	6	665	29	0.9	128	0.44

Notes:

(a) Hyphen indicates that Preliminary Remediation Goal ("PRG") could not be calculated due to lack of toxicity information.

(b) PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive the PRG for lead.

(c) Values for toluene were used for isopropyltoluene.

(d) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

TABLE 5-13
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON HIGH TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{high} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Inorganic Chemicals									
Antimony	5	- (a)	-	490	1,222	1,110	-	-	490
Arsenic	224	692	2,031	6,080	15,333	13,937	5,133	42,064	692
Barium	500	3,200	9,404	19,581	48,870	44,403	23,831	198,190	3,200
Beryllium	10	8,000	23,510	11,688	29,171	26,505	59,578	495,476	8,000
Cadmium	100	0.44	15	38.80	653	362	190	108	0.44
Chromium	200	42	124	11,001	27,455	24,946	314	2,615	42
Cobalt	75	41,567	122,156	3,300	8,237	7,484	309,559	2,574,431	3,300
Copper	400	200	1,599	775	4,435	2,173	8,824	30,975	200
Cyanide	-	-	-	18,894	47,154	42,844	-	-	18,894
Lead (b)	-	-	-	-	-	-	-	-	-
Tetraethyl Lead	-	52	398	6,408	44,391	43,989	1,386	8,578	52
Mercury	10	12	83	22	95	172	30	4,402	12
Molybdenum	-	582	1,710	703	1,770	1,610	4,310	35,400	582
Nickel	500	1,440	4,232	43,453	108,448	98,536	10,724	89,186	1,440
Selenium	70	2	9	4	13	57	117	210	2
Silver	2	144	423	35,752	89,230	81,074	1,072	8,919	144
Thallium	1	39	115	825	2,059	1,871	291	2,421	39
Vanadium	20	8	24	5,500	13,728	12,473	60	495	8
Zinc	864	97	2,014	1,253	14,297	11,799	21,830	5,390	97

TABLE 5-13

SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON HIGH TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{high} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Semivolatile Organic Compounds									
Acenaphthene	50	-	-	2,547	6,648	6,050	-	-	2,547
Acenaphthylene	50	-	-	2,547	6,648	6,050	-	-	2,547
Anthracene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzo(a)anthracene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzo(a)pyrene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzo(b)fluoranthene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzo(g,h,i)perylene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzo(k)fluoranthene	50	-	-	2,547	6,648	6,050	-	-	2,547
Benzyl Alcohol	-	164	480	26,490	69,139	62,924	1,201	9,371	164.36
Chrysene	50	-	-	2,547	6,648	6,050	-	-	2,547
Dibenzo(a,h)anthrancene	50	-	-	2,547	6,648	6,050	-	-	2,547
Dibenzofuran	-	-	-	-	-	-	-	-	-
Fluoranthene	50	-	-	2,547	6,648	6,050	-	-	2,547
Fluorene	50	-	-	2,547	6,648	6,050	-	-	2,547
Indeno(1,2,3-cd)pyrene	50	-	-	2,547	6,648	6,050	-	-	2,547
2-methylnaphthalene	50	-	-	2,547	6,648	6,050	-	-	2,547
4-methylphenol (p-Cresol)	50	-	-	55,782	145,591	132,504	-	-	55,782
Naphthalene	50	-	-	2,547	6,648	6,050	-	-	2,547
n-nitrosodiphenylamine	109	-	-	50,942	132,960	121,008	-	-	50,942
Pentachlorophenol	4	-	-	660	1,647	1,497	-	-	660
Phenanthrene	50	-	-	2,547	6,648	6,050	-	-	2,547
Phenol	188	-	-	7,641	19,944	18,151	-	-	7,641
Pyrene	50	-	-	2,547	6,648	6,050	-	-	2,547

TABLE 5-13
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON HIGH TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{high} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
Volatile Organic Compounds									
Acetone	-	-	-	127,356	332,399	302,520	-	-	127,356
2-Butanone (MEK)	-	-	-	25,471	66,480	60,504	-	-	25,471
Carbon disulfide	-	-	-	28,018	73,128	66,554	-	-	28,018
1,4-dichlorobenzene	128	-	-	12,736	33,240	30,252	-	-	12,736
p-isopropyltoluene (p-cymene) (c)	1,000	-	-	22,075	43,212	31,462	-	-	22,075
Methylene Chloride	-	-	-	34,377	85,798	77,956	-	-	34,377
1,2,3-trichlorobenzene	115	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	127	-	-	-	-	-	-	-	-
Trichlorfluoromethane	-	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	1,451,858	3,789,347	3,448,730	-	-	1,451,858
PCBs, Pesticides, and Herbicides									
PCBs (Aroclor 1254)	240	0.45	79	3	812	29	8	10.83	0.45
Aldrin	-	0.19	19	3	300	26	2	195	0.19
alpha-BHC	-	11	960	10	1,496	83	45	740	10
beta-BHC	-	11	960	10	1,496	83	45	740	10
delta-BHC	-	11	960	10	1,496	83	45	740	10
Chlordane	-	0.071	9	27	3,818	235	0.81	47	0.071
2,4-D	-	-	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-	-
4,4'-DDD	200	2	131	280	20,339	2,317	11	181	2
4,4'-DDE	200	2	131	280	20,339	2,317	11	181	2
4,4'-DDT	200	2	131	280	20,339	2,317	11	181	2
Dieldrin	100	0.48	47	0.94	93	68	4	488	0.48
Endosulfan	-	5	480	7	997	55	23	370	5
Endosulfan Sulfate (d)	-	5	480	7	997	55	23	370	5

TABLE 5-13

SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES BASED ON HIGH TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	Plants and Soil Fauna PRG_{high} (mg/kg)	Soil Preliminary Remediation Goal for Protection of Wildlife (mg/kg)							
		American Robin	Mourning Dove	Western Harvest Mouse	Valley Pocket Gopher	Raccoon	Peregrine Falcon	Red-tailed Hawk	Wildlife Minimum PRG Value
PCBs, Pesticides, and Herbicides (cont.)									
Endrin	-	0.50	44	9	1,330	74	2	34	0.50
Endrin Aldehyde (d)	-	0.50	44	9	1,330	74	2	34	0.50
Endrin Ketone (d)	-	0.50	44	9	1,330	74	2	34	0.50
gamma-BHC (Lindane)	-	2	144	35	5,318	295	7	111	2
Heptachlor	-	199	5,467	7	148	57	358	47,169	7
Heptachlor Epoxide	-	199	5,467	7	148	57	358	47,169	7
Isodrin (e)	-	0.19	19	3	300	26	2	195	0.19
MCPP	-	-	-	-	-	-	-	-	-
Methoxychlor	-	110	9,598	35	5,318	295	451	7,401	35

Notes:

(a) Hyphen indicates that Preliminary Remediation Goal ("PRG") could not be calculated due to lack of toxicity information.

(b PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive the PRG for lead.

(c) Values for toluene were used for isopropyltoluene.

(d Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(e) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-14
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Soil PRG (mg/kg); (b)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean	
Inorganic Chemicals							
Antimony	5	5	5	162	490	326	5
Arsenic	10	224	117	46	692	369	120
Barium	500	500	500	320	3,200	1,760	500
Beryllium	10	10	10	160	8,000	4,080	10
Cadmium	4	100	52	0.017	0.44	0.23	0.23
Chromium	5	200	103	4	42	23	23
Cobalt	20	75	48	220	3,300	1,760	48
Copper	50	400	225	30	200	115	120
Cyanide	- (c)	-	-	6,298	18,894	12,596	13,000
Lead (d)							300
Tetraethyl Lead	-	-	-	1	52	27	27
Mercury	0.3	10	5.15	0.038	12	6	5.2
Molybdenum	-	-	-	11.5	582	297	300
Nickel	30	500	265	58	1,440	749	270
Selenium	1	70	35.5	0.20	2	1	1.1
Silver	2	2	2	6	144	75	2
Thallium	1	1	1	0.15	39	20	1
Vanadium	2	20	11	2	8	5	5
Zinc	50	864	457	4	97	51	50

TABLE 5-14
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Soil PRG (mg/kg); (b)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean	
Semivolatile Organic Compounds							
Acenaphthene	30	50	40	84	2,547	1,316	40
Acenaphthylene	30	50	40	84	2,547	1,316	40
Anthracene	30	50	40	84	2,547	1,316	40
Benzo(a)anthracene	30	50	40	84	2,547	1,316	40
Benzo(a)pyrene	30	50	40	84	2,547	1,316	40
Benzo(b)fluoranthene	30	50	40	84	2,547	1,316	40
Benzo(g,h,i)perylene	30	50	40	84	2,547	1,316	40
Benzo(k)fluoranthene	30	50	40	84	2,547	1,316	40
Benzyl Alcohol	-	-	-	1	164	83	83
Chrysene	30	50	40	84	2,547	1,316	40
Dibenzo(a,h)anthrancene	30	50	40	84	2,547	1,316	40
Dibenzofuran	-	-	-	-	-	-	-
Fluoranthene	30	50	40	84	2,547	1,316	40
Fluorene	30	50	40	84	2,547	1,316	40
Indeno(1,2,3-cd)pyrene	30	50	40	84	2,547	1,316	40
2-methylnaphthalene	30	50	40	84	2,547	1,316	40
4-methylphenol (p-Cresol)	50	50	50	11,167	55,782	33,474	50
Naphthalene	30	50	40	84	2,547	1,316	40
n-nitrosodiphenylamine	20	109	65	16,981	50,942	33,962	65
Pentachlorophenol	3	4	3.5	22	660	341	3.5
Phenanthrene	30	50	40	84	2,547	1,316	40
Phenol	30	188	109	2,547	7,641	5,094	109
Pyrene	30	50	40	84	2,547	1,316	40

TABLE 5-14
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Soil PRG (mg/kg); (b)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean	
Volatile Organic Compounds							
Acetone	-	-	-	8,490	127,356	67,923	68,000
2-butanone (MEK)	-	-	-	4,245	25,471	14,858	15,000
Carbon disulfide	-	-	-	934	28,018	14,476	14,476
1,4-dichlorobenzene	20	128	74	2,123	12,736	7,429	74
p-isopropyltoluene (p-cymene) (e)	200	1000	600	2,207	22,075	12,141	600
Methylene Chloride	-	-	-	459	34,377	17,418	17,000
1,2,3-trichlorobenzene	20	115	67.5	-	-	-	67.5
1,2,4-trichlorobenzene	20	127	73.5	-	-	-	73.5
Trichlorofluoromethane	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	9,679	1,451,858	730,768	730,000
PCBs, Pesticides, and Herbicides							
PCBs (Arochlor 1254)	40	240	140	0.010	0.45	0.23	0.23
Aldrin	-	-	-	0.0039	0.19	0.1	0.1
alpha-BHC	-	-	-	0.062	10	4.9	4.9
beta-BHC	-	-	-	0.062	10	4.9	4.9
delta-BHC	-	-	-	0.062	10	4.9	4.9
Chlordane	-	-	-	0.0090	0.071	0.04	0.04
2,4-D	-	-	-	-	-	-	-
Dicamba	-	-	-	-	-	-	-
4,4'-DDD	40	200	120	0.049	2	1.2	1.2
4,4'-DDE	40	200	120	0.098	2	1.3	1.3
4,4'-DDT	40	200	120	0.0082	2	1.2	1.2
Dieldrin	50	100	75	0.039	0.48	0.26	0.26
Endosulfan	-	-	-	1.1	5.5	3.3	3.3
Endosulfan Sulfate (f)	-	-	-	1.1	5.5	3.3	3.3

TABLE 5-14
SOIL PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS PLANT AND WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Soil PRG (mg/kg); (b)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean	
PCBs, Pesticides, and Herbicides							
Endrin	-	-	-	0.004	0.50	0.25	0.25
Endrin Aldehyde (f)	-	-	-	0.004	0.50	0.25	0.25
Endrin Ketone (f)	-	-	-	0.004	0.50	0.25	0.25
gamma-BHC (Lindane)	-	-	-	0.010	2	0.83	0.83
Heptachlor	-	-	-	0.017	7	3.7	3.7
Heptachlor Epoxide	-	-	-	0.017	7	3.7	3.7
Isodrin (g)	-	-	-	0.0039	0.19	0.1	0.1
MCPP	-	-	-	-	-	-	-
Methoxychlor	-	-	-	0.44	35	18	18

Notes:

(a) Listed in this table are the low and high Preliminary Remediation Goals ("PRGs") values for plants and soil fauna, and the lowest wildlife PRGs recalculated using TBV_{low} values from Table 5-12 and TBV_{high} values from Table 5-13.

(b) The soil PRG proposed for protection of non-special status species is the lower of the arithmetic means of plants and soil fauna PRGs, and wildlife PRGs.

(c) Hyphen indicates that PRG could not be calculated due to lack of toxicity information.

(d) Values for toluene were used for isopropyltoluene.

(e) PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive the PRG for lead.

(f) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(g) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-15
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment PRG for Wildlife Based on TBV_{low} (mg/kg); (a)		Sediment PRG for Wildlife Based on TBV_{high} (mg/kg); (a)	
	Mallard Duck	Western Sandpiper	Mallard Duck	Western Sandpiper
Inorganic Chemicals				
Antimony	- (a)	-	-	-
Arsenic	7,874	81	23,621	1,219
Barium	11,031	564	110,309	5,639
Beryllium	5,515	282	275,774	14,097
Cadmium	12	0.082	61	2
Chromium	148	9	1,456	74
Cobalt	143,289	2,930	1,432,886	73,246
Copper	1,328	114	8,721	748
Cyanide	-	-	-	-
Lead (b)				
Tetraethyl Lead	60	3	2,958	169
Mercury	2	0.33	344	52
Molybdenum	394	20.3	19,900	1,020
Nickel	1,984	101	49,639	2,537
Selenium	3	0.84	35	8.5
Silver	198	10	4,964	254
Thallium	5	0.26	1,348	69
Vanadium	57	3	276	14
Zinc	1,787	18	8,933	445
Semivolatile Organic Compounds				
Acenaphthene	-	-	-	-
Acenaphthylene	-	-	-	-
Anthracene	-	-	-	-
Benzo(a)anthracene	-	-	-	-
Benzo(a)pyrene	-	-	-	-
Benzo(b)fluoranthene	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-
Benzyl Alcohol	22	1	5,417	288
Chrysene	-	-	-	-
Dibenzo(a,h)anthrancene	-	-	-	-
Dibenzofuran	-	-	-	-
Fluoranthene	-	-	-	-
Fluorene	-	-	-	-

TABLE 5-15
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment PRG for Wildlife Based on TBV_{low} (mg/kg); (a)		Sediment PRG for Wildlife Based on TBV_{high} (mg/kg); (a)	
	Mallard Duck	Western Sandpiper	Mallard Duck	Western Sandpiper
Semivolatile Organic Compounds (cont.)				
Indeno(1,2,3-cd)pyrene	-	-	-	-
2-methylnaphthalene	-	-	-	-
4-methylphenol (p-Cresol)	-	-	-	-
Naphthalene	-	-	-	-
n-nitrosodiphenylamine	-	-	-	-
Pentachlorophenol	-	-	-	-
Phenanthrene	-	-	-	-
Phenol	-	-	-	-
Pyrene	-	-	-	-
Volatile Organic Compounds				
Acetone	-	-	-	-
2-butanone (MEK)	-	-	-	-
Carbon disulfide	-	-	-	-
1,4-dichlorobenzene	-	-	-	-
p-isopropyltoluene (p-cymene)	-	-	-	-
Methylene Chloride	-	-	-	-
1,2,3-trichlorobenzene	-	-	-	-
1,2,4-trichlorobenzene	-	-	-	-
Trichlorfluoromethane	-	-	-	-
1,1,1-trichloroethane	-	-	-	-
PCBs, Pesticides, and Herbicides				
PCBs (Arochlor 1254)	17	0.047	770	2
Aldrin	15	0.018	146	0.90
alpha-BHC	61	0.28	10,835	50
beta-BHC	61	0.28	10,835	50
delta-BHC	61	0.28	10,835	50
Chlordane	7	0.033	73	0.33
2,4-D	-	-	-	-
Dicamba	-	-	-	-
4,4'-DDD	25	0.22	1,263	11
4,4'-DDE	51	0.43	1,263	11
4,4'-DDT	25	0.22	1,263	11
Dieldrin	29	0.18	364	2
Endosulfan	1,083	5	5,417	25
Endosulfan Sulfate (c)	1,083	5	5,417	25

TABLE 5-15
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS WILDLIFE SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Sediment PRG for Wildlife Based on TBV_{low} (mg/kg); (a)		Sediment PRG for Wildlife Based on TBV_{high} (mg/kg); (a)	
	Mallard Duck	Western Sandpiper	Mallard Duck	Western Sandpiper
PCBs, Pesticides, and Herbicides (cont.)				
Endrin	17	0.016	498	2
Endrin Aldehyde (c)	17	0.016	498	2
Endrin Ketone (c)	17	0.016	498	2
gamma-BHC (Lindane)	10	0.048	1,625	7
Heptachlor	3	0.080	32,480	873
Heptachlor Epoxide	3	0.080	32,480	873
Isodrin (d)	15	0.018	146	0.90
MCPP	-	-	-	-
Methoxychlor	2,167	2	108,349	500

Notes:

(a) Hyphen indicates that Preliminary Remediation Goal ("PRG") could not be calculated due to lack of toxicity information.

(b) Refer to text for discussion of methodology used to derive the the PRG for lead.

(c) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(d) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-16
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
Inorganic Chemicals			
Antimony	- (c)	-	-
Arsenic	6	33	19
Barium	564	5,639	3,100
Beryllium	282	14,097	7,200
Cadmium	0.082	2	1.1
Chromium	9	74	42
Cobalt	50	50	50
Copper	32	197	114
Cyanide	-	-	-
Lead	35.7	128	82
Tetraethyl Lead	3	169	86
Mercury	0.17	1.06	0.62
Molybdenum	20.3	1,020	522
Nickel	16	75	46
Selenium (d)	0.4	38	4.5
Silver	0.5	0.5	0.5
Thallium	0.26	69	35
Vanadium	3	14	9
Zinc	18	445	230
Semivolatile Organic Compounds			
Acenaphthene	0.0067	0.62	0.31
Acenaphthylene	0.0059	0.13	0.067
Anthracene	0.047	0.85	0.45
Benzo(a)anthracene	0.032	1.05	0.54
Benzo(a)pyrene	0.032	1.45	0.74
Benzo(b)fluoranthene	0.24	1.34	0.79
Benzo(g,h,i)perylene	0.17	0.32	0.25
Benzo(k)fluoranthene	0.24	1.34	0.79
Benzyl Alcohol	1	288	145
Chrysene	0.057	1.29	0.67
Dibenzo(a,h)anthrancene	0.0062	0.135	0.071
Dibenzofuran	2	2	2
Fluoranthene	0.11	2.9	1.5
Fluorene	0.021	0.54	0.28

TABLE 5-16
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
Semivolatile Organic Compounds (cont.)			
Indeno(1,2,3-cd)pyrene	0.2	0.32	0.26
2-methylnaphthalene	0.02	0.20	0.11
4-methylphenol (p-Cresol)	-	-	-
Naphthalene	0.03	0.56	0.3
n-nitrosodiphenylamine	-	-	-
Pentachlorophenol	-	-	-
Phenanthrene	0.042	1.2	0.61
Phenol	-	-	-
Pyrene	0.053	1.5	0.79
Volatile Organic Compounds			
Acetone	-	-	-
2-butanone (MEK)	-	-	-
Carbon disulfide	-	-	-
1,4-dichlorobenzene	0.35	0.35	0.35
p-isopropyltoluene (p-cymene)	-	-	-
Methylene Chloride	-	-	-
1,2,3-trichlorobenzene	-	-	-
1,2,4-trichlorobenzene	-	-	-
Methylene Chloride	-	-	-
Trichlorfluoromethane	-	-	-
1,1,1-trichloroethane	0.17	0.17	0.17
PCBs, Pesticides, and Herbicides			
PCBs (Arochlor 1254)	0.047	0.68	0.36
Aldrin	0.002	0.008	0.005
alpha-BHC	0.006	0.01	0.008
beta-BHC	0.005	0.021	0.013
delta-BHC	0.003	0.012	0.0075
Chlordane	0.0032	0.018	0.01
2,4-D	-	-	-
Dicamba	-	-	-
4,4'-DDD	0.0035	0.028	0.016
4,4'-DDE	0.0014	0.031	0.016
4,4'-DDT	0.0012	0.063	0.032
Dieldrin	0.0019	0.062	0.032
Endosulfan	0.0054	0.0054	0.0054
Endosulfan Sulfate (e)	0.0054	0.0054	0.0054

TABLE 5-16
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
PCBs, Pesticides, and Herbicides (cont.)			
Endrin	0.0022	0.207	0.1
Endrin Aldehyde (e)	0.0022	0.207	0.1
Endrin Ketone (e)	0.0022	0.207	0.1
gamma-BHC (Lindane)	0.0009	0.005	0.003
Heptachlor	0.0006	0.016	0.0083
Heptachlor Epoxide	0.0006	0.016	0.0083
Isodrin (f)	0.002	0.008	0.005
MCPP	-	-	-
Methoxychlor	0.019	0.019	0.019

Notes:

(a) The sediment quality criteria for aquatic life (Table 5-17), and the Preliminary Remediation Goals ("PRGs") for the mallard duck and western sandpiper (Table 5-15) were considered together to select potential sediment PRGs for each potential chemical of concern ("PCOC"). The lowest values defining the range of PRGs developed for these indicator species of aquatic habitats are listed.

(b) Proposed sediment PRG for protection of non-special status species is the arithmetic mean of the range of PRGs listed in this table for aquatic life, and the mallard duck and western sandpiper.

(c) Hyphen indicates that PRG could not be calculated due to lack of toxicity information.

(d) PRG_{low} is the United States Fish and Wildlife Service recommended no-observed-adverse-effect-level developed in Skorupa J.P., S.P. Morman, and J.S. Sefchick-Edwards. March 1996. *Guidelines for Interpreting Selenium Exposures of Biota Associated with Nonmarine Aquatic Habitats*. Sacramento Field Office.

(e) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(f) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-17
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
Inorganic Chemicals			
Antimony	2	25	14
Arsenic	8.2	70	39
Barium	564	5,639	3,100
Beryllium	282	14,097	7,200
Cadmium	1.2	2	1.6
Chromium	9	74	42
Cobalt	2,930	73,246	38,088
Copper	34	270	152
Cyanide	-	-	-
Lead	46.7	218	132
Tetraethyl Lead	3	169	86
Mercury	0.15	0.71	0.43
Molybdenum	20.3	1,020	522
Nickel	20.9	51.6	36
Selenium (d)	0.4	8.5	4.5
Silver	1	3.7	2.4
Thallium	0.26	69	35
Vanadium	3	14	8.5
Zinc	18	410	214
Semivolatile Organic Compounds			
Acenaphthene	0.016	0.62	0.32
Acenaphthylene	0.044	0.64	0.34
Anthracene	0.0853	1.1	0.59
Benzo(a)anthracene	0.261	1.6	0.93
Benzo(a)pyrene	0.43	1.6	1.0
Benzo(b)fluoranthene	-	-	-
Benzo(g,h,i)perylene	-	-	-
Benzo(k)fluoranthene	-	-	-
Benzyl Alcohol	1.2	288	145
Chrysene	0.384	2.8	1.6
Dibenzo(a,h)anthrancene	0.0634	0.26	0.16
Dibenzofuran	2.0	2.0	2.0
Fluoranthene	0.6	5.1	2.9
Fluorene	0.019	0.54	0.28

TABLE 5-17
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
Semivolatile Organic Compounds (cont.)			
Indeno(1,2,3-cd)pyrene	-	-	-
2-methylnaphthalene	0.07	0.67	0.37
4-methylphenol (p-Cresol)	-	-	-
Naphthalene	0.16	2.1	1.1
n-nitrosodiphenylamine	-	-	-
Pentachlorophenol	-	-	-
Phenanthrene	0.24	1.5	0.87
Phenol	-	-	-
Pyrene	0.665	2.6	1.6
Volatile Organic Compounds			
Acetone	-	-	-
2-butanone (MEK)	-	-	-
Carbon disulfide	-	-	-
1,4-dichlorobenzene	0.35	0.35	0.35
p-isopropyltoluene (p-cymene) (e)	0.67	0.67	0.67
Methylene Chloride	-	-	-
1,2,3-trichlorobenzene (f)	9.2	9.2	9.2
1,2,4-trichlorobenzene	9.2	9.2	9.2
Methylene Chloride	-	-	-
Trichlorfluoromethane	-	-	-
1,1,1-trichloroethane	0.17	0.17	0.17
PCBs, Pesticides, and Herbicides			
PCBs (Arochlor 1254)	0.0227	0.18	0.10
Aldrin	0.018	0.90	0.46
alpha-BHC	0.00032	0.00099	0.0007
beta-BHC	0.00032	0.00099	0.0007
delta-BHC	0.00032	0.00099	0.0007
Chlordane	0.0005	0.006	0.003
2,4-D	-	-	-
Dicamba	-	-	-
4,4'-DDD	0.002	0.02	0.011
4,4'-DDE	0.0022	0.027	0.015
4,4'-DDT	0.001	0.007	0.004
Dieldrin	0.00002	0.052	0.026
Endosulfan	0.0054	0.0054	0.005
Endosulfan Sulfate (g)	0.0054	0.0054	0.005

TABLE 5-17
SEDIMENT PRELIMINARY REMEDIATION GOALS FOR NON-SPECIAL STATUS AQUATIC LIFE AND WILDLIFE SPECIES (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Range of Sediment PRGs (mg/kg); (a)		Proposed Sediment PRG (b) (mg/kg)
	PRG_{low}	PRG_{high}	
PCBs, Pesticides, and Herbicides			
Endrin	0.00002	0.045	0.023
Endrin Aldehyde (g)	0.00002	0.045	0.023
Endrin Ketone (g)	0.00002	0.045	0.023
gamma-BHC (Lindane)	0.00032	0.0037	0.002
Heptachlor	0.080	873	437
Heptachlor Epoxide	0.080	873	437
Isodrin (h)	0.018	0.90	0.46
MCPP	-	-	-
Methoxychlor	0.019	0.019	0.019

Notes:

(a) The sediment quality criteria for aquatic life (Table 5-8), and the Preliminary Remediation Goals ("PRGs") for the mallard duck and western sandpiper (Table 5-15) were considered together to select potential sediment PRGs for each potential chemical of concern ("PCOC"). The lowest values defining the range of PRGs developed for these indicator species of aquatic habitats are listed.

(b) Proposed sediment PRG for protection of non-special status species is the arithmetic mean of the range of PRGs listed in this table for aquatic life, and the mallard duck and western sandpiper.

(c) Hyphen indicates sediment quality criterion not found.

(d) PRG_{low} is the United States Fish and Wildlife Service recommended no-observed-adverse-effect-level developed in Skorupa J.P., S.P. Morman, and J.S. Sefchick-Edwards. March 1996. *Guidelines for Interpreting Selenium Exposures of Biota Associated with Nonmarine Aquatic Habitats*. Sacramento Field Office.

(e) Values for toluene were used for isopropyltoluene.

(f) Values for 1,2,4-trichlorobenzene were used for 1,2,3-trichlorobenzene.

(g) Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(h) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

SOIL PRELIMINARY REMEDIATION GOALS FOR SPECIAL STATUS PLANT SPECIES BASED ON NO-OBSERVED-EFFECTS-CONCENTRATIONS

Presidio of San Francisco, California

Potential Chemical of Concern	Toxicity Benchmarks (a)		No-Observed-Effects-Concentration (mg/kg); (b); (c)						Proposed Alternate PRG for Special Status Plant Species
					Summary Statistics				
	TBV_{low} (mg/kg)	TBV_{high} (mg/kg)	Low	High	5th Percentile	10th Percentile	25th Percentile	Arithmetic Mean	
Inorganic Chemicals									
Arsenic	10	224	10	224	21	31	**64**	117	64
Cadmium	4	100	1	50	3	6	**13**	26	13
Chromium	5	200	1	150	8	16	**38**	76	38
Lead (d)									160
Mercury	0.3	10	0.3	10	0.8	1.3	**2.7**	5.2	3
Nickel	30	500	5	270	18	32	**71**	138	71

Notes:

(a) Preliminary Remediation Goals ("PRGs") may not be protective of individual special status species, especially where the difference between the PRG_{low} and PRG_{high} values used to calculate the mean is great. PRGs for special status plant species were developed for potential chemicals of concern where the difference between the low and high toxicity benchmark values ("TBVs") for the species governing determination of the cleanup levels is more than one order of magnitude. TBV_{low} values from Table 5-12 and TBV_{high} values from Table 5-13 are included for reference.

(b) No-observed-effects-concentrations ("NOECs") were compiled from the references consulted for non-special status plant species. However, the low and high values used to develop special status species PRGs encompassed the entire range of NOECs and excluded lowest-observed-effects-concentrations ("LOECs"). The 5th, 10th, and 25th percentiles, and arithmetic means of the NOEC values were computed, as summarized in this table. The 25th percentile of NOECs for each metal is proposed as the PRG because this percentile includes NOECs obtained from studies on a variety of soil types and species, including species that are taxonomically similar to those at the Presidio.

(c) Values that are boxed and shown in bold are proposed as PRG for rare, or threatened or endangered plant (i.e., special status) species.

(d) Special status species PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive special status species PRG for lead.

TAB 5-19
SOIL PRELIMINARY REMEDIATION GOALS FOR SPECIAL STATUS WILDLIFE SPECIES BASED ON TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	PRGs for Peregine Falcon (a)		Summary Statistics for Peregrine Falcon (mg/kg); (b); (c)					Proposed Alternate PRG for Special Status Wildlife Species
	PRG_{low} (mg/kg)	PRG_{high} (mg/kg)	5th Percentile	10th Percentile	25th Percentile	Arithmetic Mean	Toxicity Endpoint of Study	
Inorganic Chemicals								
Arsenic	170	5,130	418	**666**	1,410	2,650	Protective	666
Lead (d)								
Mercury	0.095	29.7	**1.6**	3.1	7.5	15	Protective	1.58
Nickel	215	10,700	**739**	1,264	2,836	5,458	Protective	739
Selenium	6.21	117	**11.7**	17	34	62	Protective	12
Silver	21.5	1,070	**74**	126	284	546	Based on mortality/10	74
Thallium	0.614	291	**15**	30	73	146	Based on mortality/10	15
PCBs, Pesticides, and Herbicides								
PCBs (Aroclor 1254)	0.09	8	**0.490**	0.88	2.1	4.0	Protective	0.49
Aldrin	0.016	2	**0.097**	0.18	0.42	0.82	Based on mortality/10	0.097
alpha-BHC	0.13	45	**2.4**	4.6	11	23	Protective	2.4
beta-BHC	0.13	45	**2.4**	4.6	11	23	Protective	2.4
delta-BHC	0.13	45	**2.4**	4.6	11	23	Protective	2.4
Chlordane	0.04	0.81	0.080	**0.12**	0.23	0.42	Based on mortality/10	0.12
4,4'-DDD	0.14	4	0.34	**0.53**	1.12	2.10	Protective; adjusted for endpoint	0.53
4,4'-DDE	0.22	4	0.42	**0.61**	1.18	2.15	Protective; adjusted for endpoint	0.61
4,4'-DDT	0.14	4	0.34	**0.53**	1.12	2.10	Protective; adjusted for endpoint	0.53
Dieldrin			0.36	**0.55**	1.14	2.12	Low partially based on mortality	0.55
Endrin	0.007	2	**0.11**	0.21	0.5	1.0	Protective	0.11
Endrin Aldehyde (e)	0.007	2	**0.11**	0.21	0.5	1.0	Protective	0.11
Endrin Ketone (e)	0.007	2	**0.11**	0.21	0.5	1.0	Protective	0.11
gamma-BHC	0.023	7	**0.37**	0.72	1.8	3.5	Based on mortality/10	0.37
Heptachlor	0.017	358	**18**	36	90	179	Based on mortality/10	18
Heptachlor Epoxide	0.017	358	**18**	36	90	179	Based on mortality/10	18
Isodrin (f)	0.016	2	**0.097**	0.18	0.42	0.82	Based on mortality/10	0.097
Methoxychlor	0.9	451	**23**	46	113	226	Based on mortality/10	26

BASED ON TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Notes:

(a) Soil Preliminary Remediation Goals ("PRGs") for non-special status plant and animal species listed in Table 5-14.

(b) PRGs for special status wildlife species are established from the PRG_{low} and PRG_{high} values for the peregrine falcon because the PRGs for this bird are the lowest of the avian indicator species evaluated for terrestrial habitats. PRG concentrations were computed from TBVs compiled from the references consulted for non-special status wildlife species. The 5th percentile is proposed as the PRG where the difference between PRG_{low} and PRG_{high} values for non-special status species is two orders of magnitude or greater. The 10th percentile is proposed as the PRG where the difference between PRG_{low} and PRG_{high} values for non-special status species is between one and two orders of magnitude.

(c) Values that are boxed and shown in bold are proposed as PRG for rare, or threatened or endangered wildlife (i.e., special status) species.

(d) Special status species PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive special status species PRG for lead.

(e) Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(f) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TAE 5-20

SEDIMENT PRELIMINARY REMEDIATION GOALS FOR SPECIAL STATUS WILDLIFE SPECIES BASED ON TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Potential Chemical of Concern	PRGs for Western Sandpiper (a)		Summary Statistics for Western Sandpiper (mg/kg); (b); (c)					Proposed PRG for Special Status Wildlife Species
	PRG_{low} (mg/kg)	PRG_{high} (mg/kg)	5th Percentile	10th Percentile	25th Percentile	Arithmetic Mean	Toxicity Endpoint of Study	
Inorganic Chemicals								
Arsenic	81	1,220	138	**195**	366	651	Protective	195
Lead (d)								
Mercury	0.33	52	**2.9**	5.5	13.2	26	Protective	2.9
Nickel	101	2,540	223	**345**	711	1,321	Protective	345
Selenium	0.84	9	1.2	**1.6**	3	5	Protective	1.6
Silver	10	254	**22**	34	71	132	Based on mortality/10	22
Thallium	0.26	69	**3.7**	7	17	35	Based on mortality/10	3.7
PCBs, Pesticides, and Herbicides								
PCBs (Aroclor 1254)	0.047	2	**0.14**	**0.24**	0.54	1.0	Protective	0.14
Aldrin	0.018	1	0.061	**0.1**	0.23	0.45	Based on mortality/10	0.1
alpha-BHC	0.28	50	**2.8**	5.3	13	25	Protective	2.8
beta-BHC	0.28	50	**2.8**	5.3	13	25	Protective	2.8
delta-BHC	0.28	50	**2.8**	5.3	13	25	Protective	2.8
Chlordane	0.03	0.33	0.048	**0.062**	0.11	0.18	Based on mortality/10	0.062
4,4'-DDD	0.22	11	0.75	**1.3**	2.9	5.6	Protective; adjusted for endpoint	1.3
4,4'-DDE	0.44	11	0.96	**1.5**	3.1	5.7	Protective; adjusted for endpoint	1.5
4,4'-DDT	0.22	11	0.75	**1.3**	2.9	5.6	Protective; adjusted for endpoint	1.3
Dieldrin	0.179	2	0.28	**0.39**	0.69	1.21	Low partially based on mortality	0.39
Endrin	0.016	2	**0.12**	0.21	0.51	1.0	Protective	0.12
Endrin Aldehyde (e)	0.016	2	**0.12**	0.21	0.51	1.0	Protective	0.12
Endrin Ketone (e)	0.016	2	**0.12**	0.21	0.51	1.0	Protective	0.12
gamma-BHC	0.049	7	**0.4**	0.74	1.8	3.5	Based on mortality/10	0.4
Heptachlor	0.08	873	**44**	87	218	437	Based on mortality/10	44
Heptachlor Epoxide	0.08	873	**44**	87	218	437	Based on mortality/10	44
Isodrin (f)	0.018	1	**0.1**	0.10	0.23	0.45	Based on mortality/10	0.1
Methoxychlor	2	500	**27**	52	127	251	Based on mortality/10	27

SEDIMENT PRELIMINARY REMEDIATION GOALS FOR SPECIAL STATUS WILDLIFE SPECIES BASED ON TOXICITY BENCHMARK VALUES

Presidio of San Francisco, California

Notes:

(a) Sediment Preliminary Remediation Goals ("PRGs") for non-special status plant and animal species listed in Table 5-15.

(b) PRGs for special status wildlife species are established from the PRG_{low} and PRG_{high} values for the western sandpiper because the PRGs for this bird are the lowest of the avian indicator species evaluated for aquatic habitats. PRG concentrations were computed from TBVs compiled from the references consulted for non-special status wildlife species. The 5th percentile is proposed as the PRG where the difference between PRG_{low} and PRG_{high} values for non-special status species is two orders of magnitude or greater. The 10th percentile is proposed as the PRG where the difference between PRG_{low} and PRG_{high} values for non-special status species is between one and two orders of magnitude.

(c) Values that are boxed and shown in bold are proposed as PRG for rare, or threatened or endangered wildlife (i.e., special status) species.

(d) A special status species PRG for lead was not calculated because the sediment quality criteria for aquatic life is protective of aquatic life, including special status species. Refer to text for discussion of methodology used to derive special status species PRG for lead.

(e) Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(f) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-21
COMPARISON OF SOIL PRELIMINARY REMEDIATION GOALS OF NON-SPECIAL STATUS AND SPECIAL STATUS SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plant and Soil Fauna PRGs (mg/kg); (a)		Wildlife PRGs (mg/kg); (b)		Alternate PRGs for Special Status Species (mg/kg); (c)
	Non-Special Status	Special Status	Non-Special Status	Special Status	
Inorganic Chemicals					
Arsenic	117	64	369	666	64
Lead (d)					160
Mercury	5.2	2.7	5.9	1.6	1.6
Nickel	265	71	749	739	71
Selenium	36	- (e)	1.1	12	
Silver	2	-	749	74	
Thallium	1	-	196	15	
PCBs, Pesticides, and Herbicides					
PCBs (Aroclor 1254)	40	240	0.23	0.49	
Aldrin	-	-	0.1	0.097	0.097
alpha-BHC	-	-	4.9	2.4	2.4
beta-BHC	-	-	4.9	2.4	2.4
delta-BHC	-	-	4.9	2.4	2.4
Chlordane	-	-	0.04	0.12	
4,4'-DDD	120	-	1.25	0.53	0.53
4,4'-DDE	120	-	1.27	0.61	0.61
4,4'-DDT	120	-	1.23	0.53	0.53
Dieldrin	75	-	0.26	0.55	
Endrin	-	-	0.25	0.11	0.11
Endrin Aldehyde (f)	-	-	0.25	0.11	0.11
Endrin Ketone (f)	-	-	0.25	0.11	0.11
gamma-BHC	-	-	0.83	0.37	0.37

TABLE 5-21

COMPARISON OF SOIL PRELIMINARY REMEDIATION GOALS OF NON-SPECIAL STATUS AND SPECIAL STATUS SPECIES

Presidio of San Francisco, California

Potential Chemical of Concern	Plant and Soil Fauna PRGs (mg/kg); (a)		Wildlife PRGs (mg/kg); (b)		Alternate PRGs for Special Status Species (mg/kg); (c)
	Non-Special Status	Special Status	Non-Special Status	Special Status	
PCBs, Pesticides, and Herbicides (contd)					
Heptachlor	-	-	3.7	18	
Heptachlor Epoxide	-	-	3.7	18	
Isodrin (g)	-	-	0.1	0.097	0.097
Methoxychlor	-	-	18	26	

Notes:

(a) Preliminary Remediation Goals ("PRGs") for non-special status and special status plant and soil fauna species compiled from Table 5-14 and Table 5-18, respectively.

(b) PRGs for non-special status and special status wildlife species compiled from Table 5-14 and Table 5-19, respectively.

(c) PRGs for special status species that are proposed as soil/sediment Alternate PRGs for special status species. Receptors that are not special status species may have lower PRGs because of higher exposure or different sensitivity to potential chemicals of concern ("PCOCs"). For PCOCs where special status PRGs are not the lowest PRGs no value is presented for the Alternate PRGs for special status species.

(d) Special status species PRG for lead was calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive special status species PRG for lead.

(e) Hyphen indicates that PRG could not be calculated due to lack of toxicity information.

(f) Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(g) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-22
COMPARISON OF SEDIMENT PRELIMINARY REMEDIATION GOALS OF NON-SPECIAL STATUS AND SPECIAL STATUS SPECIES (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Aquatic Life and Wildlife PRGs (mg/kg); (a)		Special Status PRGs Proposed for Use as Cleanup Levels (b) (mg/kg)
	Non-Special Status	Special Status	
Inorganic Chemicals			
Arsenic	19	195	
Lead (c)	82		
Mercury	0.6	2.9	
Nickel	46	345	
Selenium	4.5	1.6	1.6
Silver	1	22	
Thallium	35	3.7	3.7
PCBs, Pesticides, and Herbicides			
PCBs (Aroclor 1254)	0.36	0.14	0.14
Aldrin	0.005	0.1	
alpha-BHC	0.008	2.8	
beta-BHC	0.013	2.8	
delta-BHC	0.0075	2.8	
Chlordane	0.01	0.062	
4,4'-DDD	0.016	1.3	
4,4'-DDE	0.016	1.5	
4,4'-DDT	0.032	1.3	
Dieldrin	0.032	0.39	
Endrin	0.1	0.12	
Endrin Aldehyde (d)	0.1	0.12	
Endrin Ketone (d)	0.1	0.12	
gamma-BHC	0.003	0.4	
Heptachlor	0.0083	44	
Heptachlor Epoxide	0.0083	44	
Isodrin (e)	0.005	0.1	
Methoxychlor	0.019	27	

Notes:

(a) Preliminary Remediation Goals ("PRGs") for non-special status and special status aquatic life and wildlife species compiled from Table 5-16 and Table 5-20, respectively.

(b) PRGs for special status species that are proposed as soil/sediment PRGs for special status species. Receptors that are not special status species may have lower PRGs because of higher exposure or different sensitivity to potential chemicals of concern ("PCOCs"). For PCOCs where special status PRGs are not the lowest PRGs, soil/sediment PRGs for non-special status species will be applied as cleanup levels and considered protective of special status species as well.

(c) Refer to text for discussion of methodology used to derive sediment PRG for lead.

(d) Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(e) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-23
COMPARISON OF SEDIMENT PRELIMINARY REMEDIATION GOALS OF NON-SPECIAL STATUS AND SPECIAL STATUS SPECIES (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Aquatic Life and Wildlife PRGs (mg/kg); (a)		Special Status PRGs Proposed for Use as Cleanup Levels (b) (mg/kg)
	Non-Special Status	Special Status	
Inorganic Chemicals			
Arsenic	39	195	
Lead (c)	132		
Mercury	0.43	2.9	
Nickel	36	345	
Selenium	4.5	1.6	1.6
Silver	2.4	22	
Thallium	35	3.7	3.7
PCBs, Pesticides, and Herbicides			
PCBs (Aroclor 1254)	0.10	0.14	
Aldrin	0.46	0.1	0.1
alpha-BHC	0.0007	2.8	
beta-BHC	0.0007	2.8	
delta-BHC	0.0007	2.8	
Chlordane	0.0033	0.062	
4,4'-DDD	0.011	1.3	
4,4'-DDE	0.015	1.5	
4,4'-DDT	0.004	1.3	
Dieldrin	0.026	0.39	
Endrin	0.023	0.12	
Endrin Aldehyde (d)	0.023	0.12	
Endrin Ketone (d)	0.023	0.12	
gamma-BHC	0.002	0.4	
Heptachlor	437	44	44
Heptachlor Epoxide	437	44	44
Isodrin (e)	0.46	0.1	0.1
Methoxychlor	0.019	27	

Notes:

(a) Preliminary Remediation Goals ("PRGs") for non-special status and special status aquatic life and wildlife species compiled from Table 5-17 and Table 5-20, respectively.

(b) PRGs for special status species that are proposed as soil/sediment PRGs for special status species. Receptors that are not special status species may have lower PRGs because of higher exposure or different sensitivity to potential chemicals of concern ("PCOCs"). For PCOCs where special status PRGs are not the lowest PRGs, soil/sediment PRGs for non-special status species will be applied as cleanup levels and considered protective of special status species as well.

(c) Refer to text for discussion of methodology used to derive sediment PRG for lead.

(d) Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

(e) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

TABLE 5-24
SUMMARY OF ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Alternate PRGs (mg/kg); (b)	Proposed Buffer Zone PRGs (mg/kg); (c)	Proposed Special Status PRGs (mg/kg); (d)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			
Inorganic Chemicals									
Antimony	5	5	5	162	490	326	- (e)	5	5
Arsenic	10	224	117	46	692	369	64	64	10
Barium	500	500	500	320	3,200	1,760	-	500	320
Beryllium	10	10	10	160	8,000	4,080	-	10	10
Cadmium	4	100	52	0.017	0.44	0.23	-	0.23	0.017
Chromium	5	200	103	4	42	23	-	23	4
Cobalt	20	75	48	220	3,300	1,760	-	48	20
Copper	50	400	225	30	200	115	-	120	30
Cyanide	-	-	-	6,298	18,894	12,596	-	13,000	6,300
Lead (f)	-	-	-	-	-	-	-	300	160
Tetraethyl Lead	-	-	-	1.1	52	27	-	27	1.1
Mercury	0.3	10	5.15	0.038	12	6	1.6	1.6	0.4 (g)
Molybdenum	-	-	-	11.5	582	297	-	300	12
Nickel	30	500	265	58	1,440	749	71	71	30
Selenium	1	70	35.5	0.20	2	1	-	1.1	0.2
Silver	2	2	2	6	144	75	-	2	2
Thallium	1	1	1	0.15	39	20	-	1	0.15
Vanadium	2	20	11	2	8	5	-	5	2
Zinc	50	864	457	4	97	51	-	50	4
Semivolatile Organic Compounds									
Acenaphthene	30	50	40	84	2,547	1,316	-	40	30
Acenaphthylene	30	50	40	84	2,547	1,316	-	40	30
Anthracene	30	50	40	84	2,547	1,316	-	40	30
Benzo(a)anthracene	30	50	40	84	2,547	1,316	-	40	30
Benzo(a)pyrene	30	50	40	84	2,547	1,316	-	40	30

SUMMARY OF ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Alternate PRGs (mg/kg); (b)	Proposed Buffer Zone PRGs (mg/kg); (c)	Proposed Special Status PRGs (mg/kg); (d)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			
Semivolatile Organic Compounds									
Benzo(b)fluoranthene	30	50	40	84	2,547	1,316	-	40	30
Benzo(g,h,i)perylene	30	50	40	84	2,547	1,316	-	40	30
Benzo(k)fluoranthene	30	50	40	84	2,547	1,316	-	40	30
Benzyl Alcohol	-	-	-	1	164	83	-	40 (h)	1
Chrysene	30	50	40	84	2,547	1,316	-	40	30
Dibenzo(a,h)anthracene	30	50	40	84	2,547	1,316	-	40	30
Dibenzofuran	-	-	-	-	-	-	-	-	-
Fluoranthene	30	50	40	84	2,547	1,316	-	40	30
Fluorene	30	50	40	84	2,547	1,316	-	40	30
Indeno(1,2,3-cd)pyrene	30	50	40	84	2,547	1,316	-	40	30
2-methylnaphthalene	30	50	40	84	2,547	1,316	-	40	30
4-methylphenol (p-Cresol)	50	50	50	11,167	55,782	33,474	-	50	50
Naphthalene	30	50	40	84	2,547	1,316	-	40	30
n-nitrosodiphenylamine	20	109	65	16,981	50,942	33,962	-	65	20
Pentachlorophenol	3	4	3.5	22	660	341	-	3.5	3
Phenanthrene	30	50	40	84	2,547	1,316	-	40	30
Phenol	30	188	109	2,547	7,641	5,094	-	109	30
Pyrene	30	50	40	84	2,547	1,316	-	40	30

TABLE 5-24
SUMMARY OF ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Alternate PRGs (mg/kg); (b)	Proposed Buffer Zone PRGs (mg/kg); (c)	Proposed Special Status PRGs (mg/kg); (d)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			
Volatile Organic Compounds									
Acetone	-	-	-	8,490	127,356	67,923	-	68,000	8,500
2-butanone (MEK)	-	-	-	4,245	25,471	14,858	-	15,000	4,200
Carbon disulfide	-	-	-	934	28,018	14,476	-	14,000	934
1,4-dichlorobenzene	20	128	74	2,123	12,736	7,429	-	74	20
p-isopropyltoluene (p-cymene)	200 (i)	1,000 (i)	600 (i)	2,207 (i)	22,075 (i)	12,141 (i)	-	600 (i)	200 (i)
Methylene Chloride	-	-	-	459	34,377	17,418	-	17,000	459
1,2,3-trichlorobenzene (j)	20	115	67.5	-	-	-	-	68	20
1,2,4-trichlorobenzene	20	127	73.5	-	-	-	-	74	20
Trichlorofluoromethane	-	-	-	-	-	-	-	-	-
1,1,1-trichloroethane	-	-	-	9,679	1,451,858	730,768	-	730,000	9,700
PCBs, Pesticides, and Herbicides									
PCBs (Arochlor 1254)	40	240	140	0.010	0.45	0.23	-	0.23	*0.033*
Aldrin	-	-	-	0.0039	0.19	0.1	0.097	0.1	0.0039
alpha-BHC	-	-	-	0.062	9.8	4.9	2.4	2.4	0.062
beta-BHC	-	-	-	0.062	9.8	4.9	2.4	2.4	0.062
delta-BHC	-	-	-	0.062	9.8	4.9	2.4	2.4	0.062
Chlordane	-	-	-	0.0090	0.071	0.04	-	0.04	0.0090
2,4-D	-	-	-	-	-	-	-	5	*0.025*
Dicamba	-	-	-	-	-	-	-	5	*0.01*
4,4'-DDD	40	200	120	0.049	2.4	1.2	0.53	0.53	0.049
4,4'-DDE	40	200	120	0.098	2.4	1.3	0.61	0.61	0.098
4,4'-DDT	40	200	120	0.0082	2.4	1.2	0.53	0.53	0.0082
Dieldrin	50	100	75	0.039	0.48	0.26	-	0.26	0.039
Endosulfan	-	-	-	1.1	5.5	3.3	-	3.3	1.1

TABLE 5-24

SUMMARY OF ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Potential Chemical of Concern	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Alternate PRGs (mg/kg); (b)	Proposed Buffer Zone PRGs (mg/kg); (c)	Proposed Special Status PRGs (mg/kg); (d)
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			
PCBs, Pesticides, and Herbicides									
Endosulfan Sulfate (j)	-	-	-	1.1	5.5	3.3	-	3.3	1.1
Endrin	-	-	-	0.0035	0.50	0.25	0.11	0.11	*0.004*
Endrin Aldehyde (j)	-	-	-	0.0035	0.50	0.25	0.11	0.11	*0.004*
Endrin Ketone (j)	-	-	-	0.0035	0.50	0.25	0.11	0.11	*0.004*
gamma-BHC (Lindane)	-	-	-	0.010	1.6	0.8	0.37	0.37	0.010
Heptachlor	-	-	-	0.017	7.4	3.7	-	3.7	0.017
Heptachlor Epoxide	-	-	-	0.017	7.4	3.7	-	3.7	0.017
Isodrin (j)	-	-	-	0.0039	0.19	0.1	0.097	0.1	0.0039
MCPP	-	-	-	-	-	-	-	-	*5.0*
Methoxychlor	-	-	-	0.44	35	18	-	18	0.44

Notes:

(a) Listed in these columns are the following: (1) the plant and soil fauna represent the low and high Preliminary Remediation Goals ("PRGs") from Tables 5-12 and 5-13; (2) the wildlife PRG_{low} represents the lowest of the wildlife PRG_{low} from Table 5-12; and (3) the wildlife PRG_{high} represents the lowest of the wildlife PRG_{high} from Table 5-13.

(b) Alternate PRGs for special status species were developed by the Trust for PCOCs which have a large difference (greater than one order of magnitude) between PRG_{low} and PRG_{high}. These values were obtained from Table 5-21.

(c) The buffer zone PRG proposed for protection of non-special status species is the lowest of the arithmetic mean of plant and soil fauna PRGs, the arithmetic mean of wildlife PRGs, the Alternate PRG for special status species, or 5 mg/kg for pesticides or herbicides for which not enough toxicological data exist to calculate a PRG_{low} and PRG_{high} (i.e., 2,4-D, Dicamba, and MCPP).

(d) Values are proposed as soil PRGs for protection of special status species. The special status PRG, as used in this document, is established as the lower value of (1) the PRG_{low} for plant and soil fauna or (2) the PRG_{low} for wildlife, unless the PRG_{low} is less than the laboratory method detection limit. Italics indicates that the laboratory detection limit exceeds the PRG_{low}, and thus the detection limit is selected as the PRG. The laboratory detection limit is also used as the special status PRG for pesticides and herbicides for which not enough toxicological data exist to calculate ecological PRGs.

TABLE 5-24
SUMMARY OF ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Notes:

(e) Hyphen indicates that PRG could not be calculated due to lack of applicable toxicity data in available literature, or no value is appropriate based on the Trust's assessment of alternate PRGs for special status species.

(f) Ecological PRGs for lead were calculated through use of the Monte Carlo method. Refer to text for discussion of methodology used to derive the ecological PRGs for lead.

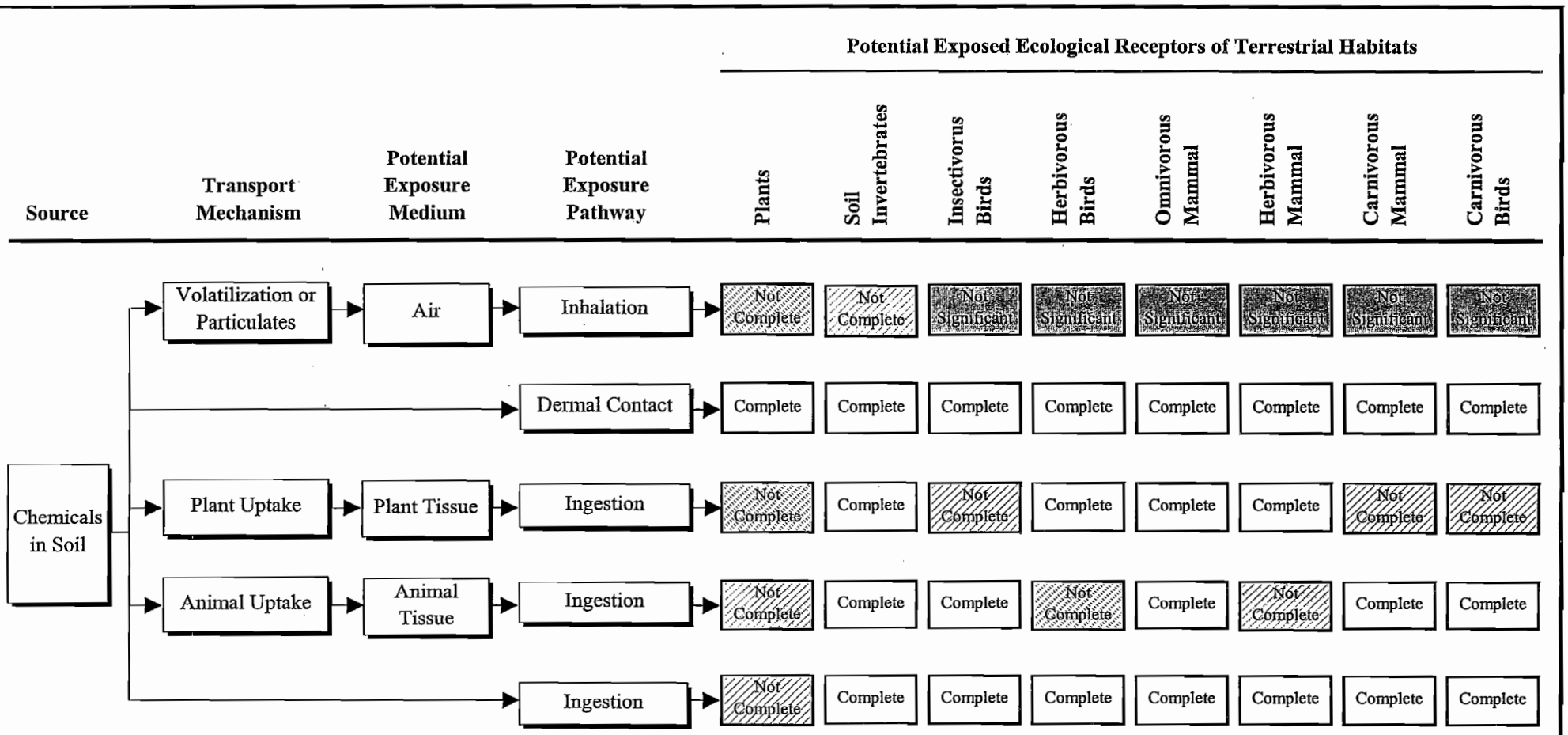
(g) Mercury level for special status species is based on risk management concerns and is established at 2 times the typical method detection limit.

(h) For benzyl alcohol, the buffer zone PRG was decreased from the wildlife arithmetic mean PRG to be more in line with the other semivolatile organic compounds.

(i) Toluene was used as a surrogate for isopropyltoluene.

(j) Values for Endosulfan were used for Endosulfan Sulfate, values for Endrin were used for Endrin Aldehyde and Endrin Ketone.
Isodrin is an isomer of Aldrin; values for Aldrin were used for Isodrin.

FIGURES



Legend

Complete — Pathway Complete or Potentially Complete. Pathway Has Been Quantitatively Evaluated.

Not Significant — Pathway Complete or Potentially Complete; Exposure is Not Considered Significant. Pathway Has Not Been Evaluated Quantitatively.

Not Complete — Pathway is Not Considered Complete.

Harding ESE

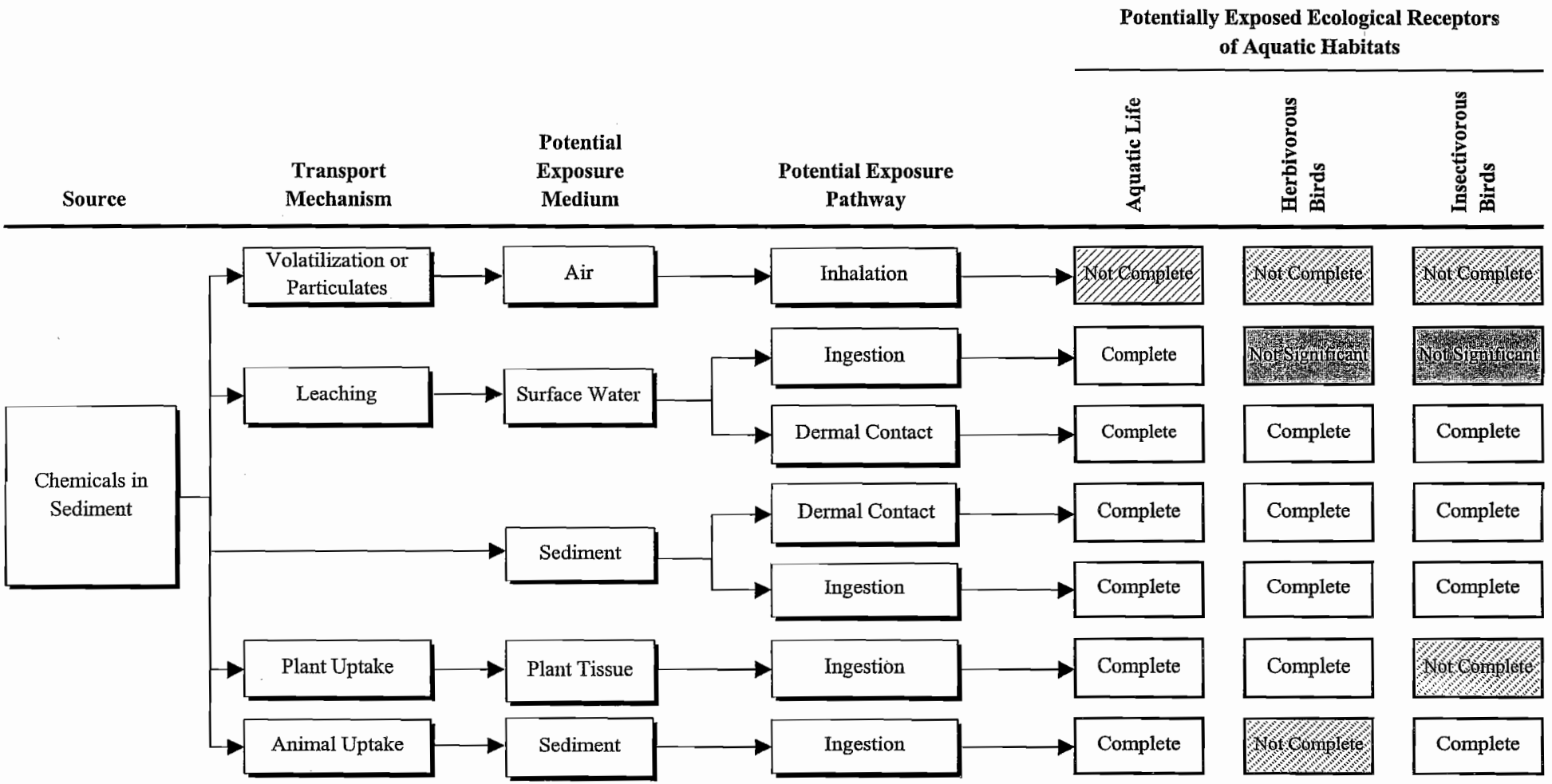
Potential Ecological Chemical Exposure Pathways for Terrestrial Habitats

Presidio of San Francisco, California

Erler & Kalinowski, Inc.

October 2002

Figure 5-1



Potential Ecological Chemical Exposure Pathways for Aquatic Habitats

Presidio of San Francisco, California

Harding ESE

Erler & Kalinowski, Inc.

October 2002

Figure 5-2

6. BACKGROUND CONCENTRATIONS OF METALS IN SOIL AND WATER AT THE PRESIDIO

6. BACKGROUND CONCENTRATIONS OF METALS IN SOIL AND WATER AT THE PRESIDIO

Under 22 CCR §66261.24, DTSC lists seventeen metals (i.e., antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc) that may pose human health and ecological risks if present in waste at sufficiently high concentrations. U.S. EPA (1999b) has established PRGs for these metals in soil and water based upon available toxicological data. However, identification of a release is complicated by the fact that all of these metals are naturally occurring (i.e., at background levels) in soil, sediment, groundwater, and surface water. Background metal concentrations were assessed because it is impractical to remediate releases of metals to less than naturally occurring concentrations. Background concentrations of metals derived in this section have been incorporated into cleanup levels presented in Section 7 to assist in distinguishing between releases of metals at Presidio sites and naturally occurring concentrations of metals in soil and water at the Presidio.

6.1 PRESIDIO GEOLOGY

Studies conducted by the Army (Dames & Moore, 1997b; IT Corporation, 1999; Montgomery Watson, 1999a, 1998a, 1996, 1995; Argonne National Laboratory, 1989) and others (Schlocker, 1974) have identified serpentinite, Colma Formation, and beach/dune sand as the three primary lithologies or soil types at the Presidio. Serpentinite is bedrock unit, part of the Franciscan Formation, whereas the Colma Formation and the beach/dune sands are unconsolidated sediments deposited on top of bedrock. These three primary units were distinguished in borehole logging performed by the Army and considered as distinct geochemically in its assessment of background metals. Based upon mapping performed by the USGS (Schloker, 1974), the generalized surface distribution of serpentinite, Colma Formation, and beach/dune sand is shown on Figure 6-1. This figure is a geological map; each contact has not been field verified at each site. Actual field observations at a particular site will be used to determine site-specific lithology.

Five other secondary geologic units occur at the Presidio in sufficient volumes to be discernible on the 1:24,000-scale USGS geologic map (Schloker, 1974). These units consist of four Franciscan Formation bedrock units (which were not distinguished by the Army in borehole logs nor in the background metals assessment) and Artificial Fill. In detail, the bedrock units are Sheared Rock, Jurassic/Cretaceous Sedimentary Rocks, Greenstone, and Chert/Shale. The Sheared Rock unit is a mixed bedrock unit. It is made up of a soft, highly sheared, clayey matrix of serpentinite, shale, or both, in which occur coherent blocks of Jurassic/Cretaceous Sedimentary Rock and serpentinite. The Jurassic/Cretaceous Sedimentary Rocks is a bedrock unit that is made up of interbedded sandstones, shales, and occasional conglomerates. Greenstone is a bedrock unit made up of dark green meta-basalt that occurs interbedded with the Jurassic/Cretaceous

Sedimentary Rocks and the Chert/Shale. Chert/Shale is a bedrock unit made up of alternating beds of hard, red-brown chert and softer, red-brown shale. It occurs interbedded with greenstone and Jurassic/Cretaceous Sedimentary Rocks. At the Presidio, both Greenstone and Chert/Shale are exposed in minor outcrops only along the Coastal Bluffs. Artificial Fill is an all-inclusive term for unconsolidated material artificially placed for engineering purposes. It includes material probably excavated from local sources at the Presidio as well as material brought in from Fort Baker/Marin Peninsula or dredged from San Francisco Bay.

Although these soil types can be found separately at the Presidio, they are often commingled due to natural events or human activity. As shown on Figure 6-1, landslide deposits and soil reside as fill in ravines at the Fort Scott, Presidio Hill, and Presidio Forest planning areas. These deposits are likely to be derived from any of the three soil types, individually or mixed together. Dames & Moore (1997b) indicates that the landslide deposits and soil in these ravines are generally thin, but may be as thick as 150 feet at some locations. In addition, Artificial Fill is common at the Presidio and may include any or all of the Presidio rock and soil types as well as material brought in from off-site.

The main significance of the secondary geologic units is that, with the exception of Chert/Shale, they have not been characterized geochemically in terms of background metals. Hence, if encountered during remedial activities, these units may have background metals "signatures" that differ from the primary soil types and therefore, can be confused with contamination. For example, Greenstone will typically show higher background levels of chromium, nickel, copper, and vanadium than many other rocks or soils.

The characteristics of the three primary soil types, serpentinite, Colma Formation, and beach/dune sand, are discussed further in Sections 6.1.1 through 6.1.3. Chert/Shale, which have been used as fill and base rock at Crissy Field and other locations at the Presidio, is discussed in Section 6.1.4 because this material is also likely to be encountered during implementation of remedial actions. Greenstone is discussed in Section 6.1.5 because it seems to be present in some fill and, therefore, may be encountered during remedial actions. The actual site-specific lithology will be determined in the field through sampling.

6.1.1 Serpentinite

Serpentinite is an ultramafic rock (i.e., a rock composed mostly of magnesium and iron minerals) that is associated with the Franciscan Formation at the Presidio. It is made up of varying proportions of the three magnesium silicate serpentine minerals, antigorite, chrysotile (a form of asbestos), and lizardite. Serpentinite intrusives and coherent blocks of hard rock in a matrix of intensely sheared shale and serpentinite comprise the outcrops or exposed bedrock observed in the remainder of the Presidio (Schlocker, 1974). Serpentinite is a distinctive greenish gray to bluish gray crumbly rock that tends to form

poorly developed soils with a wide range of grain sizes. It is geochemically distinctive in that it typically contains high concentrations of chromium, nickel, and cobalt.

6.1.2 Colma Formation

The Colma Formation overlies bedrock in the south and southeast portions of the Presidio. The Colma Formation consists of unconsolidated fine to medium sand with moderate amounts of silt and clay. Dames & Moore (1997b) notes that these unconsolidated deposits are generally yellow to reddish brown, but can be gray to black at some locations. Schlocker (1974) reports that the Colma Formation may range in thickness from 75 to 300 feet. The Colma Formation overlies Franciscan Formation lithologies (e.g., serpentinite, Jurassic/Cretaceous Sedimentary Rocks, etc.) and may in turn be covered by geologically younger beach/dune sand. In terms of background metals, the Colma Formation is geochemically very similar to the beach/dune sand.

6.1.3 Beach/Dune Sand

Beach and dune sand comprises the bulk of the exposed deposits in the southwest portion, and along the ocean and bay fronts of the Presidio. These deposits are highly permeable, clean, well-sorted sand that are yellowish brown to light gray in color. Schlocker (1974) reports that the thickness of beach/dune sand deposits are typically on the order of 100 feet. Beach and dune sand overlie the Franciscan and Colma Formations. In terms of background metals, beach/dune sand is very similar to the Colma Formation.

6.1.4 Chert/Shale

Investigations and remedial actions conducted at Crissy Field find that reddish brown chert and shale have been placed as fill in the upper 2 feet of ground throughout much of this area. Chert/shale has also been used as fill and base rock at other areas of the Presidio. As noted by Schlocker (1974), only minor outcrops of chert are present at the Presidio, and only in the relatively inaccessible Coastal Bluffs planning area. Based upon a study conducted for the Army, IT Corporation believes that the chert/shale found at Crissy Field was imported to the Presidio. IT Corporation (1999) states:

> Although the specific source is presently unknown, it is possible that the quickest, easiest and cheapest source was the Marin Peninsula chert, barged in as fill probably for the 1915 Panama-Pacific International Exposition. The similarities between the Presidio chert and shale and the southern Marin Peninsula chert and shale...would tend to support this possibility.

Chert/shale is a dark reddish brown rock with regularly alternating layers of chert and shale. Individual layers of chert and shale observed in outcrops generally vary from a fraction of an inch to several inches thick. These thin layers or bands cause the two rock types to become intimately mixed together when imported and placed as fill. The reddish

brown shale associated with the chert is a distinctly different lithology from the gray-green sheared shale sometimes associated with serpentinite.

6.1.5 Greenstone

Greenstone is a dark greenish gray to gray olive colored basaltic rock found associated with chert/shale and/or Jurassic/Cretaceous sedimentary rocks of the Franciscan Formation. When it occurs as a submarine pillow lava, greenstone can develop curving, slickensided surfaces that resemble serpentinite. It appears to be present in fill at Graded Area 9 and the Transfer Station sites where it has been erroneously logged as serpentinite. The locations of these sites are shown on Figure 2-2. Greenstone is not specifically mapped on Figure 6-1. Greenstone is geochemically similar to serpentinite in that it naturally contains higher concentrations of chromium and nickel than other geologic units at the Presidio. Greenstone is geochemically distinctive relative to serpentinite in that the concentrations of nickel and chromium are in the hundreds of mg/kg instead of thousands of mg/kg and greenstone typically contains several hundred mg/kg vanadium. Schloker (1974) reports greenstone analyses from the northern San Francisco Quadrangle that range from 15 to 300 mg/kg chromium, 150 to 300 mg/kg nickel, and 150 to 300 mg/kg vanadium.

6.2 APPROACH TO DEVELOPING BACKGROUND METALS CONCENTRATIONS IN SOIL

Evaluation of background metals in soil included development of a DTSC-approved approach to evaluate background metals concentrations, evaluation of the existing soil metal data set, determining screening levels of metals in soil, and determining threshold levels of metals in soil. These topics are discussed in Sections 6.2.1 through 6.2.4.

6.2.1 Regulatory Guidelines

During preparation of the Revised Final Feasibility Study for Main Installation Sites, the Trust received feedback from the DTSC regarding the approach for evaluating background metals at the Presidio. The DTSC expressed an interest in promoting consistency among base closure sites throughout California. The principal features of the background metals evaluation approach were as follows:

- The probability of "false negatives", i.e., erroneously concluding that significant contamination is not present when it actually is present, should be made as small as possible.

- Evaluating background metals concentrations at the Presidio should be a two-tiered statistical process involving definition of "screening" levels and "threshold" levels. Screening levels are used to determine PCOCs and threshold levels are used to define COCs.

- Only site-specific background data should be used to determine both screening levels and threshold levels (i.e., regional data would not be appropriate to establish background concentrations).

- For a given metal, there should be separate screening and threshold levels for each of the primary soil types encountered at the Presidio.

- In order to make valid estimates of screening and threshold metals levels, a minimum statistical mass must be present, i.e., there should be at least 20 background samples for each soil type.

- When there are insufficient background samples, i.e., samples specifically collected to be representative of background conditions, selected site sample data may be used to supplement the background data set if the DTSC and other stakeholders concur that the supplemental data represent background.

6.2.2 Background Metals Data Set

The Army compiled limited background soil data as part of its RI (Dames & Moore, 1997b) and subsequent studies (IT Corporation, 1999, Montgomery Watson, 1999a). The U.S. EPA's National Enforcement Investigations Center ("NEIC") (1997b) has also analyzed background soil samples collected at the Presidio. The aggregate suite of background samples included 16 beach/dune sand, 11 Colma Formation, 10 serpentinite, and 49 Chert/Shale samples. These data sets are presented in Appendix C.

According to the DTSC guidelines discussed above, three of the four soil types were not represented by a sufficient number of samples to reasonably estimate background screening or threshold levels. In order to avoid the considerable expense and schedule delay involved in collecting additional samples as part of a supplemental background metals study, the DTSC agreed to the inclusion of selected site data in the background data set. The selection of these additional data is described below.

The Trust searched the RI database provided by the Army/Montgomery Watson and retrieved soil samples classified as beach/dune, Colma Formation, or serpentinite. The retrieved data were then progressively screened according to the following scheme:

- Samples that were grossly misclassified were excluded, e.g., Colma or beach/dune samples with high levels of chromium, nickel, and cobalt.

- Samples with obvious contamination were excluded.

- Samples with suspect analyses or laboratory quality assurance/quality control ("QA/QC") problems were excluded.

- Site samples collected from the surface to 0.5 feet below ground surface ("bgs") were excluded because of the potential for general surface contamination and difficulty in accurately classifying topsoil.

- Samples from landfill sites were excluded unless they were collected at least 2 feet below the bottom of the fill.

- Samples collected from sites with known metals contamination were excluded if the samples were collected from 2 feet bgs or less.

- All Fill Site 7 data were excluded due to the presence of hydraulically placed fill.

- All RI samples from the Building 900's and 600's Series sites were excluded due to possible metals contamination and the presence of mixed soil types (e.g., serpentinite fragments in beach/dune material).

Because of the paucity of serpentinite samples, two small sets of data were added to the serpentinite background data set. One set consisted of five soil samples reported by Montgomery Watson in their *Fuel Product Action Level Development Report* ("FPALDR") (1995) that were unclassified as to soil type but which appeared to be serpentinite on the basis of their chromium and nickel concentrations. The second set consisted of three serpentinite bedrock samples collected by Montgomery Watson during the 1998 excavation for petroleum-impacted soil at the Presidio Golf Course clubhouse and reported in their *Hexavalent Chromium in Serpentinite Bedrock and Groundwater in Upland Areas* study (1999a).

The resulting sets of site-derived background data were combined with the RI background data sets into revised background data sets by soil type. The revised background data sets were then evaluated in a joint meeting of the Trust, DTSC, and other stakeholders. The primary evaluation tool used to check the revised background data sets was the bivariate scatterplot (e.g., Figures 6-2 and 6-3) which showed the relationships between metals that are potential contaminants and major elements which are not considered potential contaminants (e.g., iron, aluminum, magnesium, and manganese). Data that were clearly "outliers" from the main mass or trend of data were eliminated, e.g., a single high barium result shown in Figure 6-2 or the cluster of anomalous cobalt data shown in Figure 6-3. The full set of background metals scatterplots is reported in a Technical Memorandum (EKI, 2001).

The outcome of this process was revised background data sets (shown in Tables C–1 through C–4 in Appendix C) that were agreed to by the stakeholders and which contained sufficient samples for statistically estimating background screening and threshold levels.

6.2.3 Determining Metals Screening (PCOC) Levels

According to the DTSC, the main reason for establishing "screening" levels for metals is to build in an evaluation step that would help prevent "false negatives", i.e., situations

wherein it is concluded that no contamination is present when, in fact, it is present. Phrased another way, the screening level step is meant to answer the question, "Are we at the edge of a plume or release?"

The means for accomplishing this goal was to set the screening level very conservatively in a statistical sense, i.e., at the 95% upper confidence level of 80th percentile of the data distribution[8]. The meaning of this terminology is shown graphically on Figure 6-4. The generic metal concentrations presented on Figure 6-4 are shown with a logarithmic scale because the background metals data are best described by logarithmic distributions. A specific screening level example, i.e., chromium in beach/dune sand, is shown on Figure 6-5.

The 80th percentile method for defining the screening level could not be meaningfully applied in those situations wherein 50% or more of the results for a particular metal were below detection limits, e.g., antimony. For these instances, the screening level was defined as the most commonly encountered detection limit.

The process of defining screening levels summarized above was followed and the results discussed in a meeting of the Trust, DTSC, and other stakeholders. The consensus screening levels agreed to by the stakeholders are summarized for serpentinite, Colma Formation, beach/dune, and chert/shale in Tables 6-1 through 6-4, respectively.

The screening levels presented in Tables 6-1 through 6-4 are used to identify which metals at a given site are PCOCs. In other words, if a metal concentration exceeds the screening level for the soil type at the site, then that metal is retained as a PCOC.

6.2.4 Determining Metals Threshold (COC) Levels

The objective of threshold levels evaluation is to define concentration levels (by metal and soil type) above which soil sample metals results would reasonably be considered indicative of contamination and therefore retained as a chemical of concern for the selected site.

As with the screening levels, the threshold levels were defined statistically. The threshold level for a particular metal and soil type was usually defined as the 95% upper confidence limit of the 95th percentile of the data distribution[9]. The meaning of this terminology is shown graphically on Figure 6-4, and an example showing the threshold level for chromium in beach/dune soil is shown on Figure 6-6.

As with the screening levels, threshold levels could not be derived statistically when there were 50% or more results below detection limits. In these instances, the threshold level

[8] Because of the small number of samples in the background metals data set, the DTSC and the Trust agreed to define the screening and threshold levels for serpentinite soils as the 80th and the 95th percentiles, respectively, of the data distributions (rather than the 95% upper confidence limit of those percentiles).

[9] Because of the small number of samples in the background metals data set, the DTSC and the Trust agreed to define the screening and threshold levels for serpentinite soils as the 80th and the 95th percentiles, respectively, of the data distributions (rather than the 95% upper confidence limit of those percentiles).

was defined as the greater of either the maximum concentration detected or the most common detection limit[10]. Background threshold levels derived as described above were reviewed in a meeting of the Trust, DTSC, and other stakeholders. The consensus threshold levels agreed to by the stakeholders are summarized for serpentinite, Colma Formation, beach/dune, and chert/shale in Tables 6-1 through 6-4, respectively.

The threshold levels presented in Tables 6-1 through 6-4 and summarized in Table 6-5 represent the Trust's best estimate of background metals concentrations based on available data. Additional data collected during Presidio remedial activities may indicate the need to modify these estimates. Furthermore, these threshold levels are not cleanup levels; rather, the threshold should be compared to cleanup levels to determine if a specific cleanup level should be established as the background threshold. In particular, if the PRG is less than the background, the cleanup level is established as the background threshold because it is not practical or possible to clean up to concentrations below background.

6.2.5 Summary of Background Threshold Data

Table 6-5 summarizes the background threshold levels by metal and the soil type at each site. The soil type will be determined in the field based on lithologic logs. In addition, the derivation of each threshold is indicated, i.e., 95% UCL, maximum detection, or common detection limit. To provide a larger frame of reference, background metals data from regional sources are summarized in Table 6–6.

6.3 PRESIDIO HYDROGEOLOGY

The Army evaluated the hydrogeology of the Presidio in detail as part of preparation of the FPALDR (Montgomery Watson, 1995). Three groundwater basins that are hydraulically isolated from each other by the bedrock topography have been identified. As shown on Figure 6-7, these groundwater basins consist of the Lobos Creek, Coastal Bluffs, and Marina Groundwater Basins. The shallow depths to bedrock in the entire Coastal Bluffs Groundwater Basin, and in portions of the Lobos Creek and Marina Groundwater Basins indicate that significant amounts of groundwater are not present in these areas and their use as potable supply is limited. Further, the Crissy Field Groundwater Area in the Marina Groundwater Basin (Figure 6-7) is tidally influenced. Saltwater intrusion restricts groundwater use in this area.

Groundwater with the highest likelihood of being developed as potable supply is found in portions of the Presidio where thick sand deposits enhance the infiltration and storage of water in the subsurface. The Army identified three locations where groundwater may be a significant resource. These areas consist of the Lobos Creek Groundwater Area in the

[10] The "common detection limit" is the reporting limit typically achieved by analytical laboratories that have analyzed soil samples at the Presidio. These common detection limits were identified in a series of meetings with the Trust, DTSC, and other stakeholders.

Lobos Creek Groundwater Basin, and the West Valley and Northeastern Groundwater Areas in the Marina Groundwater Basin, as shown on Figure 6-7.

6.4 BACKGROUND CONCENTRATIONS OF METALS IN SURFACE WATER, SEEPS, AND GROUNDWATER

Low concentrations of metals in surface water, seeps, and groundwater have been identified as PCOCs at several Presidio sites where such samples have been collected. The occurrence of these metals in the majority of surface water, seep, and groundwater monitoring well samples are likely to be naturally occurring. However, except for chromium, background water quality has not been sufficiently characterized to confirm that the metals are naturally occurring. U.S. EPA (1997b, 1997f) and the Army (Montgomery Watson, 1999a, 1998b) conducted studies of chromium in bedrock, and dissolved and hexavalent chromium in surface water and groundwater. The results of these studies indicate that dissolved chromium is widespread at low concentrations in surface water and groundwater throughout the Presidio. This occurrence is suggestive of natural, rather than anthropogenic sources of chromium.

6.4.1 Hypothesis that Serpentinite is a Natural Source of Chromium in Water

Chromium exists in two valence states or forms. One form is trivalent chromium, which can also be expressed as Cr(III), and the other form is hexavalent chromium, which can also be expressed as Cr(VI). Under ambient conditions, such as those found at the Presidio, trivalent chromium is insoluble and not detected in water, but present in soil as a precipitate or solid. In contrast, hexavalent chromium is soluble and found dissolved in water under ambient conditions. The solubility and toxicological properties of hexavalent chromium are the reasons that this form of chromium is of greater environmental concern than trivalent chromium.

Dissolved chromium is a very good surrogate for hexavalent chromium because of the differing solubility of trivalent and hexavalent chromium in water. As such, dissolved chromium can be assumed to be hexavalent chromium. Seep and groundwater monitoring well locations from which water samples were collected and analyzed for dissolved chromium are shown on Figure 6-8.

High, naturally occurring concentrations of chromium are associated with serpentinite (Kreckeberg, 1984). As shown in Table 6-1, the background threshold concentration of chromium in serpentinite has been determined to be 1,700 mg/kg. In comparison, the naturally occurring or background threshold chromium concentration in the Colma Formation and beach/dune sand at the Presidio has been determined to be 140 mg/kg and 120 mg/kg, respectively (Tables 6-2 and 6-3). Given that serpentinite is a natural source of chromium, it has been hypothesized that dissolved chromium (i.e., hexavalent chromium) measured in seeps and groundwater at the Presidio is due to the presence of chromium in serpentinite. The Army performed studies to confirm this hypothesis. Representatives of U.S. EPA, DTSC, San Francisco State University, NPS, Presidio

Trust, and community members of the RAB provided significant input to the development of the studies. Montgomery Watson, on behalf of the Army, conducted these studies in 1998 and 1999 (1999a).

6.4.2 Evidence that Serpentinite is a Natural Source of Chromium in Water

As discussed in Sections 6.4.2.1 through 6.4.2.4, the results of the Army's studies support the hypothesis that chromium measured in groundwater is naturally occurring. Results of these studies are included in Appendix D.

6.4.2.1 Background Groundwater Geochemistry

Five monitoring wells were constructed in upland locations considered representative of background conditions (Montgomery Watson, 1999a). Locations of these wells were selected with input from the agencies and organizations that collaborated on development of the Army's studies. The wells, UBR01GW01, UBR02GW01, UBR02GW02, UBR03GW01, and UBR03GW02 (Figure 6-8), were constructed in locations that are up gradient of the direction of groundwater flow from potential anthropogenic sources of chromium. Groundwater samples collected from the three wells screened within the serpentinite contained dissolved or hexavalent chromium ranging from 25 to 100 µg/L (Appendix D). The groundwater conditions in these wells were alkaline (with measured pH values ranging from 8.3 to 9.1) and oxidizing (with measured Eh values ranging from 308 to 423 mV). These conditions are favorable for producing stable concentrations of hexavalent chromium in upland groundwater created by leaching and/or interaction of groundwater with serpentinite bedrock.

6.4.2.2 Serpentinite Geochemistry

Samples of serpentinite bedrock collected during monitoring well construction in upland locations were analyzed for hexavalent chromium (Montgomery Watson, 1999a). Hexavalent chromium was detected in these samples at concentrations ranging from 0.064 mg/kg to 0.602 mg/kg. In addition, the aqueous extracts of serpentinite bedrock were moderately alkaline (with measured pH values ranging from 8 to 8.5) and oxidizing (with measured Eh values ranging from 421 to 454 mV) (Appendix D). These conditions are favorable for leaching and/or creating hexavalent chromium from serpentinite through interaction with infiltrating surface water or contact with groundwater.

6.4.2.3 Leaching Test Results

Serpentinite samples collected during monitoring well construction in upland locations were subjected to leaching tests to evaluate whether hexavalent chromium could be leached from bedrock under different conditions (Montgomery Watson, 1999a). Hexavalent chromium was measured in leachate from the serpentinite samples (Appendix D).

6.4.2.4 Occurrence of Dissolved Chromium in Groundwater Throughout the Presidio

The occurrence and distribution of hexavalent chromium in groundwater at the Presidio appears to result from the fact that hexavalent chromium is present in serpentinite bedrock at the Presidio and/or can be created from serpentinite through interaction with infiltrating surface water or contact with groundwater. Hexavalent chromium can be leached and/or generated from serpentinite by various complex reactions because the geochemical conditions, including pH and Eh, are favorable for producing stable concentrations of hexavalent chromium in surface water and groundwater. Conversion of dissolved hexavalent chromium to insoluble trivalent chromium likely occurs in areas where geochemical conditions are reducing in nature, either from naturally occurring organic matter (e.g., bay muds at Crissy Field) or anthropogenic organic matter (e.g., petroleum hydrocarbons at Nike Facility). Thus, the presence of serpentinite and oxidizing conditions, and the lack of organic matter, produce conditions whereby hexavalent chromium is stable in groundwater.

Chromium has been measured in groundwater samples, and in some cases, seep samples collected from Building 215, Fill Site 6, Battery Howe/Wagner, Landfill 8, Landfill 10, Landfill E, Fill Site 1, Nike Facility, Landfill 2, Landfill 4 and Fill Site 5 (Table 6-7 and Figure 6-8). In addition, chromium has been detected in groundwater samples collected from other areas of the Presidio, including background locations (UBR monitoring wells) and wells constructed in the Tennessee Hollow, which are situated a significant distant from known chemical release sites. Serpentinite has been observed in at least one monitoring well at each of these sites or areas with the exceptions of Building 215, Fill Site 6, and Landfill 4.

6.4.3 Further Assessment Required to Confirm Other Metals in Water are Naturally Occurring

Based upon the Army's study results, hexavalent chromium in groundwater in upland areas of the Presidio appears to be naturally occurring. In its letter, dated 13 July 2000, DTSC agreed that hexavalent chromium is naturally occurring in areas where groundwater contacts serpentinite. DTSC (2000c) has stated that further assessment of the occurrence of hexavalent chromium is required for areas where serpentinite is not present or is not directly down gradient from the flow of groundwater through serpentinite. DTSC is interested in understanding the background concentrations of chromium in water that result from contact with other soil types, and whether these background chromium concentrations would be expected to be higher than potential cleanup levels, as is the case of chromium concentrations in water that contacts serpentinite.

The findings of investigations and studies conducted by the Army clearly indicate that hexavalent chromium is naturally occurring in surface water and groundwater at Battery Howe/Wagner, Landfill 8, Landfill 10, Landfill E, Fill Site 1, Nike Facility, Landfill 2, and Fill Site 5. Hexavalent chromium in groundwater at the Building 215 Area and Fill Site 6 is also likely to be naturally occurring but further assessment is required due to the

proximity of these areas to Crissy Field. It is probable that groundwater containing hexavalent chromium has migrated through upland serpentinite to the Building 215 Area and Fill Site 6. The Colma and Beach/Dune Formations beneath Fill Site 6 and Building 215 consist largely of sands and other material generally poor in naturally occurring organic material. With the exception of releases of petroleum hydrocarbons at the nearby Building 1065 and Building 1027 Areas, there are no reducing agents in the saturated zone beneath Fill Site 6 and Building 215. Consequently, hexavalent chromium formed at upland locations and transported in groundwater to Fill Site 6 and Building 215 is chemically stable. No sources of hexavalent chromium have been identified at these areas and the chromium concentrations are consistent with this type of transport mechanism.

Similar to hexavalent chromium, low concentrations of other metals, such as barium, cadmium, copper, lead, mercury, nickel, selenium, and zinc, are detected in surface water, seep, and groundwater samples collected at Presidio sites. The low concentrations at which these metals are detected and their distribution in surface water, seeps, and groundwater throughout the Presidio suggest that these metals are also naturally occurring. However, this finding cannot be confirmed based upon available data. Analytical results of background metal concentrations in surface water and groundwater have not been obtained for all Presidio sites. It may be appropriate to collect additional data in the vicinity of sites where metals have been identified as COCs in water to demonstrate that the metals are naturally occurring and do not derive from historic chemical releases.

TABLES

TABLE 6-1
SUMMARY OF BACKGROUND DATA, SCREENING LEVELS, AND THRESHOLD LEVELS -- SERPENTINITE SOIL (a)

Presidio of San Francisco, California

	Background Data Summary			Screening Level (mg/kg)				Threshold Level (mg/kg)				
Metal	Number of Detections	Total Samples	Maximum Detected (mg/kg)	Detection Limit	80th Percentile	95% UCL of 80th Percentile	Trust Screening Level	Detection Limit	Maximum Detected	95th Percentile	95% UCL of 95th Percentile	Trust Threshold Level
Antimony	0	8	NM (b)	3.0	-- (d)	--	3.0	3.0	NA	--	--	3.0
Arsenic	8	12	4.1	NA (c)	2.5	4.7	2.5	NA	NA	5.4	12	5.4
Barium	15	16	149	NA	100	180	100	NA	NA	230	510	230
Beryllium	6	14	1.1	0.50	--	--	0.50	0.50	1.1	--	--	1.1
Cadmium	4	12	1.9	0.80	--	--	0.80	0.80	1.9	--	--	1.9
Chromium	22	22	1700 (e)	NA	1,300	1,500	1,300	NA	NA	1,700	2,200	1,700
Cobalt	18	18	165	NA	140	160	140	NA	NA	170	200	170
Copper	22	22	65	NA	48	68	18	NA	NA	85	140	85
Lead	11	15	77	NA	21	49	21	NA	NA	66	200	66
Mercury	2	9	0.069	0.20	--	--	0.20	0.20	0.069	--	--	0.20
Molybdenum	0	4	NM	2.0	--	--	2.0	2.0	NA	--	--	2.0
Nickel	22	22	4,300	NA	3,100	3,900	3,100	NA	NA	4,500	6,100	4,500
Selenium	0	7	NM	0.5	--	--	0.5	0.5	NA	--	--	0.5
Silver	1	10	1.7	1.0	--	--	1.0	1.0	1.7	--	--	1.7
Thallium	4	8	0.077	1.0	--	--	1.0	1.0	0.077	--	--	1.0
Vanadium	22	22	84	NA	51	64	51	NA	NA	74	100	74
Zinc	22	22	140	NA	86	120	86	NA	NA	160	250	160

Notes:

(a) Column headings have the following meanings:

Detection Limit: A typical detection limit is included when there were insufficient data to calculate an 80th percentile or a 95th percentile (e.g., no detections or fewer than 50% detections).

80th Percentile: The concentration corresponding to the 80th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%. Because of the small number of samples in the background data set, DTSC and the Trust agreed to use the 80th percentile to establish screening levels for serpentinite soils.

95% UCL of 80th Percentile: The concentration corresponding to the 95% upper confidence level ("UCL") of the 80th percentile of the lognormal data distribution.

Trust Screening Level: Screening level for classification of corresponding metal as a potential chemical of concern.

Maximum: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).

95th Percentile: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%. Because of the small number of samples in the background data set, DTSC and the Trust agreed to use the 95th percentile to establish threshold levels for serpentinite soils.

95% UCL of 95th Percentile: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

Trust Threshold Level: Threshold level for classification of corresponding metal as a chemical of concern.

(b) NM means not measured; there were no data above applicable laboratory reporting limits.

(c) NA means not applicable; there were sufficient data to estimate a data distribution so the detection limit or maximum detected concentration are not screening or threshold levels.

(d) A double hyphen ("--") indicates that there were insufficient data above laboratory reporting limits to estimate a data distribution.

(e) Hexavalent chromium has been measured in serpentinite at the Presidio at concentrations ranging from 0.064 to 0.602 mg/kg (Montgomery Watson, 1999a).

TABLE 6-2
SUMMARY OF BACKGROUND DATA, SCREENING LEVELS, AND THRESHOLD LEVELS -- COLMA FORMATION SOIL (a)

Presidio of San Francisco, California

	Background Data Summary			Screening Level (mg/kg)				Threshold Level (mg/kg)				
Metal	Number of Detections	Total Samples	Maximum Detected (mg/kg)	Detection Limit	80th Percentile	95% UCL of 80th Percentile	Trust Screening Level	Detection Limit	Maximum Detected	95th Percentile	95% UCL of 95th Percentile	Trust Threshold Level
Antimony	0	8	NM (b)	3.0	-- (d)	--	3.0	3.0	NA	--	--	3.0
Arsenic	13	20	5.0	NA (c)	3.1	3.9	3.9	NA	NA	4.5	6.2	6.2
Barium	36	36	180	NA	77	99	99	NA	NA	130	180	180
Beryllium	17	32	0.68	NA	0.33	0.46	0.46	NA	NA	0.64	0.99	0.99
Cadmium	5	28	0.49	0.80	--	--	0.80	0.80	0.49	--	--	0.80
Chromium	36	36	150	NA	81	95	95	NA	NA	110	140	140
Cobalt	36	36	19	NA	14	16	16	NA	NA	18	21	21
Copper	36	36	81	NA	18	24	24	NA	NA	33	49	49
Lead	32	35	8.2	NA	4.5	5.2	5.2	NA	NA	6.1	7.5	7.5
Mercury	3	19	0.12	0.20	--	--	0.20	0.20	0.12	--	--	0.20
Molybdenum	0	0	NM	2.0	--	--	2.0	2.0	NA	--	--	2.0
Nickel	35	35	120	NA	72	83	83	NA	NA	96	110	110
Selenium	2	12	0.46	0.5	--	--	0.5	0.50	0.46	--	--	0.50
Silver	0	12	NM	1.0	--	--	1.0	1.0	NA	--	--	1.0
Thallium	0	6	NM	1.0	--	--	1.0	1.0	NA	--	--	1.0
Vanadium	35	35	85	NA	53	62	62	NA	NA	73	90	90
Zinc	36	36	62	NA	38	43	43	NA	NA	50	60	60

Notes:

(a) Column headings have the following meanings:

Detection Limit: A typical detection limit is included when there were insufficient data to calculate an 80th percentile or a 95th percentile (e.g., no detections or fewer than 50% detections).

80th Percentile: The concentration corresponding to the 80th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 80th Percentile: The concentration corresponding to the 95% upper confidence level ("UCL") of the 80th percentile of the lognormal data distribution.

Trust Screening Level: Screening level for classification of corresponding metal as a potential chemical of concern.

Maximum: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).

95th Percentile: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 95th Percentile: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

Trust Threshold Level: Threshold level for classification of corresponding metal as a chemical of concern.

(b) NM means not measured; there were no data above applicable laboratory reporting limits.

(c) NA means not applicable; there were sufficient data to estimate a data distribution so the detection limit or maximum detected concentration are not screening or threshold levels.

(d) A double hyphen ("--") indicates that there were insufficient data above laboratory reporting limits to estimate a data distribution.

TABLE 6-3
SUMMARY OF BACKGROUND DATA, SCREENING LEVELS, AND THRESHOLD LEVELS -- BEACH/DUNE SOIL (a)
Presidio of San Francisco, California

	Background Data Summary			Screening Level (mg/kg)				Threshold Level (mg/kg)				
Metal	Number of Detections	Total Samples	Maximum Detected (mg/kg)	Detection Limit	80th Percentile	95% UCL of 80th Percentile	Trust Proposed Screening Level	Detection Limit	Maximum Detected	95th Percentile	95% UCL of 95th Percentile	Trust Proposed Threshold Level
Antimony	0	11	NM (b)	3.0	-- (d)	--	3.0	3.0	NA	--	--	3.0
Arsenic	55	69	6.0	NA (c)	3.4	3.9	3.9	NA	NA	5	5.9	5.9
Barium	63	70	250	NA	43	54	54	NA	NA	87	120	120
Beryllium	37	56	1.3	NA	0.44	0.52	0.52	NA	NA	0.70	0.89	0.89
Cadmium	3	32	1.7	0.80	--	--	0.80	0.80	1.7	--	--	1.7
Chromium	75	75	140	NA	72	81	81	NA	NA	100	120	120
Cobalt	62	71	24	NA	10	11	11	NA	NA	14	16	16
Copper	61	70	57	NA	17	21	21	NA	NA	33	43	43
Lead	66	83	89	NA	16	21	21	NA	NA	39	57	57
Mercury	11	65	0.65 (e)	0.20	--	--	0.20	0.20	0.11	--	--	0.20
Molybdenum	0	1	NM	2.0	--	--	2.0	2.0	NA	--	--	2.0
Nickel	70	70	83	NA	43	48	48	NA	NA	60	70	70
Selenium	5	31	4.3 (e)	0.5	--	--	0.5	0.50	0.75	--	--	0.75
Silver	5	39	0.86	1.0	--	--	1.0	1.0	0.86	--	--	1.0
Thallium	1	19	0.37	1.0	--	--	1.0	1.0	0.37	--	--	1.0
Vanadium	71	71	100	NA	52	59	59	NA	NA	77	92	92
Zinc	61	69	93	NA	37	42	42	NA	NA	55	66	66

Notes:

(a) Column headings have the following meanings:

Detection Limit: A typical detection limit is included when there were insufficient data to calculate an 80th percentile or a 95th percentile (e.g., no detections or fewer than 50% detections).

80th Percentile: The concentration corresponding to the 80th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 80th Percentile: The concentration corresponding to the 95% upper confidence level ("UCL") of the 80th percentile of the lognormal data distribution.

Trust Screening Level: Screening level for classification of corresponding metal as a potential chemical of concern.

Maximum: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).

95th Percentile: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 95th Percentile: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

Trust Threshold Level: Threshold level for classification of corresponding metal as a chemical of concern.

(b) NM means not measured; there were no data above applicable laboratory reporting limits.

(c) NA means not applicable; there were sufficient data to estimate a data distribution so the detection limit or maximum detected concentration are not screening or threshold levels.

(d) A double hyphen ("--") indicates that there were insufficient data above laboratory reporting limits to estimate a data distribution.

(e) The concentration shown was the maximum detected in the data set. DTSC requested that the second highest concentration be used for evaluating the threshold level.

TABLE 6-4
SUMMARY OF BACKGROUND DATA, SCREENING LEVELS, AND THRESHOLD LEVELS -- CHERT/SHALE SOIL (a)

Presidio of San Francisco, California

	Background Data Summary			Screening Level (mg/kg)				Threshold Level (mg/kg)				
Metal	Number of Detections	Total Samples	Maximum Detected (mg/kg)	Detection Limit	80th Percentile	95% UCL of 80th Percentile	Trust Screening Level	Detection Limit	Maximum Detected	95th Percentile	95% UCL of 95th Percentile	Trust Threshold Level
Antimony	0	46	NM (b)	3.0	-- (c)	--	3.0	3.0	NA (d)	--	--	3.0
Arsenic	3	47	15 (e)	2.5	--	--	2.5	NA	3.2	--	--	3.2
Barium	47	47	1100	NA	210	310	310	NA	NA	540	900	900
Beryllium	14	47	0.72	0.20	--	--	0.2	0.20	0.72	--	--	0.72
Cadmium	11	47	1.7	0.80	--	--	0.80	0.80	1.7	--	--	1.7
Chromium	37	47	52	NA	8.7	13	13	NA	NA	24	41	41
Cobalt	33	47	87	NA	9.2	13	13	NA	NA	22	37	37
Copper	47	47	310	NA	90	130	130	NA	NA	220	360	360
Lead	6	47	45	10	--	--	10	10	45	--	--	45
Mercury	1	47	0.036	0.20	--	--	0.20	0.20	0.036	--	--	0.20
Molybdenum	0	46	NM	2.0	--	--	2.0	2.0	NA	--	--	2.0
Nickel	34	47	110	NA	19	27	27	NA	NA	44	71	71
Selenium	0	1 (f)	NM	0.50	--	--	0.5	0.50	NA	--	--	0.50
Silver	0	47	NM	1.0	--	--	1.0	1.0	NA	--	--	1.0
Thallium	0	46	NM	1.0	--	--	1.0	1.0	NA	--	--	1.0
Vanadium	45	47	71	NA	16	23	23	NA	NA	38	61	61
Zinc	43	47	140	NA	27	41	41	NA	NA	73	120	120

Notes:

(a) Column headings have the following meanings:

Detection Limit: A typical detection limit is included when there were insufficient data to calculate an 80th percentile or a 95th percentile (e.g., no detections or fewer than 50% detection

80th Percentile: The concentration corresponding to the 80th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 80th Percentile: The concentration corresponding to the 95% upper confidence level ("UCL") of the 80th percentile of the lognormal data distribution.

Trust Screening Level: Screening level for classification of corresponding metal as a potential chemical of concern.

Maximum: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).

95th Percentile: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%.

95% UCL of 95th Percentile: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

Trust Threshold Level: Threshold level for classification of corresponding metal as a chemical of concern.

(b) NM means not measured; there were no data above applicable laboratory reporting limits.

(c) NA means not applicable; there were sufficient data to estimate a data distribution so the detection limit or maximum detected concentration are not screening or threshold levels.

(d) A double hyphen ("--") indicates that there were insufficient data above laboratory reporting limits to estimate a data distribution.

(e) The concentration shown was the maximum detected in the data set. DTSC requested that the second highest concentration be used for evaluating the threshold level.

(f) The total number of samples analyzed for selenium was 47. However, 46 of these samples had elevated detection limits and were not considered in the evaluation.

TABLE 6-5
SUMMARY OF BACKGROUND SCREENING AND THRESHOLD DATA, PRESIDIO SOILS

Presidio of San Francisco, California

	Trust Screening and Threshold Levels by Lithology (mg/kg)							
	Serpentinite		Colma		Beach/Dune		Chert/Shale	
Metal	Screening Level	Threshold Level	Screening Level	Threshold Level	Screening Level	Threshold Level	Screening Level	Threshold Level
Antimony	3.0 (DL)	3.0 (DL)	3.0 (DL)	3.0 (DL)	3.0 (DL)	3.0 (DL)	3.0 (DL)	3.0 (DL)
Arsenic	2.5 (80th)	5.4 (95th)	3.9 (UCL80)	6.2 (UCL95)	3.9 (UCL80)	5.9 (UCL95)	2.5 (DL)	3.2 (Max)
Barium	100 (80th)	230 (95th)	99 (UCL80)	180 (UCL95)	54 (UCL80)	120 (UCL95)	310 (UCL80)	900 (UCL95)
Beryllium	0.50 (DL)	1.1 (Max)	0.46 (UCL80)	0.99 (UCL95)	0.52 (UCL80)	0.89 (UCL95)	0.2 (DL)	0.72 (UCL95)
Cadmium	0.80 (DL)	1.9 (Max)	0.80 (DL)	0.8 (DL)	0.80 (DL)	1.7 (Max)	0.80 (DL)	1.7 (Max)
Chromium	1,300 (80th)	1,700 (95th)	95 (UCL80)	140 (UCL95)	81 (UCL80)	120 (UCL95)	13 (UCL80)	41 (UCL95)
Cobalt	140 (80th)	170 (95th)	16 (UCL80)	21 (UCL95)	11 (UCL80)	16 (UCL95)	13 (UCL80)	37 (UCL95)
Copper	18 (80th)	85 (95th)	24 (UCL80)	49 (UCL95)	21 (UCL80)	43 (UCL95)	130 (UCL80)	360 (UCL95)
Lead	21 (80th)	66 (95th)	5.2 (UCL80)	7.5 (UCL95)	21 (UCL80)	57 (UCL95)	10 (DL)	45 (Max)
Mercury	0.2 (DL)	0.2 (DL)	0.2 (DL)	0.2 (DL)	0.2 (DL)	0.2 (DL)	0.2 (DL)	0.2 (DL)
Molybdenum	2.0 (DL)	2.0 (DL)	2.0 (DL)	2.0 (DL)	2.0 (DL)	2.0 (DL)	2.0 (DL)	2.0 (DL)
Nickel	3,100 (80th)	4,500 (95th)	83 (UCL80)	110 (UCL95)	48 (UCL80)	70 (UCL95)	27 (UCL80)	71 (UCL95)
Selenium	0.5 (DL)	0.5 (DL)	0.5 (DL)	0.5 (DL)	0.5 (DL)	0.75 (Max)	0.5 (DL)	0.5 (DL)
Silver	1.0 (DL)	1.7 (Max)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)
Thallium	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)	1.0 (DL)
Vanadium	51 (80th)	74 (95th)	62 (UCL80)	90 (UCL95)	59 (UCL80)	92 (UCL95)	23 (UCL80)	61 (UCL95)
Zinc	86 (80th)	160 (95th)	43 (UCL80)	60 (UCL95)	42 (UCL80)	66 (UCL95)	41 (UCL80)	120 (UCL95)

Notes:

DL - Detection Limit: A typical detection limit is included when there were insufficient data to calculate a 95% UCL of the 80th and/or the 95th percentiles (e.g., fewer than 50% detections).

Max: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).

95th: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%. Applied to serpentinite only due to small number of data in background data set.

80th: The concentration corresponding to the 80th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%. Applied to serpentinite only due to small number of data in background data set.

UCL95: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

UCL80: The concentration corresponding to the 95% UCL of the 80th percentile of the lognormal data distribution.

TABLE 6-6
CONCENTRATIONS OF METALS IN REGIONAL BACKGROUND SOIL STUDIES

Presidio of San Francisco, California

Metal	Location and Range of Metal Concentrations Reported											
	N. Santa Clara County (a)		Lawrence Berkeley Lab (b)		California Soils (c)		SF Bay Wetlands (d)		Panoche Creek (e)		Hamilton Air Field (f)	
	150 samples		492 samples		50 samples		14 samples		721 samples		62 samples	
	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)
Antimony	-	-	1	9	0.15	1.95	-	-	-	-	0.06	1.2
Arsenic	0.5	20	0.25	63	0.6	11	5.29	23.7	3.4	21	1.1	25.2
Barium	-	-	0.5	1,300	133	1,400	-	-	12	2,300	26	435
Beryllium	0.25	3.2	0.05	2.7	0.25	2.7	-	-	1	3	0.53	1.68
Cadmium	0.4	14	0.05	16	0.05	1.7	0.14	0.56	-	-	0.41	1.8
Chromium	9.5	170	4.1	478	23	1,579	110	224	11	410	9.6	149
Cobalt	-	-	1.7	39	2.7	46.9	-	-	5	34	5.5	32
Copper	4.6	67	0.3	250	9.1	96.4	24.2	90.6	2	86	5.7	88.7
Lead	3.4	54	0.5	31	12.4	97.1	13.7	85.6	2	96	3.3	85.6
Mercury	0.02	1.3	0.05	2.2	0.1	0.9	0.059	0.515	0.02	2.5	0.07	0.43
Molybdenum	-	-	0.25	63	1	9.6	-	-	2	9	0.28	0.97
Nickel	6	145	6	309	9	509	32.2	145.2	6	380	10	139
Selenium	0.12	4	0.5	28	0.015	0.43	0.14	0.91	0.1	4.5	0.34	0.37
Silver	0.3	4.8	0.2	6.5	0.1	8.3	-	-	-	-	0.1	0.21
Thallium	0.41	3.8	0.5	18 (g)	0.17	1.1	-	-	-	-	5.7	33.7 (i)
Vanadium	-	-	0.5	130	39	288	-	-	30	260	15	136
Zinc	7.8	120	3.8	174	88	236	88.5	166.1	11	230	16.6	232

TABLE 6-6
CONCENTRATIONS OF METALS IN REGIONAL BACKGROUND SOIL STUDIES

Presidio of San Francisco, California

Notes:

(a) Scott, C.M. 1995. *Background Metal Concentrations in Soils in Northern Santa Clara County, California* in Recent Geological Studies in the San Francisco Bay Area, Pacific Section of the Society of Economic Paleontologists and Mineralogists, Volume 76.

(b) Lawrence Berkeley National Laboratory. 1995. *Protocol for Determining Background Concentrations of Metals in Soil at Lawrence Berkeley National Laboratory*. U.S. Department of Energy Contract DE-AC03-76F00098.

(c) Bradford, G.R., et al. 1996. *Background Concentrations of Trace and Major Elements in California Soils*. Kearney Foundation of Soil Science, University of California, Riverside.

(d) Lee, C.R., et al. 1995. *Field Survey of Contaminant Concentrations in Existing Wetlands in the San Francisco Bay Area*. Miscellaneous Paper EL-95, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

(e) Ryder, J.L., et al. 1989. *Analysis of 721 Soil Samples from the Panoche Fan Area of the San Joaquin Valley, California*. USGS Open File Report 89-298.

(f) International Technology Corporation. 27 April 2000. *Draft Human Health and Ecological Risk Assessment, BRAC Property, Hamilton Army Airfield, Novato, California.*

(g) Apparent outliers removed by EKI.

TABLE 6-7
DISSOLVED CHROMIUM AND HEXAVALENT CHROMIUM CONCENTRATIONS IN SURFACE WATER, SEEPS, AND GROUNDWATER (a)

Presidio of San Francisco, California

Site	Surface Water, Seep, or Groundwater Sample Location	Is Monitoring Well Screened in Serpentinite?	Range of Dissolved Chromium (b); (c)		Range of Hexavalent Chromium (b); (c)	
			minimum	maximum	minimum	maximum
Main Post:						
• Building 215 Area	215GW01	no	**17**	**26.8**	**12**	**38**
	215GW02	no	**31.8**	**31.8**	**23.5**	**26**
	215GW03	no	**29.5**	**29.5**	**24.6**	**26**
Fort Scott:						
• Battery Howe/Wagner	HWGW01	yes	**82**	**146**	**120**	**220**
	HWGW04	yes	**7**	**18**	**7.4**	**36.6**
	HWGW05	yes	<1	<10	<0.5	**16.1**
	HWGW100	yes	- (d)	-	**40**	**40**
	HWGW101	yes	-	-	**40**	**40**
	HWSW100	seep	-	-	**10**	**10**
	BHWSP01	seep	**6**	**6**	-	-
	BHWSP02	seep	<3	<3	-	-
Letterman Complex:						
• Fill Site 6	LF6GW100	no	<10	<10	-	-
	LF6GW101	no	**12**	**12**	-	-
	LF6GW102	no	<10	<10	-	-
	LF6GW103	no	**27**	**28**	-	-
Public Health Service Hospital:						
• Landfill 8	LF8GW01	yes	**2.3**	**16 (50.7); (e)**	-	-
	LF8GW02B	yes	**20**	**58.4**	-	-
	LF8GW03	no	**22**	**32.3**	-	-
	LF8GW04	no	**1.9**	**25.4**	-	-
	LF8GW06	no	<10	<10	-	-
• Landfill 10	LF10GW01	yes	**71.5**	**110**	-	-
	LF10GW02	no	<1	<10	-	-
	LF10GW03	yes	**2.1**	**14**	-	-
East Housing:						
• Landfill E	DAEGW03	no	**15**	**30**	-	-
	DAEGW04	no	**10**	**23.4 (130); (e)**	-	-
	DAEGW05	no	<10	**22**	-	-
	DAEGW06	yes (f)	<1	<10	-	-
	DAEGW07	no	<1	<10	-	-
	DAEGW08	no	**1**	**19**	-	-
	DAESP01	seep	<3	**20.4**	-	-
	DAESP02	seep	<10	<50	-	-
	DAESP02A	seep	<3	<3	-	-
	DAESP03	seep	<10	**29.1**	-	-
	DAESP04	seep	<10	<10	-	-

TABLE 6-7
DISSOLVED CHROMIUM AND HEXAVALENT CHROMIUM CONCENTRATIONS IN SURFACE WATER, SEEPS, AND GROUNDWATER (a)

Presidio of San Francisco, California

Site	Surface Water, Seep, or Groundwater Sample Location	Is Monitoring Well Screened in Serpentinite?	Range of Dissolved Chromium (b); (c)		Range of Hexavalent Chromium (b); (c)	
			minimum	maximum	minimum	maximum
East Housing (contd):						
• Fill Site 1	LF1GW01	no	<1	<10	**1.3**	**15.1**
	LF1GW02	no	**11**	**40.4**	**32.1**	**34.5**
	LF1GW03	no	**34**	**49**	**38.3**	**137**
	LF1GW04	yes (f)	**16**	**24**	**18.9**	**82.4**
	LF1GW05	no	**9**	**12**	**2.1**	**102**
	LF1GW06	no	**5**	**22.4**	**10.7**	**31.1**
	LF1GW07	yes (f)	**14**	**29**	<10	**24.7**
	LF1SP01	seep	<3	<10	-	-
	LF1SP02	seep	<3	<10	-	-
• Tennessee Hollow	TH-1	yes (g)	**17.1**	**17.4**	**12**	**14**
	TH-2	no	**20.4**	**23.1**	<10	**19**
	TH-3	no	<10	**16.7**	<10	<10
	TH-4	no	**20.9**	**22.2**	**19**	**26**
• El Polin Spring	EPSP01 (h)	seep	**19**	**29**	**22.4**	**29.7**
Presidio Hill:						
• Nike Facility and Nike Swale	NKGW01	yes	**2.5**	**4.1**	-	-
	NKGW02	yes (f)	**5.9**	**20**	<10	<10
	NKGW03	no	<10	<10	<10	<10
	NKGW04	yes	**4.2**	<10	<10	<10
	NKGW05	yes	**4.8**	**23**	<10	<10
	NSSW100	surface water	-	-	ND (i)	ND
Presidio Forest:						
• Landfill 2	LF2GW01	yes	**6**	**14**	**5**	**29.9**
	LF2GW02	yes	<1	<10	<0.5	**13.7**
	LF2GW04	yes (f)	<1	<10	**0.72**	<10
	LF2SP01	seep	<3	<10	-	-
• Landfill 4	LF4GW03	no	**2**	<10	<10	<10
• Building 1349 Area	1349MW01	yes (j)	-	-	<10	<10
	1349MW02	yes	-	-	**43**	**43**
Coastal Bluffs:						
• Fill Site 5	1349MW03	yes	-	-	**69**	**69**
	LF5GW100	yes	**31**	**31**	**30**	**30**
	LF5GW101	yes	**36**	**38**	**40**	**40**

TABLE 6-7
DISSOLVED CHROMIUM AND HEXAVALENT CHROMIUM CONCENTRATIONS IN SURFACE WATER, SEEPS, AND GROUNDWATER (a)

Presidio of San Francisco, California

Site	Surface Water, Seep, or Groundwater Sample Location	Is Monitoring Well Screened in Serpentinite?	Range of Dissolved Chromium (b); (c)		Range of Hexavalent Chromium (b); (c)	
			minimum	maximum	minimum	maximum
Upland Areas of Presidio:						
Background Locations	UBR01GW01	yes	**25**	**66**	**26.6**	**65.4**
	UBR02GW01	yes	**48**	**49**	**45**	**52.1**
	UBR02GW02	yes	**98**	**100**	**89.2**	**98.3**
	UBR03GW01	no	<10	<10	<0.5	<0.5
	UBR03GW02	no	<10	<10	**0.64**	**0.64**

Notes:

(a) Surface water, seep, and groundwater sample analytical results were obtained from an electronic database assembled by Montgomery Watson, and the following additional sources:

- Montgomery Watson. 1998 and 1999. *Groundwater Monitoring Program. Building 1349 Area.*
- Montgomery Watson. 16 July 1999. *Hexavalent Chromium in Serpentinite Bedrock and Groundwater in Upland Areas.*
- Erler & Kalinowski, Inc. October 2000. *Draft Sampling Results for Selected Main Installation Sites.*

(b) Analytical results of dissolved chromium and hexavalent chromium in groundwater consist of filtered samples and unfiltered samples collected through use of low flow sampling techniques.

(c) Analytical results of unfiltered samples are included for dissolved chromium and hexavalent chromium in surface water and freshwater seeps.

(d) Hyphen indicates sample not analyzed or analytical results are not available.

(e) Concentration in parenthesis is not likely representative of dissolved chromium because high concentrations of other metals in sample indicate filter breakthrough likely occurred.

(f) Screened in serpentinite or Franciscan Formation at the bottom of monitoring well only.

(g) Lithologic log of boring in which monitoring well was constructed indicates greenish clay that is possibly weathered serpentinite.

(h) Seep samples consist of samples identified as EPSP01, EPSPRING, EPSPRING2, and EPSSWO1.

(i) Not detected ("ND"). Chromium was not measured above analytical laboratory reporting limit. Reporting limit value was not provided in reference reviewed.

(j) Monitoring well is screened in melange, which typically contains serpentinite fragments. Lithologic log of boring in which monitoring well was constructed indicates weathered serpentinite at bottom of boring.

FIGURES

Golden Gate Bridge, Highway and Transportation District (GGBHTD) Study Area

Building 900 Series Study Area

San Francisco Bay

DEH Study Area

East of Mason

Fort Point U.S. Coast Guard

Baker Beach Disturbed Area 1A

Baker Beach Disturbed Area 1

Baker Beach Disturbed Area 2

Baker Beach Disturbed Area 3

Pacific Ocean

Bldg 1388 Area

Bldg 640/643 Area

Bldg 611 Area

Sewer lift Station No. 1

Sewer Lift Station No. 2

Bldg 207/231 Area

Bldg 1167 Area

Bldg 1369 Area

Battery Howe/ Wagner

Bldg 662 Area

Bldg 633 Firing Range

Former Bldg 609 Area

Bldg 1065 Area

Fill Site 6

Bldg 1151/1153 Area

Bldg 1245

Bldg 669 Area

Bldg 1957 Area

Bldg 1244

Bldg 1351 Area

Bldg 680 Area

Bldg 215 Area

Fill Site 5

Landfill 4

Transfer Station Area

Baker Beach Disturbed Area 4

Bldg 1450/1451 Area

Nike Facility

Nike Swale

Graded Area 9

Landfill E

El Polin Spring

Fill Site 1

Landfill 2

Bldg 302 Area

Bldg 1750 Area

Lobos Creek

Former Bldg 1827

Mountain Lake

N

0 800 1600

(Approximate Scale in Feet)

LEGEND

Quarternary Surficial Deposits

- Qaf — Artificial Fill
- Qb — Modern Beach Deposits
- Qsr — Slope Debris & Ravine Fill
- Qd — Dune Sand
- Ql — Landslide Deposits
- Qu — Undivided Surficial Deposits
- Qob — Older Beach Deposits
- Qc — Colma Formation

Mesozoic Franciscan Formation Bedrock

- Ks — Undifferentiated Sheared Rocks
- KJsp — Serpentinite
- KJc — Radiolarian Chert & Shale
- KJss — Sandstone
- KJs — Undifferentiated Sandstone & Shale

Notes:

1. All locations are approximate.
2. Figure modified from Montgomery Watson, Draft Basewide Groundwater Monitoring Plan, July 1996.

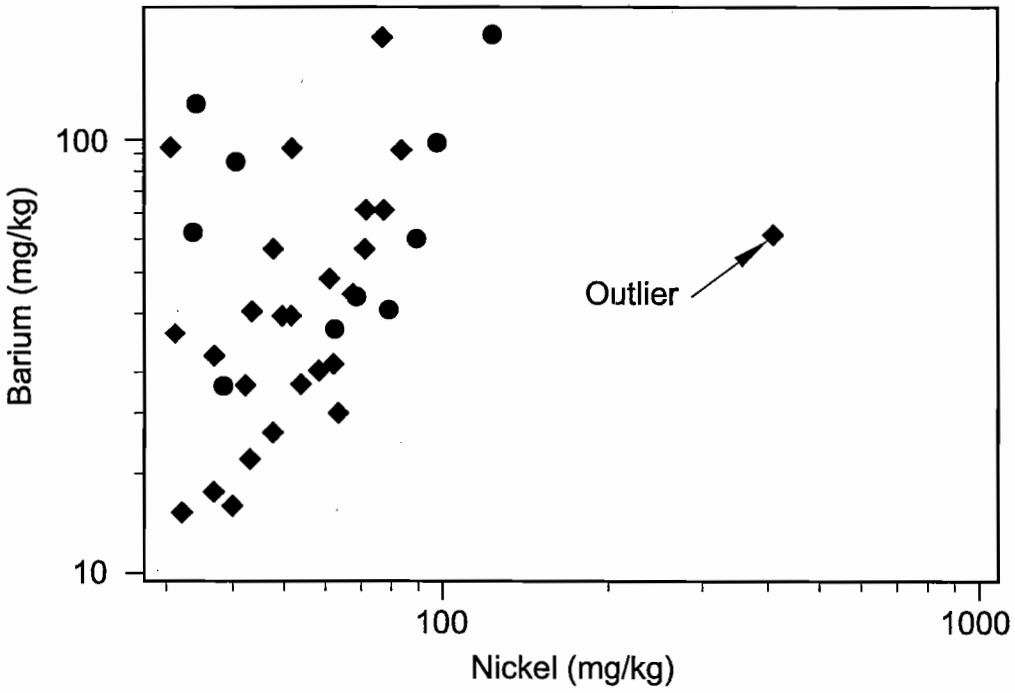
Erler & Kalinowski, Inc.

Surface Deposits at the Presidio

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04

Figure 6-1

Colma Formation Soils
Outlier Identification



LEGEND:

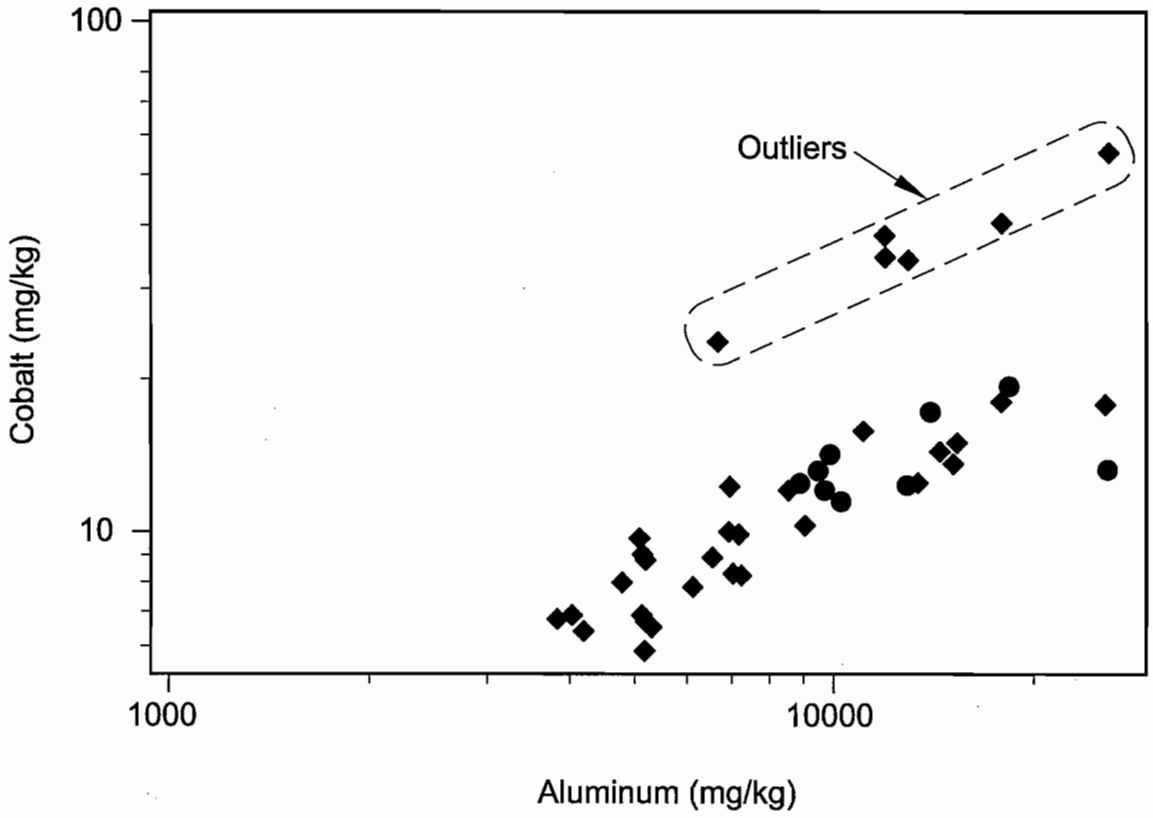
- ● Background
- ◆ Site

Erler & Kalinowski, Inc.

Screening of Individual Outlier from Proposed Colma Background Data Set

Presidio Trust
San Francisco, CA
September 2002
EKI A000003.04

Figure 6-2



LEGEND:

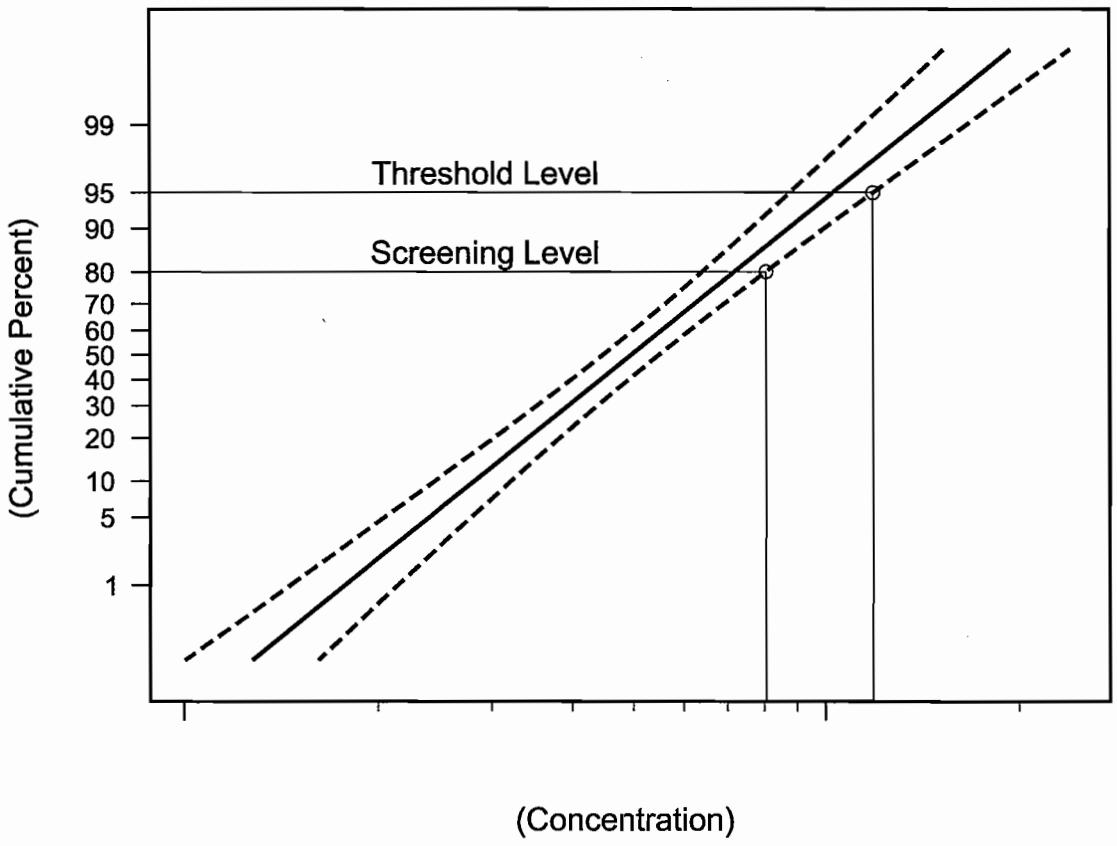
- ● Background
- ◆ Site

Erler & Kalinowski, Inc.

Screening of Outlier Trend from Proposed Colma Background Data Set

Presidio Trust
San Francisco, CA
September 2002
EKI A000003.04

Figure 6-3



LEGEND:

——— Lognormal Metal Population

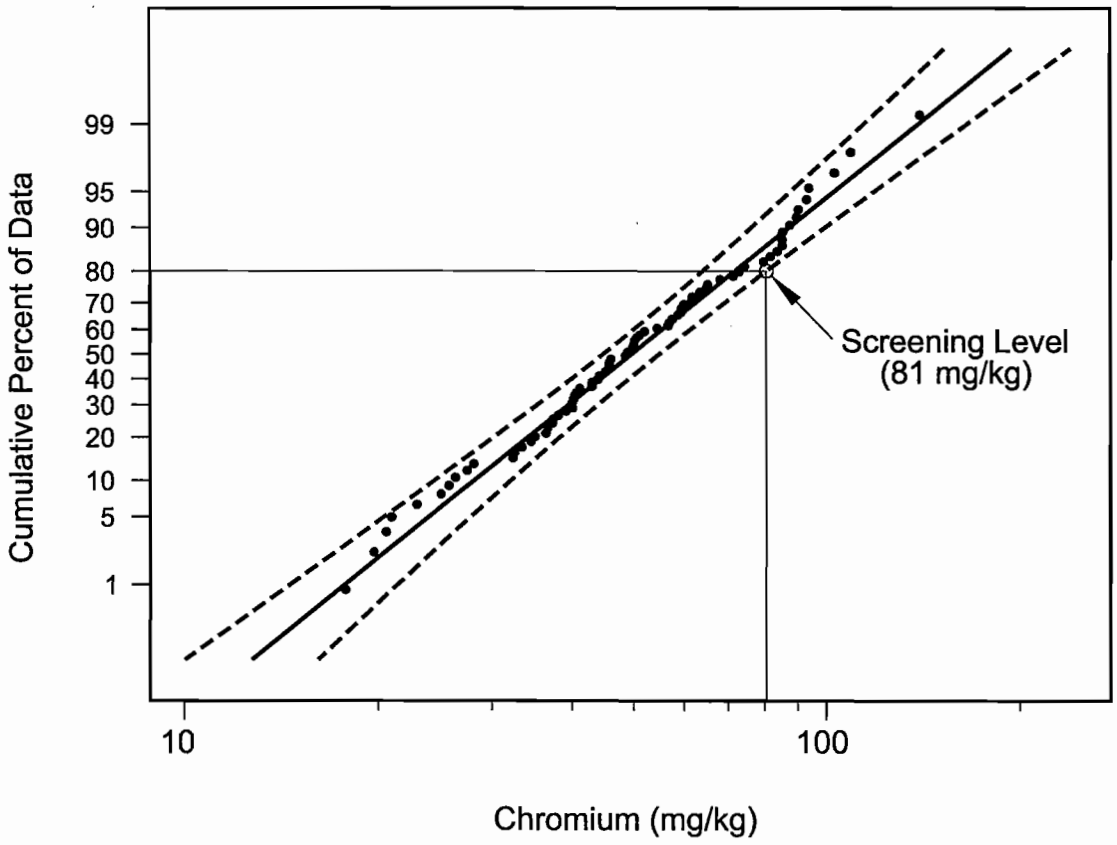
----- 95% Confidence Interval Around Metals Population

Erler & Kalinowski, Inc.

Schematic Data Plot Showing Terminology Used to Define Screening and Threshold Metals Levels

Presidio Trust
San Francisco, CA
September 2002
EKI A000003.04

Figure 6–4



LEGEND:

- 80th Percentile
- 95% Confidence Interval Around Metals Population
- Lognormal Metal Population

Erler & Kalinowski, Inc.

Derivation of Screening Level Concentration for Chromium in Background Beach/Dune Soil

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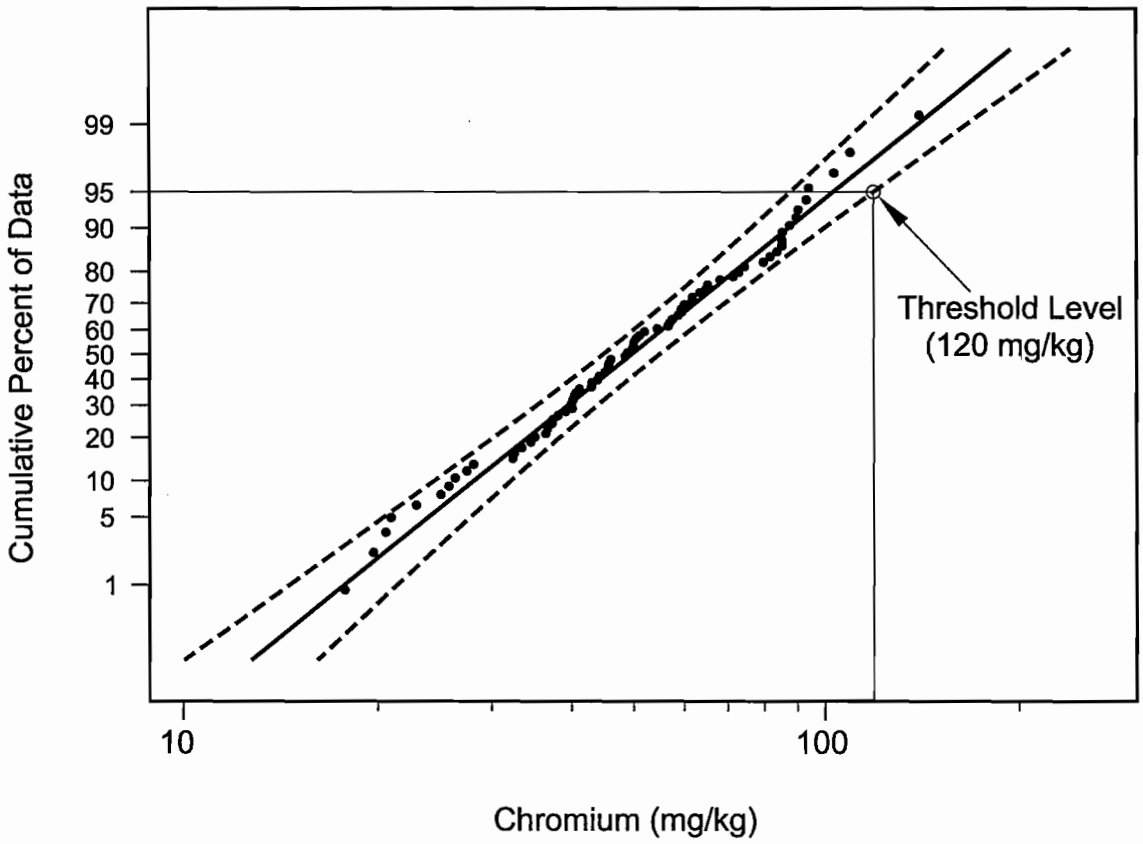
San Francisco, CA
September 2002
EKI A000003.04

Figure 6-5



LEGEND:

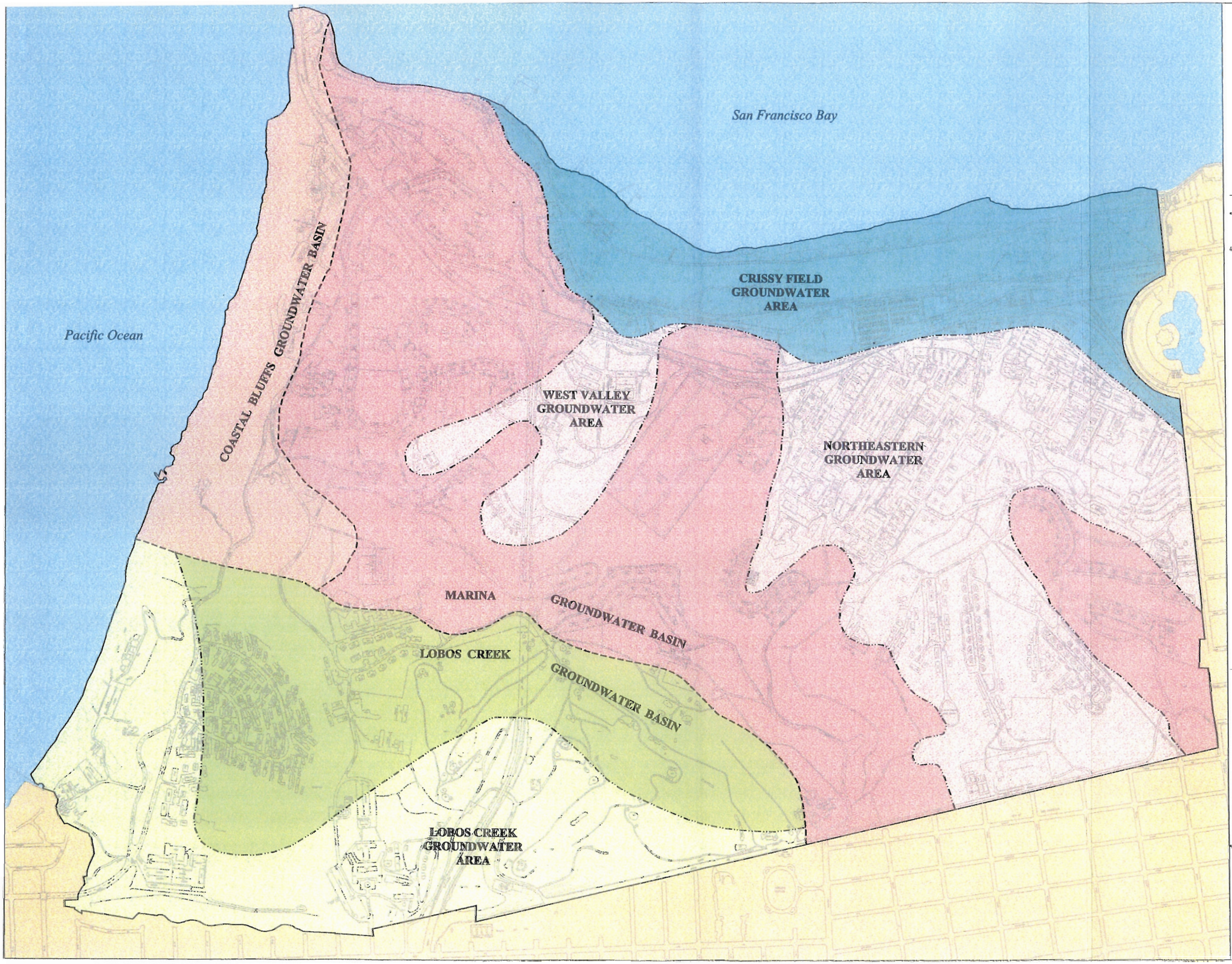
- 95th Percentile
- 95% Confidence Interval Around Metals Population
- Lognormal Metal Population

Erler & Kalinowski, Inc.

Derivation of Threshold Level Concentration for Chromium in Background Beach/Dune Soil

Presidio Trust
San Francisco, CA
September 2002
EKI A000003.04

Figure 6-6



N

0 800 1600

(Approximate Scale in Feet)

LEGEND

- Groundwater Basin Boundaries
- Groundwater Area Boundaries
- Coastal Bluffs Groundwater Basin
- Lobos Creek Groundwater Basin
- Lobos Creek Groundwater Area
- Marina Groundwater Basin
- West Valley and Northwestern Groundwater Area
- Crissy Field Groundwater Area

Notes:

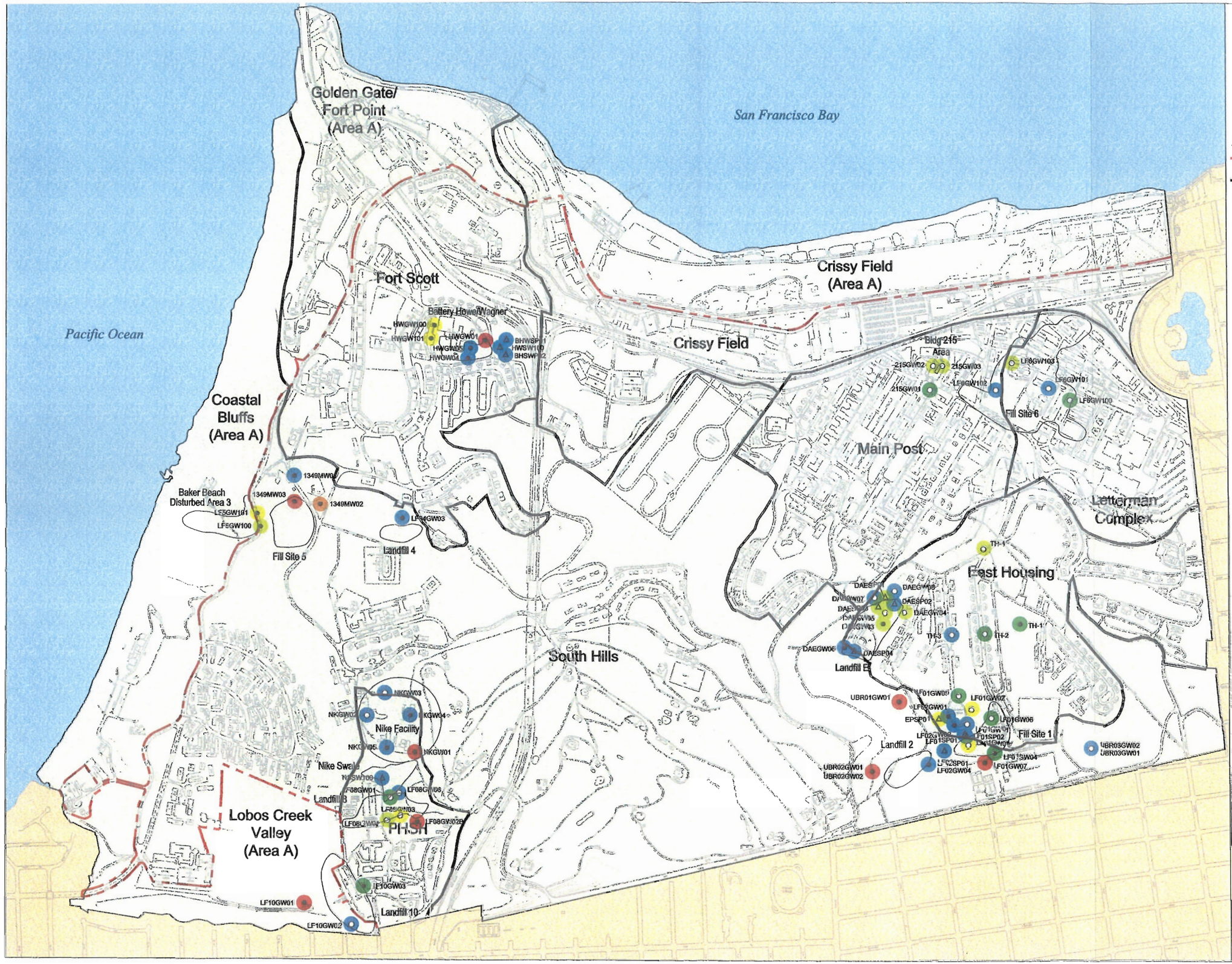
1. All locations are approximate.
2. Figure modified from Montgomery Watson, Draft Basewide Groundwater Monitoring Plan, July 1996.

Erler & Kalinowski, inc.

Groundwater Basins and Areas at the Presidio

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04

Figure 6-7



N

0 800 1600

(Approximate Scale in Feet)

LEGEND

- Area A/B Boundary
- Presidio Planning Area or District Boundary
- Groundwater Monitoring Well Screened in Serpentinite
- Groundwater Monitoring Well Screened in Other Formations
- Seep or Surface Water Sample

Dissolved Chromium and Hexavalent Chromium Concentrations in µg/L

- 0–10
- 10–20
- 20–30
- 30–40
- 40–50
- >50

Note:

1. All locations are approximate.

References for Groundwater Data:

Analytical Results Obtained from: Draft Sampling Results for Selected Main Installation Sites, Presidio of San Francisco, California, Erler & Kalinowski, Inc., October 2000.

Montgomery Watson, Hexavalent Chromium in Serpentinite Bedrock and Groundwater in Upland Areas, Technical Memorandum, Presidio of San Francisco, 16 July 1999.

Montgomery Watson, Groundwater Monitoring Program, Annual and Quarterly Summary Reports, 1998 and 1999.

U.S. EPA, Analytical Results, Elemental Constituent Results for Groundwater Samples, Presidio Army Base, San Francisco, California, 24 February 1999.

U.S. EPA, Analytical Reports, Inorganic Results for Samples from Presidio Army Base, San Francisco, California, 30 April 1997.

Dames & Moore, Final Remedial Investigation Report, Presidio Main Installation, January 1997.

Erler & Kalinowski, Inc.

Chromium Concentrations in Surface Water, Seeps, and Groundwater

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04

Figure 6-8

7. DERIVATION OF CLEANUP LEVELS

7. DERIVATION OF CLEANUP LEVELS

Remedial measures should assure protection of human health and the environment. U.S. EPA (1995c, 1991c, 1989a) requires remedies to take into account future land use that is reasonable and that is associated with the most significant risk posed by exposure to COCs. Accordingly, remedial action objectives ("RAOs") for Presidio sites consist of implementing remedies that are cost-effective, and prevent humans and ecological receptors from being exposed to unacceptable concentrations of COCs but still allow the reuse described in the GMPA and PTMP or other planned uses envisioned by the Trust. To determine the appropriate cleanup levels that should be applied to specific areas of the Presidio, future land use and planned water resource use at Presidio sites must be clearly defined. Sections 7.1 and 7.2 describe the planned land and water resource uses at the Presidio. Section 7.3 presents the procedures to determine which specific cleanup levels are applicable to a given site.

7.1 PLANNED LAND USES

Figures 7-1 and 7-2 depict planned human and ecological land use at the Presidio.

7.1.1 Human Land Use

Four broad categories of land use are defined in the GMPA for the Presidio (and are generally maintained in the PTMP). These categories consist of residential, recreational, institutional (education/conference), and industrial uses. The hatch type on Figure 7-1 signifies residential, recreational, institutional, and commercial/industrial areas on the Presidio and the color type depicts the corresponding cleanup levels that will protect people who reside, work, or visit these areas. Suitable cleanup levels are defined by the most sensitive population that is reasonably associated with the planned land use identified for different areas of the Presidio. These soil cleanup levels should be applied to a depth of 10 feet below ground surface, to account for soil disturbance during potential future construction.

7.1.1.1 Residential

Significant portions of the Presidio are designated as residential areas. Residential cleanup levels are applied to those Presidio sites situated in areas that have the following uses:

- **Residential:** Residential use is designated for single family housing and the grounds extending 150 feet from the structures in all directions, as well as playgrounds, and common areas near such housing. For example, it is reasonable to assume that children living in housing next to Fill Site 1 will use the open space at Fill Site 1 for a play area. Similarly, Julius Kahn playground is considered a

"residential" area because adults and children who live adjacent to the Presidio spend considerable time at this playground and use it like a "backyard."

- **Institutional (Educational/Conference):** As described in the GMPA and PTMP, several areas of the Presidio will be used as educational/conference centers. Housing in these areas will provide permanent and temporary lodging for tenant employees and their families, visiting scholars, students, and researchers. While the land use for such areas generally may be described as institutional, the distinction between residential and institutional housing is inconsequential for purposes of selecting appropriate cleanup levels. The potential exposure scenarios for people living in such housing are comparable to those living in single family residences. Accordingly, residential cleanup levels are applied to institutional housing. For example, the GMPA and PTMP indicate Fort Scott may be used for education, research, and training. The barracks would provide residential accommodations for people completing short- and long-term internships.

7.1.1.2 Recreational

Recreational cleanup levels are applied to those Presidio sites situated in areas that have the following land uses:

Commercial/Recreational: Areas and the surrounding open spaces surrounding such places as museums, visitor centers, and park partner buildings will be frequented by recreational users, including children who likely will be picnicking and playing in the areas surrounding the buildings (e.g., the Main Post and Crissy Field). At sites having such mixed or multiple uses, the population having the most significant risk (i.e., the most sensitive user) determines the applicable cleanup levels. For the Presidio, the most sensitive populations frequenting commercial/recreational areas will be recreational users.

Open Spaces: Areas of the Presidio not designated as residential, institutional, commercial/recreational, or industrial use areas are open spaces. Recreational users will frequent open spaces. Accordingly, recreational cleanup levels are applied in such areas.

7.1.1.3 Commercial/Industrial

As shown on Figure 7-1, only a small portion of the Presidio can be considered strictly commercial/industrial. These commercial/industrial areas consist of the water treatment plant area and the park maintenance facilities at Building 1750. Commercial/industrial cleanup levels are applied to these areas.

7.1.2 Ecological Land Use

The planned and existing ecological land use areas depicted on Figure 7-2 encompass most open spaces and recreational areas. Also included on Figure 7-2 are the saltwater and freshwater ecological protection zones defined in Order 96-070 issued by RWQCB in 1996 to the U.S. Army. In this order, the Tennessee Hollow riparian corridor, the Crissy Field wetlands, and Crissy Field shoreline are identified as sensitive habitats requiring more stringent petroleum hydrocarbon cleanup levels than elsewhere on the Presidio. The area where more stringent petroleum cleanup levels apply to the Tennessee Hollow riparian corridor is designated as the freshwater ecological protection zone. The area where more stringent petroleum cleanup levels apply to the Crissy Field wetlands is designated as the saltwater ecological protection zone.

Figure 7-3 indicates the vegetation types to be preserved and rehabilitated at the Presidio. This figure is taken from the VMP. Native plants, including threatened or endangered species, and historic plants are some of the vegetation types to be preserved and their growth enhanced in the future. Also to be preserved and enhanced under the VMP is the historic forest. The historic forest originates from the efforts of Army Major W.A. Jones. In 1883, Major Jones proposed a major tree-planting program to create windbreaks and to visually enhance the ridges, entrances, and perimeters of the Presidio. Planting of the historic forest began in 1886 and continued until the early 1900s.

Arguably, ecological cleanup levels should apply throughout the Presidio since activities at all locations may have some impact on the environment. However, review of the GMPA, VMP, and PTMP suggest that most ecologically sensitive areas and special status species[11] areas encompass land designated for open space and recreational use (e.g., forested areas of South Hills, , Coastal Bluffs, Lobos Creek), and areas designated as ecological protection zones (i.e., Crissy Field wetlands, Crissy Field shoreline, and concomitant drainage area that includes the Tennessee Hollow riparian corridor). Figure 7-2 identifies areas where special status species are assumed to be present and ecological special status cleanup levels are applicable. These areas were established from the VMP and correspond to native plant habitat areas and forested areas. The remaining areas of the Presidio designated as ecological land use areas where special status species are not likely to be present (e.g., the golf course in the South Hills) are established as "buffer zone" ecological areas subject to the less-stringent buffer zone ecological cleanup levels (see Figure 7-2). Areas on Figure 7-2 where ecological cleanup levels are not applicable generally correspond to developed areas of the Presidio.

As described above, in areas where special status species are likely to be present, more stringent cleanup levels are applicable than in buffer zone ecological areas. However, the NPS (in Area A) and the Trust (in Area B), will have the option to assess and modify the applicability of special status cleanup levels on a site-by-site basis. In such cases, the

[11] Special status species include those species that are listed or proposed for listing as threatened or endangered under federal or state Endangered Species Acts, the California Native Plant Protection Act, the Migratory Bird Treaty Act, California Species of Special Concern as defined by the California Department of Fish and Game, or protected by other laws.

Trust or NPS will coordinate with the State or Federal natural resource trustees, as appropriate, to determine if special status species are present at these sites. Such areas could include locations that are not currently identified as ecological land use on Figure 7-2. If an area demarcated as special status species on Figure 7-2 is modified to be a buffer zone ecological area or a non-ecological area (i.e., a less stringent cleanup level would become applicable), then the Trust must obtain approval from the DTSC to change the applicable cleanup level. Where ecological land uses overlap with human land uses, the more stringent cleanup level is the assigned cleanup level upon which remedial actions will be based. The identification of applicable cleanup levels at individual sites is described in more detail in Section 7.3.

7.2 PLANNED WATER RESOURCE USE

U.S. EPA has established in the NCP various expectations regarding the types of remedies that it has determined are consistent with (1) preferences and mandates set forth in Section 121 of CERCLA and (2) its practical experience in complying with such preferences and mandates (Federal Register, 1990). U.S. EPA expects, in part, to return usable groundwater to its beneficial use wherever practicable, within a reasonable time frame. When restoration of groundwater is not practicable, the NCP at 40 CFR §300.430(a)(1)(iii)(F) states that U.S. EPA expects that action will be taken to prevent continued migration of contamination, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Similar expectations are contained in California's laws, regulations, and policies (e.g., California Water Code §13304 and SWRCB Resolution No. 92-49).

Both the GMPA and RWQCB (1995) recognize that beneficial uses of groundwater at the Presidio include municipal or potable water supply and recharge to streams that enhance ecological and recreational uses. Surface water flow in Lobos Creek has provided most of the potable water at the Presidio. Planned future use of surface water and groundwater at the Presidio includes potable supply (NPS, 1994). As described in the GMPA, potable supply will continue to be provided by on-site sources but reliance on surface water will be reduced in favor of increased use of groundwater. The reasons for this change are that groundwater is less intensive to treat than surface water and that the Lobos Creek ecosystem might benefit if surface water is not diverted (NPS, 1994).

Besides potable supply, beneficial uses of surface water and groundwater that discharges to water bodies at the Presidio include ecological and recreational uses. Areas of the Presidio where ecological and recreational beneficial uses should be protected include, at a minimum, Lobos Creek drainage basin, Tennessee Hollow drainage basin, Nike Swale, Mountain Lake, Crissy Field wetlands, and coastal and shoreline areas.

7.3 PRESIDIO CLEANUP LEVELS APPLICABLE TO SPECIFIC SITES

According to U.S. EPA (1991a), under the NCP, chemical-specific ARARs and risk-based PRGs are the two sources that can be used to establish cleanup levels that remedial actions must achieve under a ROD or RAP. Chemical-specific ARARs identified in Section 3 have been adopted as proposed cleanup levels, if available and greater than naturally occurring or background concentrations of metals in soil and water. In the absence of chemical-specific ARARs, risk-based PRGs derived in Sections 4 and 5 are used as cleanup levels if the PRGs are greater than background concentrations of metals in soil and water.

Naturally occurring metal concentrations should be considered when adopting chemical-specific ARARs and PRGs as cleanup levels for a site because it is not the intent of U.S. EPA (1992b, 1989a) nor DTSC (1999) to have releases of COCs remediated to concentrations below inorganic background levels. To reduce the potential of this event occurring at Presidio sites, chemical-specific ARARs and PRGs were compared to threshold concentrations of metals in soil to determine if the chemical-specific ARARs and PRGs are attainable cleanup levels.

It should also be recognized that chemical-specific ARARs and PRGs derived from toxicological data may be below the range of typical analytical method reporting limits for some PCOCs, such as SVOCs, and PCBs, pesticides, and herbicides in water. The typical analytical method reporting limits range from 0.1 to 10 µg/L for SVOCs by U.S. EPA Methods 8310 and 8270, and from 0.05 to 0.5 µg/L for PCBs, pesticides, and herbicides by U.S. EPA Methods 8081 and 8082 (U.S. EPA, 1997c). For those PCOCs in water, the Trust has selected the chemical-specific ARAR or PRG as the desirable cleanup level, but attainment can only be determined at the standard analytical method reporting limit. For SVOCs, PCBs, pesticides, herbicides and other classes of compounds that may have very low chemical-specific ARARs or PRGs in soil or water, the cleanup levels are established at the typical analytical method reporting limit ranges for these PCOCs assuming no matrix interference. In the event of matrix interference in soil or water samples, actual method reporting limits determining compliance with cleanup levels may be raised.

To allow timely reuse contemplated under the GMPA, the Army addressed chemical release sites at DEH and Crissy Field under separate RAPs. These RAPs (Army and DTSC, 1997 and 1998,) contained cleanup levels specific to sites at DEH and Crissy Field. Cleanup levels in the DEH and Crissy Field RAPs should be used at sites considered under those RAPs to avoid confusion regarding which cleanup levels should be applied in the event that additional contamination is discovered at these areas. The cleanup levels presented in this Presidio-wide Cleanup Level Document are intended for use at all other chemical release sites at the Presidio (e.g., Main Installation sites, the Firing Ranges, and new sites that may be discovered).

Based on chemical-specific ARARs and risk-based PRGs, human health cleanup levels for soil, ecological cleanup levels for soil and sediment, and cleanup levels for surface

water, seeps, and groundwater were developed for the Presidio. Table 7-1 summarizes the process used to identify site-specific cleanup levels applicable to each Presidio site. The table presents the evaluation steps, potential parameters, and reference figures or tables from this document to identify which cleanup level applies to a given site. Fill Site 1 is included in Table 7-1 as an example. Sections 7.3.1 through 7.3.4 discuss the basis for the human health cleanup levels for soil, ecological cleanup levels for soil and sediment, and cleanup levels for surface water, seeps, and groundwater developed for the Presidio and referenced in Table 7-1. Section 7.3.5 revisits Table 7-1 and illustrates how site specific cleanup levels are determined for the Presidio.

7.3.1 Human Health Cleanup Levels for Non-Petroleum Compounds in Soil

Chemical-specific ARARs for soil are available for only a limited number of contaminants. Human health cleanup levels for lead, PCBs, VOCs, and petroleum hydrocarbons in soil and water at the Presidio are generally derived from ARARs (for some receptors, the cleanup levels for these compounds are risk-based). Cleanup levels for remaining PCOCs in soil are risk-based PRGs or, in the case of metals, background concentrations if naturally occurring levels of metals in soil are greater than PRGs. Background concentrations of metals in serpentinite, Colma Formation, beach/dune sand, and chert/shale are derived in Tables 6-1 through 6-4, respectively, and summarized in Table 6-5. These four soil types are the primary lithologies encountered at the Presidio. Chert/shale, believed to be imported from Marin County, has been used as fill and base rock at Crissy Field and other locations at the Presidio and is not necessarily considered chemically-impacted soil material.

The 5 January 2001 *Federal Register* stated that TSCA was amended to establish a hazard standard of 400 mg/kg lead in bare residential soil. A human health cleanup level of 400 mg/kg of lead in soil is being used as a not-to-exceed value for residential areas at the Presidio; the PRG of 370 mg/kg of lead in soil derived in Section 4.2.10 is being used as a maximum average lead concentration in soil at residential sites.

Requirements governing cleanup of PCB-containing soil and wastes were broadened by amendments to TSCA in 1998. As part of these amendments, U.S. EPA added 40 CFR §761.61 to Subpart D of TSCA, which provides cleanup and disposal provisions for PCB-containing soil and other types of remediation wastes. This section of Subpart D sets cleanup levels for high occupancy areas (e.g., residence) at 1 mg/kg of PCBs in soil. However, the human health PRGs for PCBs were calculated in Tables 4-3 through 4-5. For the residential and recreational land uses, the calculated site-specific PRGs for PCBs are less than 1 mg/kg. Therefore, the calculated value is proposed as the cleanup level for those populations. For the commercial/industrial land use, a human health cleanup level of 1 mg/kg of PCBs is proposed to comply with TSCA because the site-specific PRG is greater than the TSCA value. Cleanup levels for petroleum hydrocarbons and related constituents are presented in Section 7.3.3.

Soil cleanup levels for PCOCs other than lead in residential areas, PCBs in commercial/industrial locations, most VOCs, and petroleum hydrocarbons are risk-based

PRGs presented in Section 4. As presented in Sections 4.2.7 and 4.2.9, PRGs for most VOCs were established as the Groundwater Protection RBSL. Table 7-2 includes human health cleanup level values for PCOCs in soil, other than petroleum hydrocarbons and related constituents. Naturally occurring concentrations of metals in soil are also shown on this table, to ensure that the cleanup level used for a given PCOC and specific lithology is not less than background levels. The human health cleanup levels also need to be compared to the ecological cleanup levels in Table 7-2, as appropriate, to identify the lowest applicable cleanup level for the location (Figures 7-1 and 7-2).

7.3.2 Ecological Cleanup Levels for Non-Petroleum Compounds in Soil and Sediment

Figure 7-2 indicates areas of the Presidio where habitat suitable for ecological receptors exists or is planned. Buffer zone and special status ecological cleanup levels pertain to specific areas shown on Figure 7-2. Ecological cleanup levels do not apply to locations that are paved or dominated by designed landscapes (e.g., lawns or ornamental plantings). The NPS (in Area A) and the Trust (in Area B), will have the option to assess and modify the applicability of ecological cleanup levels on a site-by-site basis, with approval from DTSC if the applicable cleanup level is changed to a less stringent value (e.g., modifying a buffer zone ecological area to a non-ecological area).

Table 7-2 lists ecological PRGs that are used for the development of ecological cleanup levels of non-petroleum compounds. The table identifies buffer zone and special status species cleanup levels, which can be compared to background metal and human health cleanup levels to identify the lowest appropriate cleanup level for a location.

Tables 7-3 and 7-4 list ecological cleanup level values for non-petroleum compounds in freshwater and marine sediment at the Presidio, respectively. The tables include cleanup levels for special status species, if available. In the absence of values for special status species, the regular ecological cleanup levels should be used. To account for naturally occurring concentrations of metals in the primary lithologies encountered at the Presidio, ecological cleanup levels for sediments have been developed separately for serpentinite, Colma Formation, beach/dune sand, and chert/shale lithologies.

7.3.3 Human Health and Ecological Cleanup Levels for Petroleum Hydrocarbons and Constituents in Soil and Sediment

Cleanup levels for petroleum hydrocarbons and related constituents developed in connection with Order No. 96-070 are being adopted for areas of the Presidio where releases of petroleum hydrocarbons may have occurred with other types of chemicals. Cleanup levels for petroleum hydrocarbons and related constituents were included in Order No. 96-070 or were developed from subsequent studies required by the order. These studies consisted of performing bioassays and reviewing toxicological data published in scientific literature to develop cleanup levels for the saltwater ecological protection zone (IT Corporation, 1997) and freshwater protection zone (Montgomery Watson, 1999b).

Cleanup level values for petroleum hydrocarbons and related constituents in soil and sediment within the saltwater and freshwater ecological protection zones, and at other areas of the Presidio are summarized in Table 7-5. Figure 7-2 identifies the locations of the saltwater and freshwater ecological protection zones. For sites within these zones, cleanup levels for ecological protection must include not only the values for terrestrial receptors, but also the values for saltwater or freshwater aquatic organisms listed in Table 7-5.

7.3.4 Cleanup Levels for Surface Water, Seeps, and Groundwater

Chemical-specific ARARs were used to establish groundwater and surface cleanup levels for protection of human health and the environment. Promulgated MCLs or published action levels have been adopted as cleanup levels to protect human health due to groundwater ingestion (U.S. EPA, Region IX, 2000d).

Promulgated water quality criteria were applied to existing and planned freshwater surface bodies, and groundwater that recharges surface water or emerges as seeps. Existing surface water bodies at the Presidio include Mountain Lake, Crissy Field wetlands, and Lobos Creek. In addition, Tennessee Hollow and Dragonfly Creek are recognized surface water resources of the Presidio and will be treated as such in applying cleanup levels. Water quality criteria adopted as cleanup levels for surface water and groundwater that recharges surface water at the Presidio are intended to protect freshwater aquatic organisms, and humans who may drink the water and consume fish or other organisms inhabiting the water bodies from chronic exposure to PCOCs. Water quality criteria adopted as cleanup levels for freshwater seeps at the Presidio are intended to protect freshwater aquatic organisms from chronic exposure to PCOCs. Seeps observed at the Presidio are not considered potential habitat that would support fish or other organisms that could be consumed by humans. Water quality criteria used to establish surface water, groundwater recharge to surface water, and seep cleanup levels were obtained from the following references:

- RWQCB *Water Quality Control Plan, San Francisco Bay Basin* or Basin Plan, dated 21 June 1995.

- Title 40 CFR §131.38, *Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California* or CTR.

Table 7-6 presents cleanup level values for PCOCs in surface water, seeps, and groundwater. Groundwater cleanup level values for PCOCs in Table 7-6 are established as drinking water standards (i.e., MCLs or action levels) unless the site is located near a surface water body (e.g., Mountain Lake, Tennessee Hollow riparian corridor, Lobos Creek) or seep. For sites near surface water bodies, cleanup levels based on water quality criteria for protection of aquatic life or human health are applicable if they are more stringent than relevant MCL or action levels for the PCOC under consideration. For sites near seeps, cleanup levels are based on protection of aquatic life alone.

7.3.5 Site-Specific Cleanup Level Selection Process

Once a site is identified, site-specific cleanup levels for each media must be determined. The process for soil and sediment is presented first in Table 7-1, followed by the process for surface water, seeps and groundwater. The following discussion presents this process for soils and sediments followed by water. The cleanup level selection for Fill Site 1 is also provided as an example of the cleanup level selection process.

- For sites with soil, freshwater sediment, and/or marine sediment, the predominant lithology should be identified based on Figure 6-1 and lithologic logs for the site. For Fill Site 1, the soil lithology is Colma.

- Next, the planned human land use should be determined, as identified on Figure 7-1 and described in Section 7.1.1; for Fill Site 1 residential use is planned. The appropriate human land use and soil lithology columns should be used to select cleanup levels from Table 7-2.

- The site should be evaluated to determine if it is located in an area where buffer zone or special status ecological cleanup levels are applicable, based on Figure 7-2. In addition, NPS or Trust natural resource staff should be consulted to determine if special status species are present. For Fill Site 1, the site is located in an area with significant ecological habitat where special status species may be present. The combination of ecological land use, lithology, and media (soil, freshwater sediment, or marine sediment) is used to select the appropriate column of cleanup levels from Tables 7-2, 7-3, or 7-4. If no values are listed for special status species for the sediments, then the non-special status species values should be used.

- If petroleum hydrocarbons and related constituents are present, cleanup levels are presented on Table 7-5 that are specific to the various human land uses (which will correspond to the same land use from Table 7-2), ecological protection, and groundwater protection. The petroleum hydrocarbon standards are taken directly from Order No. 96-070, Site Cleanup Requirements (RWQCB, 1996). Where cleanup levels for petroleum related constituents, such as PAHs, are presented in both Tables 7-2 through 7-4 and in Table 7-5, the more stringent value should be used for the appropriate land use at a given site. At Fill Site 1, petroleum hydrocarbons and related constituents cleanup levels include the following columns on Table 7-5: protection of residential human health, protection of terrestrial ecological receptors, protection of freshwater aquatic organisms (since Fill Site 1 is with the Freshwater Ecological Protection Zone identified on Figure 7-2), and protection of groundwater resources to maintain drinking water standards in groundwater assuming soil is greater than five feet above groundwater.

- The cleanup level for each PCOC is the minimum cleanup level from the applicable columns of the applicable Tables 7-2 through 7-5. For example, cleanup levels at Fill Site 1 for arsenic, lead, benzo(a)pyrene, and total petroleum hydrocarbons as diesel

("TPHd") would be 6.2 mg/kg (based on Table 7-2), 160 mg/kg (based on Table 7-2), 0.027 mg/kg (based on Table 7-2), and 700 mg/kg (based on Table 7-5), respectively. Any chemical that has been detected at a site at a concentration greater than this minimum cleanup level is identified as a COC for soil or sediment.

The process of screening PCOCs in surface water, seeps and groundwater is similar to that described above for soil and sediment.

- Once the site and type of water resource are identified, the protection level for the water resource must be determined. The cleanup level for freshwater bodies should be used to protect freshwater aquatic organisms, and humans who may drink the water and consume fish or other organisms inhabiting the surface water body. The cleanup level for freshwater seeps should be used to protect only freshwater aquatic organisms within a freshwater seep. The cleanup level for drinking water should be used to protect use of surface water or groundwater as potable supply. The cleanup level for saltwater should protect saltwater aquatic organisms. In some cases, site-specific requirements will include the combination of more than one cleanup level to protection a variety of potential receptors. For Fill Site 1, cleanup levels should consider both protection of drinking water and freshwater aquatic organisms in the seeps.

- The PCOCs should be screened against the lowest water cleanup level. The cleanup level for each PCOC is the minimum cleanup level from the applicable columns of Table 7-6. Any chemical that has been detected at a site at a concentration greater than this minimum cleanup level is identified as a COC for water. Cleanup levels at Fill Site 1 for arsenic, lead, benzo(a)pyrene, and TPHd in groundwater would be 10 µg/L (based on MCLs), 3.2 µg/L (based on freshwater seep water quality criteria), 0.2 µg/L (based on MCLs, since there is no freshwater seep value), and 880 µg/L (based on FPALDR), respectively.

Once cleanup levels are identified, COCs can be determined, and appropriate remedial alternatives, if required, evaluated and selected. In addition, cleanup levels for any chemical, whether or not a PCOC, can be determined through the process described in this section.

7.3.6 Summary

In summary, this document can be used to identify PCOCs and COCs at Presidio sites, and to determine applicable cleanup levels for these chemicals. PCOCs include all organic chemicals detected at a site, assuming these are anthropogenic. In addition, inorganic chemicals detected in soil samples above screening levels identified in Table 6-5 are also included as PCOCs. The screening levels are based on the four main Presidio lithologies (serpentinite, Colma Formation, beach/dune, and chert/shale). The process outlined in Table 7-1 is used to identify the applicable cleanup levels. These cleanup levels are compared with site data to identify the chemicals that are considered COCs at a given site.

Cleanup levels derived from the process and tables presented in this document are intended to be applicable to all Presidio sites that do not have an existing regulatory agency-approved decision document. If new chemicals are identified at a site, the process used herein should be used to derive cleanup levels for those chemicals.

In addition, it is possible that the background metals concentrations developed in this document may not accurately reflect background conditions at all sites throughout the Presidio. If, for example, the Trust is having difficulty meeting cleanup levels during site remediation (when no other indicators for site contamination are present), the Trust may present supporting data to the DTSC and other stakeholders to determine if alternate background concentrations or lithologies may be appropriate for that site, or if other risk management measures should be considered. Similarly, the special status species PRGs developed in Section 5.10 were, in some cases, established as the method detection limit or other low concentration. As a practical matter, it may be difficult to achieve these cleanup levels during remediation. If such cases arise during remediation, the Trust may present the data to the DTSC and other stakeholders to determine alternate ecological cleanup levels at that time or other risk management measures.

TABLES

TABLE 7-1
STEPS TO IDENTIFY SITE-SPECIFIC CLEANUP LEVELS AT THE PRESIDIO

Presidio of San Francisco, California

	Evaluation Process Steps	Potential Parameters	References	Example
Soil and Sediment				
1	Identify Site	--	--	Fill Site 1
2	Identify Media	Soil, freshwater sediment, marine sediment	--	soil
3	Identify Predominant Lithology(ies)	Colma, Serpentinite, Beach/Dune, Chert/Shale	Site-specific lithologic logs, Figure 6-1	Colma
4	Identify Planned Human Land Use and Applicable Cleanup Levels	Residential, Recreational, Commercial/Industrial	Figure 7-1	Residential
5	Identify Applicable Ecological Cleanup Levels	None, buffer zone ecological ("ECO"), ecological special status	Figure 7-2 and NPS or Trust Natural Resource Staff (if ecological special status)	ECO special status
6	Identify Whether Petroleum Hydrocarbons and Related Constituents Present	Petroleum hydrocarbons, BTEX, and PAHs	List of chemicals detected at site	Petroleum hydrocarbons are present
7	If Petroleum Hydrocarbons and Related Constituents Present, Identify Resources to be Protected	Human health, terrestrial ecological receptors, freshwater or saltwater ecological protection zone, soil 5 feet above or below groundwater protected to drinking water standards, soil 5 feet above or below groundwater in Lobos Creek Basin, soil 5 feet above or below groundwater at Crissy Field	Figures 7-1 and 7-2, Table 7-5	Residential, ECO terrestrial, freshwater ECO protection zone, soil greater than 5 feet above groundwater (drinking water standard)
8	Screen Site Chemicals Based on Most Stringent Cleanup Levels from Applicable Tables	• Human Health and Ecological (Non-Petroleum, Soil)	Table 7-2	Colma, residential, ECO special status
		• Ecological (Non-Petroleum, Freshwater Sediment)	Table 7-3	--
		• Ecological (Non-Petroleum, Marine Sediment)	Table 7-4	--
		• Human Health and Ecological (Petroleum Hydrocarbons and Constituents, Soil and Sediment)	Table 7-5	Residential, ECO terrestrial and freshwater, soil >5 feet above groundwater (drinking water standard)

TABLE 7-1
STEPS TO IDENTIFY SITE-SPECIFIC CLEANUP LEVELS AT THE PRESIDIO

Presidio of San Francisco, California

	Evaluation Process Steps	Potential Parameters	References	Example
Surface Water, Seeps, and Groundwater				
1	Identify Site	--	--	Fill Site 1
2	Determine Type of Water	Surface water, seep, groundwater; freshwater or marine	--	Groundwater and seeps
3	Determine Protection Level for Groundwater	Cleanup level to protect aquatic organisms and humans who potentially drink the water or consume fish or other species from surface water ("SW"); cleanup level to protect aquatic organisms in freshwater seep ("FW"); cleanup level to protect marine organisms ("M"); and cleanup level to protect use of water as potable supply ("DW").	Table 7-6	Potential drinking water and freshwater seeps immediately downstream of site
4	Screen Site Chemicals Based on Most Stringent Cleanup Levels from Applicable Table	SW, FW, M, DW	Table 7-6	DW and FW

TABLE 7-2
SUMMARY OF SELECTION OF PRELIMINARY REMEDIATION GOALS AND PROPOSED CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

	Ecological								Human Health			Lithology				
	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Buffer Zone PRGs (mg/kg); (b)	Proposed Special Status PRGs (mg/kg); (c)	Proposed PRGs (mg/kg); (d)			Presidio Background Metals Concentrations by Lithology (mg/kg); (e)				
Potential Chemical of Concern	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			Residential	Recreational	Comm/Ind.	Serpentinite	Colma	Beach/Dune	Chert/Shale	Notes (f)
Inorganic Chemicals																
Antimony	5	5	5	162	490	326	5	5	29	70	760	$3.0^{(DL)}$	$3.0^{(DL)}$	$3.0^{(DL)}$	$3.0^{(DL)}$	1
Arsenic	10	224	117	46	692	369	64 (g)	10	0.36	0.88	3.3	$5.4^{(95th)}$	$6.2^{(UCL95)}$	$5.9^{(UCL95)}$	$3.2^{(Max)}$	2
Barium	500	500	500	320	3,200	1,760	500	320	5,000	12,000	130,000	$230^{(95th)}$	$180^{(UCL95)}$	$120^{(UCL95)}$	$900^{(UCL95)}$	3
Beryllium	10	10	10	160	8,000	4,080	10	10	140	350	3,800	$1.1^{(Max)}$	$0.99^{(UCL95)}$	$0.89^{(UCL95)}$	$0.72^{(UCL95)}$	1
Cadmium	4	100	52	0.017	0.44	0.23	0.23	0.017	1.7	4.2	16	$1.9^{(Max)}$	$0.8^{(DL)}$	$1.7^{(Max)}$	$1.7^{(Max)}$	2
Chromium	5	200	103	4	42	23	23	4	1,200 (h)	2,800 (h)	11,000 (h)	$1,700^{(95th)}$	$140^{(UCL95)}$	$120^{(UCL95)}$	$41^{(UCL95)}$	2
Cobalt	20	75	48	220	3,300	1,760	48	20	4,000	10,000	110,000	$170^{(95th)}$	$21^{(UCL95)}$	$16^{(UCL95)}$	$37^{(UCL95)}$	3
Copper	50	400	225	30	200	115	120	30	- (i)	-	-	$85^{(95th)}$	$49^{(UCL95)}$	$43^{(UCL95)}$	$360^{(UCL95)}$	3
Cyanide	-	-	-	6,298	18,894	12,596	13,000	6,300	1,000	2,500	23,000	-	-	-	-	4
Lead (j)	-	-	-	-	-	-	300	160	400	500	3,500	$66^{(95th)}$	$7.5^{(UCL95)}$	$57^{(UCL95)}$	$45^{(Max)}$	1
Tetraethyl Lead	-	-	-	1.1	52	27	27	1.1	0.0052	0.013	0.11	-	-	-	-	4
Mercury	0.3	10	5.15	0.038	12	6	1.6 (g)	0.4 (k)	20	52	570	$0.2^{(DL)}$	$0.2^{(DL)}$	$0.2^{(DL)}$	$0.2^{(DL)}$	1
Molybdenum	-	-	-	11.5	582	297	300	12	360	870	9,400	$2.0^{(DL)}$	$2.0^{(DL)}$	$2.0^{(DL)}$	$2.0^{(DL)}$	1
Nickel	30	500	265	58	1,440	749	71 (g)	30	1,400	3,500	38,000	$4,500^{(95th)}$	$110^{(UCL95)}$	$70^{(UCL95)}$	$71^{(UCL95)}$	2
Selenium	1	70	35.5	0.20	2	1	1.1	0.2	360	870	9,400	$0.5^{(DL)}$	$0.5^{(DL)}$	$0.75^{(Max)}$	$0.5^{(DL)}$	1
Silver	2	2	2	6	144	75	2	2	360	870	9,400	$1.7^{(Max)}$	$1.0^{(DL)}$	$1.0^{(DL)}$	$1.0^{(DL)}$	1
Thallium	1	1	1	0.15	39	20	1	0.15	5.7	14	150	$1.0^{(DL)}$	$1.0^{(DL)}$	$1.0^{(DL)}$	$1.0^{(DL)}$	2
Vanadium	2	20	11	2	8	5	5	2	650	1,600	17,000	$74^{(95th)}$	$90^{(UCL95)}$	$92^{(UCL95)}$	$61^{(UCL95)}$	2
Zinc	50	864	457	4	97	51	50	4	22,000	52,000	570,000	$160^{(95th)}$	$60^{(UCL95)}$	$66^{(UCL95)}$	$120^{(UCL95)}$	2
Semivolatile Organic Compounds																
Acenaphthene	30	50	40	84	2,547	1,316	40	30	2,700	6,600	55,000	-	-	-	-	1
Acenaphthylene	30	50	40	84	2,547	1,316	40	30	-	-	-	-	-	-	-	1
Anthracene	30	50	40	84	2,547	1,316	40	30	14,000	33,000	280,000	-	-	-	-	1
Benzo(a)anthracene	30	50	40	84	2,547	1,316	40	30	0.27	0.65	2.3	-	-	-	-	4
Benzo(a)pyrene	30	50	40	84	2,547	1,316	40	30	0.027	0.065	0.23	-	-	-	-	4
Benzo(b)fluoranthene	30	50	40	84	2,547	1,316	40	30	0.27	0.65	2.3	-	-	-	-	4
Benzo(g,h,i)perylene	30	50	40	84	2,547	1,316	40	30	-	-	-	-	-	-	-	1
Benzo(k)fluoranthene	30	50	40	84	2,547	1,316	40	30	0.27	0.65	2.3	-	-	-	-	4
Benzyl Alcohol	-	-	-	1	164	83	40 (l)	1	14,000	38,000	280,000	-	-	-	-	1
Chrysene	30	50	40	84	2,547	1,316	40	30	2.7	6.5	23	-	-	-	-	4
Dibenzo(a,h)anthracene	30	50	40	84	2,547	1,316	40	30	0.078	0.19	0.67	-	-	-	-	4
Dibenzofuran	-	-	-	-	-	-	-	-	910	2,200	18,000	-	-	-	-	4
Fluoranthene	30	50	40	84	2,547	1,316	40	30	1,800	4,400	37,000	-	-	-	-	1
Fluorene	30	50	40	84	2,547	1,316	40	30	1,800	4,400	37,000	-	-	-	-	1

TABLE 7-2
SUMMARY OF SELECTION OF PRELIMINARY REMEDIATION GOALS AND PROPOSED CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Potential Chemical of Concern	Ecological								Human Health			Lithology				Notes (f)
	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Buffer Zone PRGs (mg/kg); (b)	Proposed Special Status PRGs (mg/kg); (c)	Proposed PRGs (mg/kg); (d)			Presidio Background Metals Concentrations by Lithology (mg/kg); (e)				
	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			Residential	Recreational	Comm/Ind.	Serpentinite	Colma	Beach/Dune	Chert/Shale	
Semivolatile Organic Compounds																
Indeno(1,2,3-cd)pyrene	30	50	40	84	2,547	1,316	40	30	0.27	0.65	2.3	-	-	-	-	4
2-methylnaphthalene	30	50	40	84	2,547	1,316	40	30	-	-	-	-	-	-	-	1
4-methylphenol (p-Cresol)	50	50	50	11,167	55,782	33,474	50	50	260	640	5,600	-	-	-	-	1
Naphthalene	30	50	40	84	2,547	1,316	40	30	910	2,200	18,000	-	-	-	-	1
n-nitrosodiphenylamine	20	109	65	16,981	50,942	33,962	65	20	43	104	380	-	-	-	-	5
Pentachlorophenol	3	4	3.5	22	660	341	3.5	3	5	12	42	-	-	-	-	1
Phenanthrene	30	50	40	84	2,547	1,316	40	30	-	-	-	-	-	-	-	1
Phenol	30	188	109	2,547	7,641	5,094	109	30	27,000	76,000	550,000	-	-	-	-	1
Pyrene	30	50	40	84	2,547	1,316	40	30	1,400	3,300	28,000	-	-	-	-	1
Volatile Organic Compounds																
Acetone	-	-	-	8,490	127,356	67,923	68,000	8,500	0.24 (m)	0.24 (m)	0.24 (m)	-	-	-	-	4
2-butanone (MEK)	-	-	-	4,245	25,471	14,858	15,000	4,200	3.8 (m)	3.8 (m)	3.8 (m)	-	-	-	-	4
Carbon disulfide	-	-	-	934	28,018	14,476	14,000	934	200 (m)	200 (m)	200 (m)	-	-	-	-	4
1,4-dichlorobenzene	20	128	74	2,123	12,736	7,429	74	20	0.13 (m)	0.59 (m)	0.49 (m)	-	-	-	-	4
p-isopropyltoluene (p-cymene)	200 (n)	1,000 (n)	600 (n)	2,207 (n)	22,075 (n)	12,141 (n)	600 (n)	200 (n)	130 (m)	130 (m)	130 (m)	-	-	-	-	4
Methylene Chloride	-	-	-	459	34,377	17,418	17,000	459	0.076 (m)	0.076 (m)	0.076 (m)	-	-	-	-	4
1,2,3-trichlorobenzene (o)	20	115	67.5	-	-	-	68	20	15 (m)	15 (m)	15 (m)	-	-	-	-	4
1,2,4-trichlorobenzene	20	127	73.5	-	-	-	74	20	15 (m)	15 (m)	15 (m)	-	-	-	-	4
Trichlorofluoromethane	-	-	-	-	-	-	-	-	40 (m)	80 (m)	80 (m)	-	-	-	-	4
1,1,1-trichloroethane	-	-	-	9,679	1,451,858	730,768	730,000	9,700	8 (m)	8 (m)	8 (m)	-	-	-	-	4
PCBs, Pesticides, and Herbicides																
PCBs (Arochlor 1254)	40	240	140	0.010	0.45	0.23	0.23	*0.033*	0.16	0.39	1 (p)	-	-	-	-	1
Aldrin	-	-	-	0.0039	0.19	0.1	0.1	0.0039	0.029	0.07	0.26	-	-	-	-	5
alpha-BHC	-	-	-	0.062	9.8	4.9	2.4 (g)	0.062	0.18	0.44	1.6	-	-	-	-	5
beta-BHC	-	-	-	0.062	9.8	4.9	2.4 (g)	0.062	0.32	0.79	2.9	-	-	-	-	5
delta-BHC	-	-	-	0.062	9.8	4.9	2.4 (g)	0.062	0.18	0.44	1.6	-	-	-	-	5
Chlordane	-	-	-	0.0090	0.071	0.04	0.04	0.0090	0.37	0.91	3.4	-	-	-	-	1
2,4-D	-	-	-	-	-	-	5	*0.025*	620	1,500	15,000	-	-	-	-	1
Dicamba	-	-	-	-	-	-	5	*0.01*	1,800	4,500	44,000	-	-	-	-	1
4,4'-DDD	40	200	120	0.049	2.4	1.2	0.53 (g)	0.049	2.0	4.9	18	-	-	-	-	1
4,4'-DDE	40	200	120	0.098	2.4	1.3	0.61 (g)	0.098	1.4	3.5	13	-	-	-	-	1
4,4'-DDT	40	200	120	0.0082	2.4	1.2	0.53 (g)	0.0082	1.4	3.5	13	-	-	-	-	1
Dieldrin	50	100	75	0.039	0.48	0.26	0.26	0.039	0.030	0.074	0.27	-	-	-	-	5
Endosulfan	-	-	-	1.1	5.5	3.3	3.3	1.1	370	900	8,700	-	-	-	-	1
Endosulfan Sulfate (o)	-	-	-	1.1	5.5	3.3	3.3	1.1	370	900	8,700	-	-	-	-	1
Endrin	-	-	-	0.0035	0.50	0.25	0.11 (g)	*0.004*	18	45	440	-	-	-	-	1
Endrin Aldehyde (o)	-	-	-	0.0035	0.50	0.25	0.11 (g)	*0.004*	18	45	440	-	-	-	-	1
Endrin Ketone (o)	-	-	-	0.0035	0.50	0.25	0.11 (g)	*0.004*	18	45	440	-	-	-	-	1

TABLE 7-2
SUMMARY OF SELECTION OF PRELIMINARY REMEDIATION GOALS AND PROPOSED CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

	Ecological								Human Health			Lithology				
	Summary of Plant and Soil Fauna PRGs (mg/kg); (a)			Summary of Wildlife PRGs (mg/kg); (a)			Proposed Buffer Zone PRGs (mg/kg); (b)	Proposed Special Status PRGs (mg/kg); (c)	Proposed PRGs (mg/kg); (d)			Presidio Background Metals Concentrations by Lithology (mg/kg); (e)				
Potential Chemical of Concern	PRG_{low}	PRG_{high}	Arithmetic Mean	PRG_{low}	PRG_{high}	Arithmetic Mean			Residential	Recreational	Comm/Ind.	Serpentinite	Colma	Beach/Dune	Chert/Shale	Notes (f)
PCBs, Pesticides, and Herbicides																
gamma-BHC (Lindane)	-	-	-	0.010	1.6	0.8	0.37 (g)	0.010	0.44	1.1	4.0	-	-	-	-	5
Heptachlor	-	-	-	0.017	7.4	3.7	3.7	0.017	0.12	0.29	1.1	-	-	-	-	5
Heptachlor Epoxide	-	-	-	0.017	7.4	3.7	3.7	0.017	0.088	0.21	0.79	-	-	-	-	5
Isodrin (o)	-	-	-	0.0039	0.19	0.1	0.1	0.0039	0.029	0.069	0.26	-	-	-	-	5
MCPP	-	-	-	-	-	-	-	*5.0*	-	-	-	-	-	-	-	1
Methoxychlor	-	-	-	0.44	35	18	18	0.44	310	750	7,300	-	-	-	-	1

Notes:

(a) Listed in these columns are the following: (1) the plant and soil fauna represent the low and high Preliminary Remediation Goals ("PRGs") from Tables 5-12 and 5-13; (2) the wildlife PRG_{low} represents the lowest of the wildlife PRG_{low} from Table 5-12; and (3) the wildlife PRG_{high} represents the lowest of the wildlife PRG_{high} from Table 5-13.

(b) The buffer zone PRG proposed for protection of non-special status species is the lowest of the arithmetic mean of plant and soil fauna PRGs, the arithmetic mean of wildlife PRGs, the special status PRGs identified in Table 5-21, or 5 mg/kg for pesticides or herbicides for which not enough toxicological data exist to calculate a PRG_{low} and PRG_{high} (e.g., 2,4-D, Dicamba, and MCPP).

(c) Values are proposed as soil PRGs for special status species. The special status PRG, as used in this document, is established as the PRG_{low}. *Italics* indicates that the laboratory detection limit exceeds the PRGlow, and thus is selected as the cleanup level. The laboratory detection limit is also used as the special status PRG for pesticides and herbicides for which not enough toxicological data exist to calculate ecological PRGs.

(d) The human health PRGs proposed for residential, recreational, and commercial/industrial land use are from Tables 4-3, 4-4, and 4-5, respectively. For VOCs, the human health PRGs are from Table 4-7.

(e) The following abbreviations are used in the Background Metals columns:
DL - Detection Limit: A typical detection limit is included when there were insufficient data to calculate a 95% upper confidence level ("UCL") of the 95th percentile (e.g., fewer than 50% detections).
Max: Maximum concentration detected in background samples of this lithology (threshold level when there are fewer than 50% detections).
95th: The concentration corresponding to the 95th percentile of the lognormal data distribution calculated for data sets with a frequency of detection greater than 50%. Applied to serpentinite only due to small number of data in background data set.
UCL95: The concentration corresponding to the 95% UCL of the 95th percentile of the lognormal data distribution.

(f) In general, the cleanup levels are the minimum of applicable buffer zone ecological, ecological special status, and human health values, above background concentrations. Unless otherwise noted, for a given site, only applicable columns would be used to select the appropriate cleanup level. For example, ecological cleanup levels would not be applied to a site that is classified as only recreational human land use.
1. Cleanup level governed by ecological values.
2. Cleanup level governed by background metals concentrations.
3. Cleanup level governed by ecological values or background metal concentration, depending on lithology.
4. Cleanup level governed by human health values.
5. Cleanup level governed by ecological values or human health values, depending on land use.

(g) For these chemicals, which have a large difference (greater than one order of magnitude) between PRG_{low} and PRG_{high}, alternate PRGs were developed for special status species ("Alternate PRGs"). As discussed in note (c), special status values were ultimately established as the PRG_{low}. For the chemicals indicated, the Alternate PRG was subsequently established as the Buffer Zone PRG, in lieu of the arithmetic mean PRG.

(h) The cleanup levels for chromium are based on the assumption that chromium (VI) comprises up to 0.28 percent of the total chromium in serpentinite at the Presidio (Montgomery Watson, 1999a).

(i) Hyphen indicates that PRG could not be calculated due to lack of applicable toxicity data in available literature, or no value is appropriate.

(j) Ecological PRGs for lead were calculated through use of the Monte Carlo method. The residential cleanup level for lead in soil has been established as a not-to-exceed value of 400 mg/kg, based on chemical-specific ARARs and a maximum average concentration of 370 mg/kg, based on the site-specific PRG. Refer to text for discussion of methodology used to derive the ecological and human health PRGs for lead.

(k) Mercury level for special status species is based on risk management concerns and is established at 2 times the typical method detection limit.

(l) For benzyl alcohol, the buffer zone PRG was decreased from the wildlife arithmetic mean PRG to be more in line with the other semivolatile organic compounds.

TABLE 7-2
SUMMARY OF SELECTION OF PRELIMINARY REMEDIATION GOALS AND PROPOSED CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SOIL

Presidio of San Francisco, California

Notes (continued):

(m) For VOCs, human health cleanup levels were calculated using the more stringent of Risk-based Screening Levels based on the protection of groundwater quality, direct contact with soil, or vapor intrusion of VOCs into indoor air. The calculations are described in Section 4.2.9 of this document.

(n) For ecological PRGs only, toluene was used as a surrogate for isopropyltoluene.

(o) For human health PRGs only, values for for 1,2,4-trichlorobenzene were used for 1,2,3-trichlorobenzene. For all PRGs, values for Endosulfan were used for Endosulfan Sulfate, values for Endrin were used for Endrin Aldehyde and Endrin Ketone. Isodrin is an isomer of Aldrin; for all PRGs values for Aldrin were used for Isodrin.

(p) Human health cleanup level of 1 mg/kg for polychlorinated biphenyls in soil obtained from Title 40 of the Code of Federal Regulations §761.61 to Subpart D of Toxic Substances Control Act ("TSCA"). Human health PRGs for PCBs in soil in commercial/industrial land use calculated with the same assumptions as the other chemicals is 1.4 mg/kg, as shown in Table 4-5. The TSCA value of 1 mg/kg is considered protective of human health and conservative, as it corresponds to an estimated lifetime incremental cancer risks of $7x10^{-7}$, which is below U.S. EPA's acceptable risk range of 10^{-4} to 10^{-6}.

TABLE 7-3
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Inorganic Chemicals								
Antimony	3.0 (b)	3.0 (b)	3.0 (b)	3.0 (b)				
Arsenic	19	19	19	19				
Barium	3,100	3,100	3,100	3,100				
Beryllium	7,200	7,200	7,200	7,200				
Cadmium	1.9 (c)	1.1	1.7 (c)	1.7 (c)				
Chromium	1,700 (c)	140 (c)	120 (c)	42				
Cobalt	170 (c)	50	50	50				
Copper	114	114	114	360 (c)				
Cyanide	- (d)	-	-	-				
Lead	82	82	82	82				
Tetraethyl Lead	86	86	86	86				
Mercury	0.62	0.62	0.62	0.62				
Molybdenum	522	522	522	522				
Nickel	4,500 (c)	110 (c)	70 (c)	71 (c)				
Selenium	4.5	4.5	4.5	4.5	1.6	1.6	1.6	1.6
Silver	1.7 (c)	1.0 (c)	1.0 (c)	1.0 (c)				
Thallium	35	35	35	35	3.7	3.7	3.7	3.7
Vanadium	74 (c)	90 (c)	92 (c)	61 (c)				
Zinc	230	230	230	230				

TABLE 7-3
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Semivolatile Organic Compounds								
Acenaphthene	0.31	0.31	0.31	0.31				
Acenaphthylene	0.067	0.067	0.067	0.067				
Anthracene	0.45	0.45	0.45	0.45				
Benzo(a)anthracene	0.54	0.54	0.54	0.54				
Benzo(a)pyrene	0.74	0.74	0.74	0.74				
Benzo(b)fluoranthene	0.79	0.79	0.79	0.79				
Benzo(g,h,i)perylene	0.25	0.25	0.25	0.25				
Benzo(k)fluoranthene	0.79	0.79	0.79	0.79				
Benzyl Alcohol	140	140	140	140				
Chrysene	0.67	0.67	0.67	0.67				
Dibenzo(a,h)anthrancene	0.071	0.071	0.071	0.071				
Dibenzofuran	2	2	2	2				
Fluoranthene	1.5	1.5	1.5	1.5				
Fluorene	0.28	0.28	0.28	0.28				
Indeno(1,2,3-cd)pyrene	0.26	0.26	0.26	0.26				
2-methylnaphthalene	0.11	0.11	0.11	0.11				
4-methylphenol (p-Cresol)	-	-	-	-				
Naphthalene	0.3	0.3	0.3	0.3				
n-nitrosodiphenylamine	-	-	-	-				
Pentachlorophenol	-	-	-	-				
Phenanthrene	0.61	0.61	0.61	0.61				
Phenol	-	-	-	-				
Pyrene	0.79	0.79	0.79	0.79				

TABLE 7-3
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Volatile Organic Compounds								
Acetone	-	-	-	-				
2-Butanone (MEK)	-	-	-	-				
Carbon disulfide	-	-	-	-				
1,4-dichlorobenzene	0.35	0.35	0.35	0.35				
p-Isopropyltoluene (p-cymene)	-	-	-	-				
Methylene Chloride	-	-	-	-				
1,2,3-trichlorobenzene	-	-	-	-				
1,2,4-trichlorobenzene	-	-	-	-				
Trichlorfluoromethane	-	-	-	-				
1,1,1-trichloroethane	0.17	0.17	0.17	0.17				
PCBs, Pesticides, and Herbicides								
PCBs (Arochlor 1254)	0.36	0.36	0.36	0.36	0.14	0.14	0.14	0.14
Aldrin	0.005	0.005	0.005	0.005				
alpha-BHC	0.008	0.008	0.008	0.008				
beta-BHC	0.013	0.013	0.013	0.013				
delta-BHC	0.0075	0.0075	0.0075	0.0075				
Chlordane	0.01	0.010	0.01	0.01				
2,4-D	-	-	-	-				
Dicamba	-	-	-	-				
4,4'-DDD	0.016	0.016	0.016	0.016				
4,4'-DDE	0.016	0.016	0.016	0.016				
4,4'-DDT	0.032	0.032	0.032	0.032				
Dieldrin	0.032	0.032	0.032	0.032				
Endosulfan	0.0054	0.0054	0.0054	0.0054				
Endosulfan Sulfate	0.0054	0.0054	0.0054	0.0054				

TABLE 7-3
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (FRESHWATER)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
PCBs, Pesticides, and Herbicides (cont.)								
Endrin	0.1	0.1	0.1	0.1				
Endrin Aldehyde	0.1	0.1	0.1	0.1				
Endrin Ketone	0.1	0.1	0.1	0.1				
gamma-BHC (Lindane)	0.003	0.003	0.003	0.003				
Heptachlor	0.0083	0.0083	0.0083	0.0083				
Heptachlor Epoxide	0.0083	0.0083	0.0083	0.0083				
Isodrin	0.005	0.005	0.005	0.005				
MCPP	-	-	-	-				
Methoxychlor	0.019	0.019	0.019	0.019				

Notes:

(a) Buffer zone ecological cleanup levels apply to special status species as well if no special status species cleanup level is listed for a potential chemical of concern ("PCOC").

(b) Cleanup level for this compound and this lithology is based on the background level in soil. Background level for this compound and this lithology is derived from the typical detection limit.

(c) Cleanup level for this compound and this lithology is based on the background level in soil.

(d) Hyphen indicates that a cleanup level cannot be calculated. No published toxicity values for PCOC were found.

TABLE 7-4
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Inorganic Chemicals								
Antimony	14	14	14	14				
Arsenic	39	39	39	39				
Barium	3,100	3,100	3,100	3,100				
Beryllium	7,200	7,200	7,200	7,200				
Cadmium	1.9 (c)	1.6	1.7 (c)	1.7 (c)				
Chromium	1,700 (c)	140 (c)	120 (c)	42				
Cobalt	38,088	38,088	38,088	38,088				
Copper	152	152	152	152				
Cyanide	- (b)	-	-	-				
Lead	132	132	132	132				
Tetraethyl Lead	86	86	86	86				
Mercury	0.43	0.43	0.43	0.43				
Molybdenum	522	522	522	522				
Nickel	4,500 (c)	110 (c)	70 (c)	71 (c)				
Selenium	4.5	4.5	4.5	4.5	1.6	1.6	1.6	1.6
Silver	2.4	2.4	2.4	2.4				
Thallium	35	35	35	35	3.7	3.7	3.7	3.7
Vanadium	74 (c)	90 (c)	92 (c)	61 (c)				
Zinc	214	214	214	214				

TABLE 7-4
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Semivolatile Organic Compounds								
Acenaphthene	0.32	0.32	0.32	0.32				
Acenaphthylene	0.34	0.34	0.34	0.34				
Anthracene	0.59	0.59	0.59	0.59				
Benzo(a)anthracene	0.93	0.93	0.93	0.93				
Benzo(a)pyrene	1.0	1.0	1.0	1.0				
Benzo(b)fluoranthene	-	-	-	-				
Benzo(g,h,i)perylene	-	-	-	-				
Benzo(k)fluoranthene	-	-	-	-				
Benzyl Alcohol	145	145	145	145				
Chrysene	1.6	1.6	1.6	1.6				
Dibenzo(a,h)anthrancene	0.16	0.16	0.16	0.16				
Dibenzofuran	2.00	2.00	2.00	2.00				
Fluoranthene	2.85	2.85	2.85	2.85				
Fluorene	0.28	0.28	0.28	0.28				
Indeno(1,2,3-cd)pyrene	-	-	-	-				
2-methylnaphthalene	0.37	0.37	0.37	0.37				
4-methylphenol (p-Cresol)	-	-	-	-				
Naphthalene	1.1	1.1	1.1	1.1				
n-nitrosodiphenylamine	-	-	-	-				
Pentachlorophenol	-	-	-	-				
Phenanthrene	0.87	0.87	0.87	0.87				
Phenol	-	-	-	-				
Pyrene	1.6	1.6	1.6	1.6				

TABLE 7-4
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
Volatile Organic Compounds								
Acetone	-	-	-	-				
2-Butanone (MEK)	-	-	-	-				
Carbon disulfide	-	-	-	-				
1,4-dichlorobenzene	0.35	0.35	0.35	0.35				
p-Isopropyltoluene (p-cymene) (d)	0.67	0.67	0.67	0.67				
Methylene Chloride	-	-	-	-				
1,2,3-trichlorobenzene (e)	9.2	9.2	9.2	9.2				
1,2,4-trichlorobenzene	9.2	9.2	9.2	9.2				
Methylene Chloride	-	-	-	-				
Trichlorfluoromethane	-	-	-	-				
1,1,1-trichloroethane	0.17	0.17	0.17	0.17				
PCBs, Pesticides, and Herbicides								
PCBs (Arochlor 1254)	0.10	0.10	0.10	0.10				
Aldrin	0.46	0.46	0.46	0.46	0.10	0.10	0.10	0.10
alpha-BHC	0.0007	0.0007	0.0007	0.0007				
beta-BHC	0.0007	0.0007	0.0007	0.0007				
delta-BHC	0.0007	0.0007	0.0007	0.0007				
Chlordane	0.0033	0.0033	0.0033	0.0033				
2,4-D	-	-	-	-				
Dicamba	-	-	-	-				
4,4'-DDD	0.011	0.011	0.011	0.011				
4,4'-DDE	0.015	0.015	0.015	0.015				
4,4'-DDT	0.004	0.004	0.004	0.004				
Dieldrin	0.026	0.026	0.026	0.026				
Endosulfan	0.005	0.005	0.005	0.005				
Endosulfan Sulfate	0.005	0.005	0.005	0.005				

TABLE 7-4
ECOLOGICAL CLEANUP LEVELS FOR NON-PETROLEUM COMPOUNDS IN SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO (MARINE)

Presidio of San Francisco, California

Potential Chemical of Concern	Buffer Zone Ecological Cleanup Level (mg/kg)				Special Status Species Cleanup Level (mg/kg); (a)			
	Serpentinite	Colma	Beach/Dune	Chert/Shale	Serpentinite	Colma	Beach/Dune	Chert/Shale
PCBs, Pesticides, and Herbicides (cont.)								
Endrin	0.023	0.023	0.023	0.023				
Endrin Aldehyde	0.023	0.023	0.023	0.023				
Endrin Ketone	0.023	0.023	0.023	0.023				
gamma-BHC (Lindane)	0.002	0.002	0.002	0.002				
Heptachlor	437	437	437	437	44	44	44	44
Heptachlor Epoxide	437	437	437	437	44	44	44	44
Isodrin	0.457	0.457	0.457	0.457	0.10	0.10	0.10	0.10
MCPP	-	-	-	-				
Methoxychlor	0.019	0.019	0.019	0.019				

Notes:

(a) Buffer zone ecological cleanup levels apply to special status species as well if no special status species cleanup level is listed for a potential chemical of concern ("PCOC").

(b) Hyphen indicates that a cleanup level cannot be calculated. No published toxicity values for PCOC were found.

(c) Cleanup level for this compound and this lithology is based on the background level in soil.

(d) Values for toluene were used for isopropyltoluene.

(e) Values for 1,2,4-trichlorobenzene were used for 1,2,3-trichlorobenzene.

TABLE 7-5
HUMAN HEALTH AND ECOLOGICAL CLEANUP LEVELS FOR PETROLEUM HYDROCARBONS AND CONSTITUENTS IN SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

	Protection of Human Health			Protection of Ecological Receptors			Protection of Groundwater Resources					
							Cleanup Level for Soil to Maintain Drinking Water Standard in Groundwater		Cleanup Level for Soil to Maintain Non-detectable Concentration in Groundwater in Lobos Creek Basin		Cleanup Level for Soil at Crissy Field	
Potential Chemical of Concern	Residential (mg/kg); (a)	Recreational (mg/kg); (a)	Maintenance (mg/kg); (a)	Terrestrial Receptors (mg/kg); (a)	Freshwater Aquatic Organisms (mg/kg); (b)	Saltwater Aquatic Organisms (mg/kg); (c)	Less than 5 feet Above Groundwater (mg/kg); (a)	Greater than 5 feet Above Groundwater (mg/kg); (a)	Less than 5 feet Above Groundwater (mg/kg); (a)	Greater than 5 feet Above Groundwater (mg/kg); (a)	Less than 5 feet Above Groundwater (mg/kg); (a)	Greater than 5 feet Above Groundwater (mg/kg); (a)
Inorganic Chemicals												
Lead	-	-	-	50 (d)	-	-	-	-	-	-	-	-
Semivolatile Organic Compounds												
Anthracene	5,900	13,800	17,800	-	-	-	308	-	0.05	-	1,120	-
Benzo(a)anthracene	0.43	1	1.5	-	-	-	8	-	0.2	-	23	-
Benzo(a)pyrene	0.04	0.1	0.15	0.3	-	-	3	-	0.8	-	9	-
Benzo(b)fluoranthene	0.43	1	1.5	-	-	-	23	-	0.6	-	64	-
Benzo(g,h,i)perylene	620	1,400	1,700	-	-	-	5,040	-	2	-	19,500	-
Benzo(k)fluoranthene	0.43	1	1.5	-	-	-	23	-	0.6	-	64	-
Chrysene	4.3	10	15	-	-	-	54	-	0.3	-	151	-
Fluoranthene	820	1,900	2,300	-	-	-	316	-	0.05	-	1,160	-
Fluorene	770	1,800	2,300	-	-	-	60	-	0.05	-	220	-
Naphthalene	480	1,100	2,300	-	-	-	9	-	0.05	-	140	-
Phenanthrene	600	1,400	1,700	-	-	-	86	-	0.05	-	410	-
Total Carcinogenic PAHs	5.6	13	19.7	-	-	-	111	-	2.5	-	253	-
Pyrene	620	1,400	1,700	-	-	-	241	-	0.09	-	910	-
Petroleum Hydrocarbons and Constituents												
TPH (as diesel); (e)	1,380	3,200	6,700	700	144 (f); (g)	144 (f)	115	15,000	7	15,000	1,950	15,000
TPH (as gasoline)	1,030	2,400	5,900	610	140	11.6	100	5,000	7	5,000	1,690	5,000
TPH (as fuel oil) (h)	1,900	4,500	9,400	980	144 (g)	144	160	15,000	10	15,000	2,730	15,000
Benzene	0.6	1.5	5	40	0.79	50	0.005	140	0.005	140	1	140
Ethylbenzene	840	1,900	6,600	125	15	5	13	60	0.009	60	19	60
Toluene	530	1,200	12,800	270	3	260	1	420	0.005	420	14	420
Total Xylenes	1,080	2,500	109,000	55	5.7	22	33	180	0.009	180	4,340	180

TABLE 7-5
HUMAN HEALTH AND ECOLOGICAL CLEANUP LEVELS FOR PETROLEUM HYDROCARBONS AND CONSTITUENTS IN SOIL AND SEDIMENT AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Notes:

(a) Cleanup level values listed are obtained from Tables 1 through 5 of California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region Order No. 96-070, *Site Cleanup Requirements for the Cleanup of Petroleum Impacted Soils, U.S. Army, Presidio of San Francisco, California*, dated 15 May 1996.

(b) Cleanup level values listed are point-of-compliance concentrations for freshwater sediment obtained from Tables 5 and 6 of Montgomery Watson *Development of Point of Compliance Concentrations (POCCs) for Gasoline in Surface Waters and Sediments of the Proposed Freshwater Stream,* dated May 1999. Locations apply to Freshwater Ecological Protection Zones shown on Figure 7-2.

(c) Cleanup level values listed are point-of-compliance concentrations for saltwater sediment obtained from Table 16 of International Technology Corporation *Report of Petroleum Hydrocarbon Bioassay and Point-of-Compliance Concentration Determinations Saltwater Ecological Protection Zone, Presidio of San Francisco,* dated December 1997. Locations apply to Saltwater Ecological Protection Zones shown on Figure 7-2.

(d) According to Order No. 96-070, the value for lead applies only to cleanup of leaded gasoline releases and not from releases from other sources. Order No. 96-070 states that an alternative cleanup level can be derived for protection of ecological receptors from releases of lead other than leaded gasoline. Refer to Tables 7-2 through 7-4 for ecological cleanup level values that apply to releases of lead not from leaded gasoline.

(e) Total petroleum hydrocarbons ("TPH").

(f) Although value is derived for fuel oil, adoption of this cleanup level for TPH (as diesel) has been tentatively approved by RWQCB.

(g) Although value is derived for saltwater aquatic organisms, this cleanup level is also being used for freshwater organisms.

(h) These values also apply to TPH quantified as motor oil.

ble 3.2 Recommended Point of Compliance Concentrat[illegible] (POCCs) for the Freshwater Ecological Protection Zo
Presidio of [illegible]n Francisco
San Francisco, California

Site Designations	TPH-gasoline		TPH-diesel		TPH-fuel oil	
	Soil mg/kg	Water µg/L	Soil mg/kg	Water µg/L	Soil mg/kg	Water µg/L
Building 207/231 CAP Area	11.6	443	144 (115)[a]	443	144	443
Fill Site 6A	11.6	443	144 (115)[a]	443	144	443
Building 1065 CAP Area	TBD[b]	TBD[b]	TBD[b]	TBD[b]	TBD[b]	TBD[b]
Fill Site 6B	TBD[b]	TBD[b]	TBD[b]	TBD[b]	TBD[b]	TBD[b]
Other Areas Within FEPZ Zone of Application	140 (100)[a]	443	140 (115)	443	140	443
Other Areas Outside of FEPZ Zone of Application[c]	see SCRs	770	see SCRs	880	see SCRs	1,200

Inside FEPZ zone and

TPH	Total petroleum hydrcarbons.
µg/L	Micrograms per liter.
mg/kg	Milligrams per kilogram.
FEPZ	Freshwater ecological protection zone.
SCR	Site Cleanup Requirement.
TBD	To be determined.

Notes:
POCCs adopted from existing POCCs presented in the FPALDR (1995) and RWQCB Order R2-2003-0080 (2003).

[a] Cleanup level shown in parentheses applies if depth to groundwater from TPH contamination in soil is less than 5 feet.

[b] For the Building 1065 CAP Area and Fill Site 6B, the POCCs for the Building 207/231 CAP Area will be used as interim screening levels for the freshwater zone until site-specific POCCs are selected.

[c] POCCs will not apply to areas outside of the FEPZ zone of application. Soil cleanup levels for these areas are based on the SCRs from RWQCB Order R2-2003-0080 (which include SCRs for human health, ecological terrestrial, and groundwater protection). Water cleanup levels for these areas will be drinking water levels.

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Water Quality Criteria									
							Drinking Water Cleanup Level (d);(e) (µg/L)			
	Surface Water (a) (µg/L)	Reference	Freshwater Seep (b) (µg/L)	Reference	Salt Water (c) (µg/L)	Reference	Background Levels	Reference	MCLs or Risk-Based Drinking Water Standards	Reference
Inorganic Chemicals										
Antimony	14	CTR (f)	- (g)	-	-	-	-	-	6	Federal MCL
Arsenic	150 (h, i)	Basin Plan (j)	150 (h, i)	Basin Plan	36 (h, i)	Basin Plan	-	-	10	Federal MCL
Barium	-	-	-	-	-	-	-	-	1,000	California MCL
Beryllium	-	-	-	-	-	-	-	-	4	Federal MCL
Cadmium	1.1 (h, k)	Basin Plan	1.1 (h, k)	Basin Plan	9.3 (h, i)	Basin Plan	-	-	5	Federal MCL
Chloride	-	-	-	-	-	-	-	-	250,000 (l)	Secondary MCL
Chromium (III)	180 (i, k)	NTR (m)	180 (i, k)	NTR	-	-	-	-	50	California MCL
Hexavalent Chromium	11 (h, i)	Basin Plan	11 (h, i)	Basin Plan	50 (h, i)	Basin Plan	-	-	-	-
Chromium (Total)	180 (i, k)	CTR	180 (i, k)	CTR	50 (i)	Basin Plan	-	-	50	California MCL
Cobalt	-	-	-	-	-	-	-	-	-	-
Copper	9.0 (h, i, k)	Basin Plan	9.0 (h, i, k)	Basin Plan	3.1 (h, i)	CTR	-	-	1,000	Secondary MCL
Cyanide	5.2	NTR	5.2	NTR	1	NTR	-	-	150	California MCL
Lead	2.5 (h, i, k)	Basin Plan	2.5 (h, i, k)	Basin Plan	8.1 (h, i)	Basin Plan	-	-	15 (n)	Federal MCL
Mercury	0.012 (o)	Basin Plan	0.012 (o)	Basin Plan	0.025	Basin Plan	-	-	2	Federal MCL
Molybdenum	-	-	-	-	-	-	-	-	-	-
Nickel	52 (h, i, k)	Basin Plan	52 (h, i, k)	Basin Plan	8.2 (h, i)	Basin Plan	-	-	100	California MCL
Selenium	5	NTR	5	NTR	71 (i)	NTR	-	-	50	Federal MCL
Silver	3.4 (h, i, k)	Basin Plan	3.4 (h, i, k)	Basin Plan	1.9 (h, i)	Basin Plan	-	-	50	Basin Plan
Thallium	1.7	CTR	-	-	-	-	-	-	2	Federal MCL
Vanadium	-	-	-	-	-	-	-	-	-	-
Zinc	120 (h, i, k)	Basin Plan	120 (h, i, k)	Basin Plan	81 (h, i)	Basin Plan	-	-	5,000	Secondary MCL

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Water Quality Criteria									
							Drinking Water Cleanup Level (d);(e) (µg/L)			
	Surface Water (a) (µg/L)	Reference	Freshwater Seep (b) (µg/L)	Reference	Salt Water (c) (µg/L)	Reference	Background Levels	Reference	MCLs or Risk-Based Drinking Water Standards	Reference
Semivolatile Organic Compounds										
Acenaphthene	1,200	CTR	-	-	-	-	-	-	-	-
Acenaphthylene	-	-	-	-	-	-	-	-	-	-
Anthracene	9,600	CTR	-	-	-	-	0.05	FPALDR	770	FPALDR (p)
Benzo(a)anthracene	0.0044 (q)	CTR	-	-	-	-	0.05	FPALDR	0.1	Proposed MCL
Benzo(a)pyrene	0.0044 (q)	CTR	-	-	-	-	0.05	FPALDR	0.2	Federal MCL
Benzo(b)fluoranthene	0.0044 (q)	CTR	-	-	-	-	0.05	FPALDR	0.2	Proposed MCL
Benzo(g,h,i)perylene	-	-	-	-	-	-	0.06	FPALDR	150	FPALDR
Benzo(k)fluoranthene	0.0044 (q)	CTR	-	-	-	-	0.05	FPALDR	2	FPALDR
Benzyl Alcohol	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	1.8	CTR	-	-	-	-	-	-	4	California MCL
Chrysene	0.0044 (q)	CTR	-	-	-	-	0.05	FPALDR	20	FPALDR
Dibenzo(a,h)anthracene	0.0044 (q)	CTR	-	-	-	-	-	-	-	-
Dibenzofuran	-	-	-	-	-	-	-	-	-	-
Fluoranthene	300	CTR	-	-	-	-	0.06	FPALDR	300	FPALDR
Fluorene	1,300	CTR	-	-	-	-	0.05	FPALDR	300	FPALDR
Indeno(1,2,3-c,d)-pyrene	0.0044 (q)	CTR	-	-	-	-	-	-	-	-
2-methylnaphthalene	-	-	-	-	-	-	-	-	-	-
2-methylphenol (o-Cresol)	-	-	-	-	-	-	-	-	-	-
Methylphenol (m- and p-Cresol)	-	-	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	0.05	FPALDR	300	FPALDR

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Water Quality Criteria						Drinking Water Cleanup Level (d);(e) (µg/L)			
	Surface Water (a) (µg/L)	Reference	Freshwater Seep (b) (µg/L)	Reference	Salt Water (c) (µg/L)	Reference	Background Levels	Reference	MCLs or Risk-Based Drinking Water Standards	Reference
Semivolatile Organic Compounds (contd)										
n-dotriacontane	-	-	-	-	-	-	-	-	-	-
n-hentriacontane	-	-	-	-	-	-	-	-	-	-
n-nitrosodiphenylamine	5	CTR	-	-	-	-	-	-	-	-
n-triacontane	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	0.28	CTR	15	CTR	7.9	CTR	-	-	1	Federal MCL
Phenanthrene	-	-	-	-	-	-	0.05	FPALDR	230	FPALDR
Phenol	21,000	CTR	-	-	-	-	-	-	1	Basin Plan
Polycyclic Aromatic Hydrocarbons	0.031 (q)	Basin Plan	-	-	0.031 (q)	Basin Plan	-	-	26 (r)	FPALDR
Pyrene	960	CTR	-	-			0.09	FPALDR	230	FPALDR
Volatile Organic Compounds										
Acetone	-	-	-	-	-	-	-	-	-	-
Bromodichloromethane	0.56	CTR	-	-	-	-	-	-	80	Federal MCL
2-Butanone (MEK)	-	-	-	-	-	-	-	-	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	0.25	CTR	-	-	-	-	-	-	0.5	California MCL
Chlorodibromomethane	0.41	CTR	-	-	-	-	-	-	80	Federal MCL
Chlorobenzene	680	CTR	-	-	-	-	-	-	70	California MCL
Chloroform	-	-	-	-	-	-	-	-	80	Federal MCL
Chloromethane	-	-	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	400	CTR	-	-	-	-	-	-	5	California MCL
1,2-dichloroethane	0.38	CTR	-	-	-	-	-	-	0.5	California MCL
1,1-dichloroethene	0.057	CTR	-	-	-	-	-	-	6	California MCL
cis-1,2-dichloroethene	-	-	-	-	-	-	-	-	6	California MCL

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Water Quality Criteria									
							Drinking Water Cleanup Level (d);(e) (µg/L)			
	Surface Water (a) (µg/L)	Reference	Freshwater Seep (b) (µg/L)	Reference	Salt Water (c) (µg/L)	Reference	Background Levels	Reference	MCLs or Risk-Based Drinking Water Standards	Reference
Volatile Organic Compounds (contd)										
p-Isopropyltoluene (p-cymene)	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	4.7	CTR	-	-	-	-	-	-	5	Federal MCL
Tetrachloroethene	0.8	CTR	-	-	-	-	-	-	5	Federal MCL
1,2,3-trichlorobenzene (s)	-	-	-	-	-	-	-	-	5	California MCL
1,2,4-trichlorobenzene	-	-	-	-	-	-	-	-	5	California MCL
1,1,1-trichloroethane	-	-	-	-	-	-	-	-	200	Federal MCL
Trichloroethene	2.7	CTR	-	-	-	-	-	-	5	Federal MCL
Trichlorofluoromethane	-	-	-	-	-	-	-	-	150	California MCL
Petroleum Hydrocarbons and Constituents										
Gasoline Range Hydrocarbons	443	Order (t)	443	Order	1,200	Order	50	FPALDR	770	FPALDR
Diesel Range Hydrocarbons	443 (u)	BBL Study (t)	443 (u)	BBL Study	2,200	Order	50	FPALDR	880	FPALDR
Fuel Oil Range Hydrocarbons (v)	443 (u)	BBL Study	443 (u)	BBL Study	2,200	Order	50	FPALDR	1,200	FPALDR
Benzene	1.2	CTR	463	Order	510	Order	0.5	FPALDR	1	California MCL
Ethylbenzene	845	Order	845	Order	43	Order	0.5	FPALDR	300	California MCL
Toluene	490	Order	490	Order	1,000	Order	0.5	FPALDR	150	California MCL
Tetraethyl Lead	-	-	-	-	-	-	-	-	-	-
Total Xylenes	318	Order	318	Order	130	Order	0.5	FPALDR	1,750	California MCL
Methyl t-butyl ether (MTBE)	-	-	-	-	4,400	Order	-	-	13	California MCL
PCBs, Pesticides, and Herbicides										
Polychlorinated Biphenyls	0.00017 (w, x)	CTR	0.014 (w, x)	CTR	0.03	CTR	-	-	0.5	Federal MCL
Aldrin	0.00013 (x)	CTR	3	CTR	1.3	CTR	-	-	-	-
Chlordane	0.00057 (x)	CTR	0.0043 (x)	CTR	0.004	CTR	-	-	0.1	California MCL

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Potential Chemical of Concern	Water Quality Criteria									
							Drinking Water Cleanup Level (d);(e) (µg/L)			
	Surface Water (a) (µg/L)	Reference	Freshwater Seep (b) (µg/L)	Reference	Salt Water (c) (µg/L)	Reference	Background Levels	Reference	MCLs or Risk-Based Drinking Water Standards	Reference
PCBs, Pesticides, and Herbicides (contd)										
2,4-D	-	-	-	-	-	-	-	-	70	Federal MCL
4,4'-DDD (y)	0.00083 (x)	CTR	0.001 (x)	CTR	0.001 (x)	CTR	-	-	-	-
4,4'-DDE (y)	0.00059 (x)	CTR	0.001 (x)	CTR	0.001 (x)	CTR	-	-	-	-
4,4'-DDT	0.00059 (x)	CTR	0.001 (x)	CTR	0.001 (x)	CTR	-	-	-	-
Dicamba	-	-	-	-	-	-	-	-	-	-
Dieldrin	0.00014 (x)	CTR	0.056 (x)	CTR	0.0019 (x)	CTR	-	-	0.5	Action Level (z)
Endosulfan	0.056 (x)	CTR	0.056 (x)	CTR	0.0087 (x)	CTR	-	-	-	-
Endosulfan Sulfate (s)	0.056 (x)	CTR	0.056 (x)	CTR	0.0087 (x)	CTR	-	-	-	-
Endrin	0.036 (x)	CTR	0.036 (x)	CTR	0.0023 (x)	CTR	-	-	2	Federal MCL
Endrin Aldehyde (s)	0.036 (x)	CTR	0.036 (x)	CTR	0.0023 (x)	CTR	-	-	2	Federal MCL
Endrin Ketone (s)	0.036 (x)	CTR	0.036 (x)	CTR	0.0023 (x)	CTR	-	-	2	Federal MCL
beta-BHC	0.014 (x)	CTR	-	-	-	-	-	-	0.3	Action Level (z)
gamma-BHC (Lindane)	0.019 (x)	CTR	0.95	CTR	0.16	CTR	-	-	0.2	Federal MCL
Heptachlor	0.00021 (x)	CTR	0.0038 (x)	CTR	0.0036 (x)	CTR	-	-	0.01 (x)	California MCL
Heptachlor Epoxide	0.00010 (x)	CTR	0.0038 (x)	CTR	0.0036 (x)	CTR	-	-	0.01 (x)	California MCL
Isodrin (aa)	0.00013 (x)	CTR	3	CTR	1.3	CTR	-	-	-	-
MCPP	-	-	-	-	-	-	-	-	-	-
Methoxychlor	-	-	-	-	-	-	-	-	30	California MCL

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Notes:

(a) Cleanup levels are based upon concentrations of chemicals of concern ("COCs") that result in chronic toxicity to freshwater aquatic organisms, or to humans through consumption of water and fish, whichever is more stringent. Cleanup levels apply to freshwater surface water and groundwater that may exfiltrate directly to surface water, such as Lobos Creek, Mountain Lake, and the Tennessee Hollow Riparian Corridor upon enhancement.

(b) Cleanup levels are based upon concentrations of COCs that result in chronic toxicity to freshwater aquatic organisms. Cleanup levels apply to seeps and to groundwater that emerges as freshwater seeps.

(c) Cleanup levels are based upon concentrations of COCs that result in chronic toxicity to marine organisms. Cleanup levels apply to marine or salt water environments.

(d) Cleanup levels listed in the FPALDR are the Practical Quantitation Limits ("PQLs"). Background levels (i.e., the PQLs) will be used as water quality goals for the Lobos Creek Groundwater Basin.

(e) Cleanup level listed is a promulgated or proposed federal Maximum Contaminant Level ("MCL"), promulgated or proposed MCL or action level specific to the State of California, or a water quality objective for municipal supply as identified in the Basin Plan (California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region, Water Quality Control Plan, San Francisco Bay Basin, San Francisco Bay Region ("Basin Plan"), dated 21 June 1995), as updated by Resolution R2-2004-003 dated 21 January 2004. Federal MCLs obtained from U.S. EPA, 2002 Edition of Drinking Water Standards and Health Advisories, dated Summer 2002. California MCLs obtained from Title 22 of the California Code of Regulations, §64431 and §64444. Proposed MCLs and action levels obtained from U.S. EPA Region IX, *Drinking Water Standards and Health Advisories Table,* dated November 2000, revised February 2001. Drinking water cleanup levels apply to groundwater and surface water at the Presidio.

(f) Cleanup level obtained from Title 40 of the Code of Federal Regulations, Part §131.38, *Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California*, or California Toxics Rule ("CTR"), promulgated 18 May 2000.

(g) Hyphen indicates that a cleanup level is not available.

(h) Cleanup level is expressed as a function of the water-effects ratio, as defined in the CTR.

(i) These objectives for metals are expressed in terms of the dissolved fraction of the metal in the water column.

(j) Cleanup level obtained from the Basin Plan (as defined above).

(k) Cleanup level is a function of hardness. Value shown is based on a hardness of 100 mg/L as calcium carbonate.

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Notes (contd):

(l) Cleanup level listed is a secondary MCL. Secondary MCLs apply to chemicals in drinking water that adversely affect its odor, taste, or appearance and therefore cause people to discontinue using the water.

(m) Cleanup level obtained from Title 40 of the Code of Federal Regulations, Part §131.36, *Establishment of Numerical Criteria for Priority Toxic Pollutants,* or National Toxics Rule ("NTR"), promulgated 22 December 1992, as amended. The Basin Plan indicates values for these chemicals should be obtained from the NTR. The values in the NTR are consistent with those presented in the CTR.

(n) MCL based upon treatment technique. Treatment technique and public notification required at action level of 15 µg/L for lead.

(o) Cleanup level for mercury is 0.012 µg/L. However, this level is below the typical analytical method reporting limit of 0.025 µg/L. A cleanup objective of 0.012 µg/L is desirable, but attainment can only be determined at the analytical method reporting limit.

(p) Cleanup level obtained from Montgomery Watson, *Fuel Product Action Level Development Report, Presidio of San Francisco, California* ("FPALDR"), dated October 1995. Numerical values developed based upon residential exposure to COCs in groundwater through ingestion and inhalation pathways.

(q) This level is below the typical analytical method reporting limit range of 0.1 to 10 µg/L for semivolatile organic compounds. Cleanup level listed is desirable, but attainment can only be determined at the analytical method reporting limit. Cleanup level is established at the typical analytical method reporting limit range for semivolatile organic compounds assuming no matrix interference. In the event of matrix interference, actual method reporting limits determining compliance with cleanup levels may be raised.

(r) The drinking water standard in the FPALDR is for total carcinogenic polyclic aromatic hydrocarbons ("PAHs"). These carcinogenic PAHs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene.

(s) Values for 1,2,4-trichlorobenzene were used for 1,2,3-trichlorobenzene. Values for Endosulfan were used for Endosulfan Sulfate. Values for Endrin were used for Endrin Aldehyde and Endrin Ketone.

TABLE 7-6
CLEANUP LEVELS FOR SURFACE WATER, SEEPS, AND GROUNDWATER AT THE PRESIDIO OF SAN FRANCISCO

Presidio of San Francisco, California

Notes (contd):

(t) Cleanup levels for TPH-diesel for the saltwater zone are from Order No. R2-2003-0080, *Revised Site Cleanup Requirements and Recision of Order No. 91-082 and Order No. 96-070 for the Property Located at The Presidio of San Francisco, City and County of San Francisco,* issued by the California Regional Water Quality Control Board, 20 August 2003 ("Order").
Cleanup levels for TPH-diesel and TPH-fuel oil for the freshwater ecological protection zone were obtained from Blasland, Bouck, & Lee ("BBL"), *Draft Development of Freshwater TPH-diesel and TPH-fuel oil Point of Compliance Concentration Determinations, Presidio of San Francisco, California,* dated 15 July 2004 ("BBL Study"). This report was approved by the RWQCB on 7 September 2004 in a letter from Bruce H. Wolfe.

(u) The BBL Study developed Point of Compliance Concentrations for areas within the Freshwater Ecological Protection Zone ("FEPZ"). Value is to be used within FEPZ Zone of Application, as discussed in the BBL Study, and in other areas of the Presidio where freshwater cleanup levels may be appropriate (e.g., Lobos Creek).

(v) Fuel oil range hydrocarbons includes motor oil.

(w) Cleanup level applies to total polychlorinated biphenyls ("PCBs").

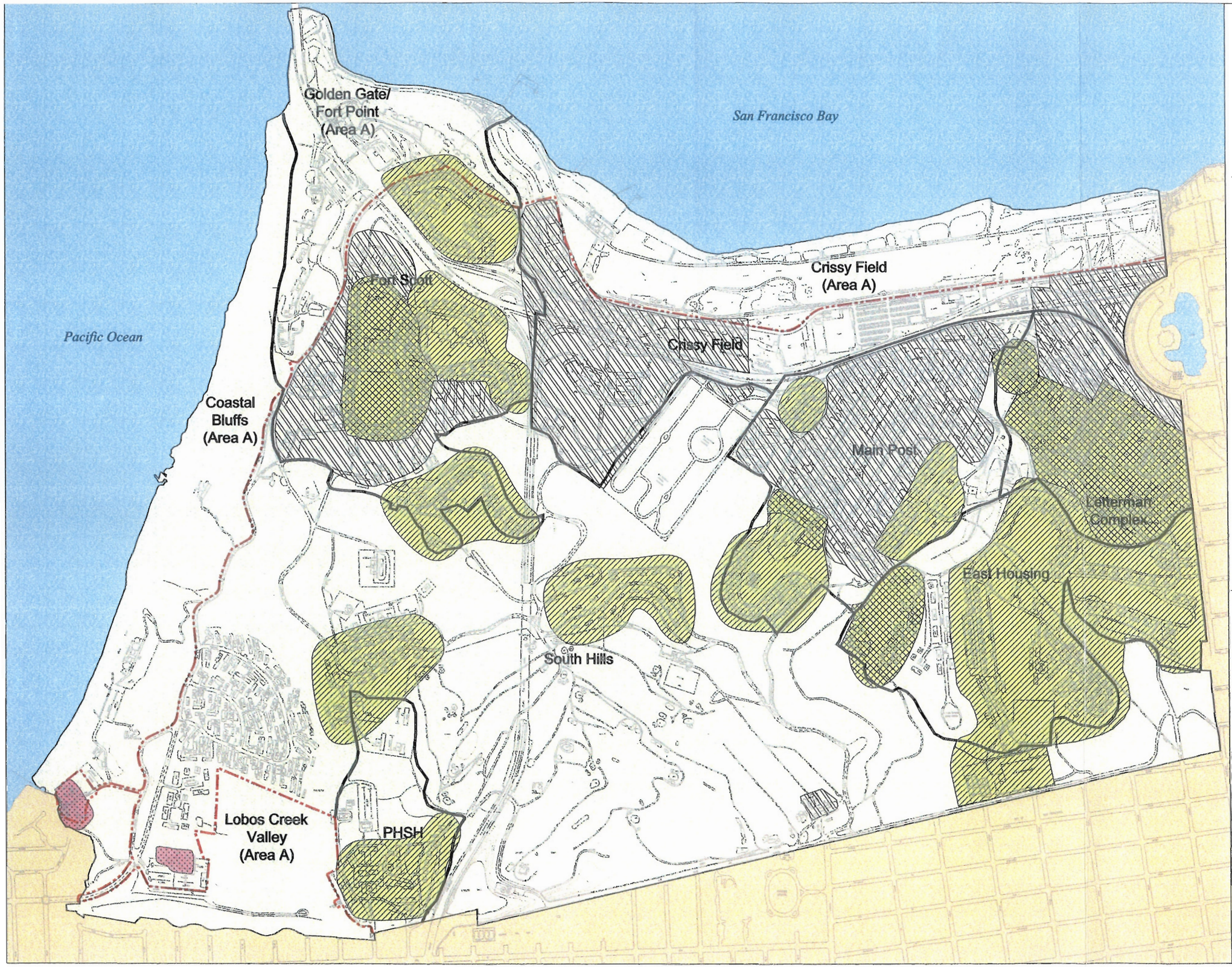
(x) This level is below the typical analytical method reporting limit range of 0.05 to 0.5 µg/L for PCBs and pesticides. Cleanup level listed is desirable, but attainment can only be determined at the analytical method reporting limit.

(y) In the absence of a published value for 4,4'-DDD or 4,4'-DDE, the value for 4,4'-DDT is used.

(z) Cleanup level is State of California action level for drinking water.

(aa) Isodrin is an isomer of Aldrin. Values for Aldrin were used for Isodrin.

FIGURES



N

0 800 1600

(Approximate Scale in Feet)

LEGEND

- Area A/B Boundary
- Presidio Planning Area or District Boundary

Planned Human Land Use (Note 4)

- Planned Residential Use
- Planned Commercial/ Recreational Use
- Planned Institutional Use (Educational/Conference)
- Planned Commercial/ Industrial Land Use

Appropriate Soil Cleanup Level

- Residential Cleanup Level
- Recreational Cleanup Level
- Commercial/Industrial Cleanup Level

Notes:

1. All locations are approximate.
2. Basemap developed from site plan provided by the Presidio Trust.
3. Designated human land use is based on the National Park Service's Final General Management Plan Amendment ("GMPA"), dated July 1994, and Presidio Trust Management Plan ("PTMP") dated May 2002.
4. Planned human land use is recreational if none of the above patterns are shown.
5. Appropriate cleanup levels are based on the most restrictive human land use defined in the GMPA and PTMP.
6. PHSH is the Public Health Service Hospital Planning Area.

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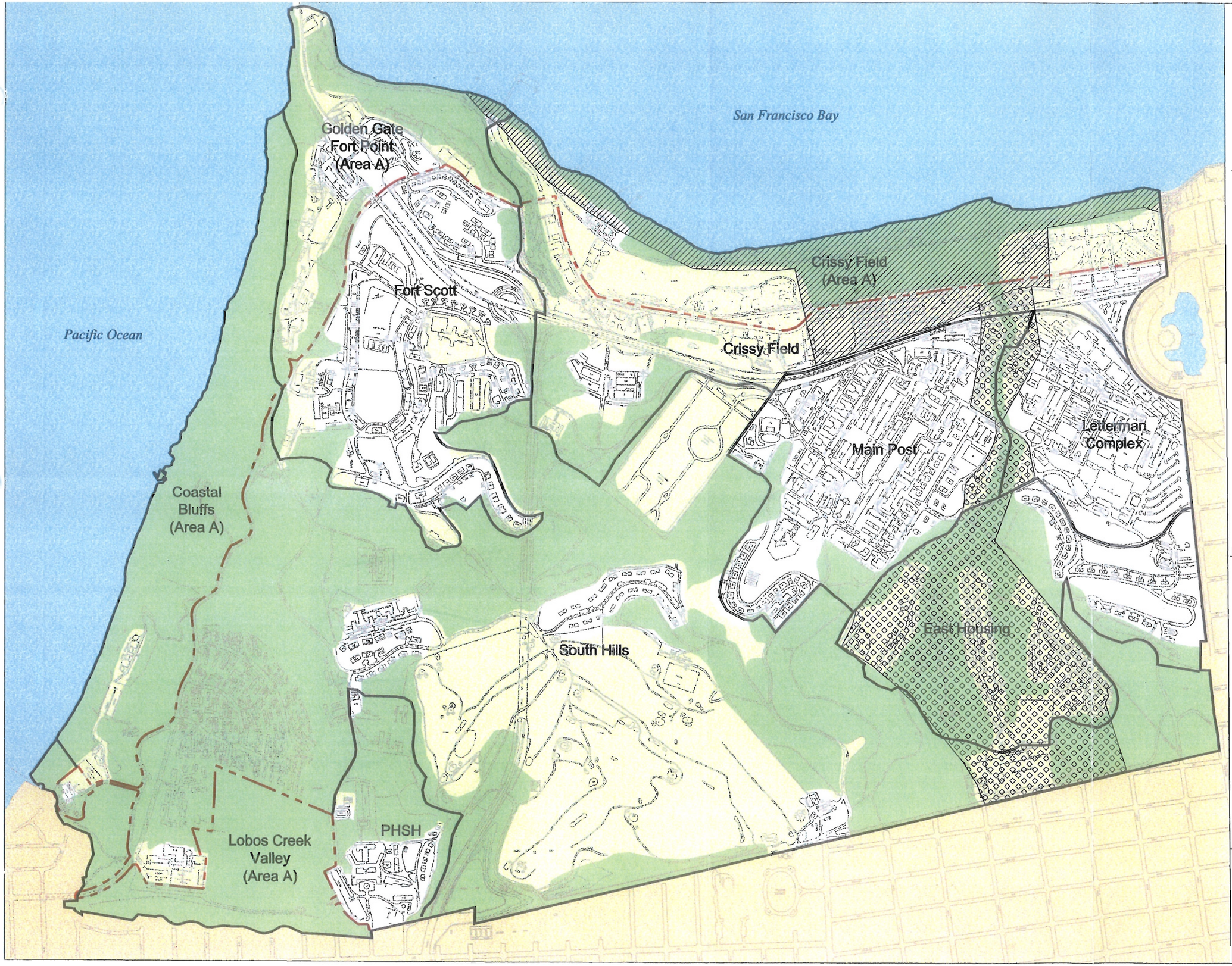
Planned Human Land Use at the Presidio

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04
Figure 7-1



N

0 800 1600

(Approximate Scale in Feet)

LEGEND

- Area A/B Boundary
- Presidio Planning Area or District Boundary

Ecological Potection Zones (Note 3)

- Saltwater Ecological Protection Zone
- Freshwater Ecological Protection Zone

Appropriate Soil Cleanup Level

- Human Health Cleanup Level (Developed Areas Outside Ecological Protection Zones)
- Buffer Zone Ecological Cleanup Level (Manicured Open Space Areas)
- Special Status Ecological Cleanup Level (See Note 4)

Notes:

1. All locations are approximate.
2. Basemap developed from site plan provided by the Presidio Trust.
3. Ecological Protection Zones are defined in California Regional Water Quality Control Board, Order No. 96-070, dated 15 May 1996.
4. Special Status Ecological Areas include Native Plant Community Zones, Historic Forest Zones, and Special Management Zones identified in the Vegetation Management Plan and Environmental Assessment, NPS and Presidio Trust, December 2001.
5. PHSH is the Public Health Service Hospital Planning Area.

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Planned Ecological Land Use at the Presidio

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October 2002
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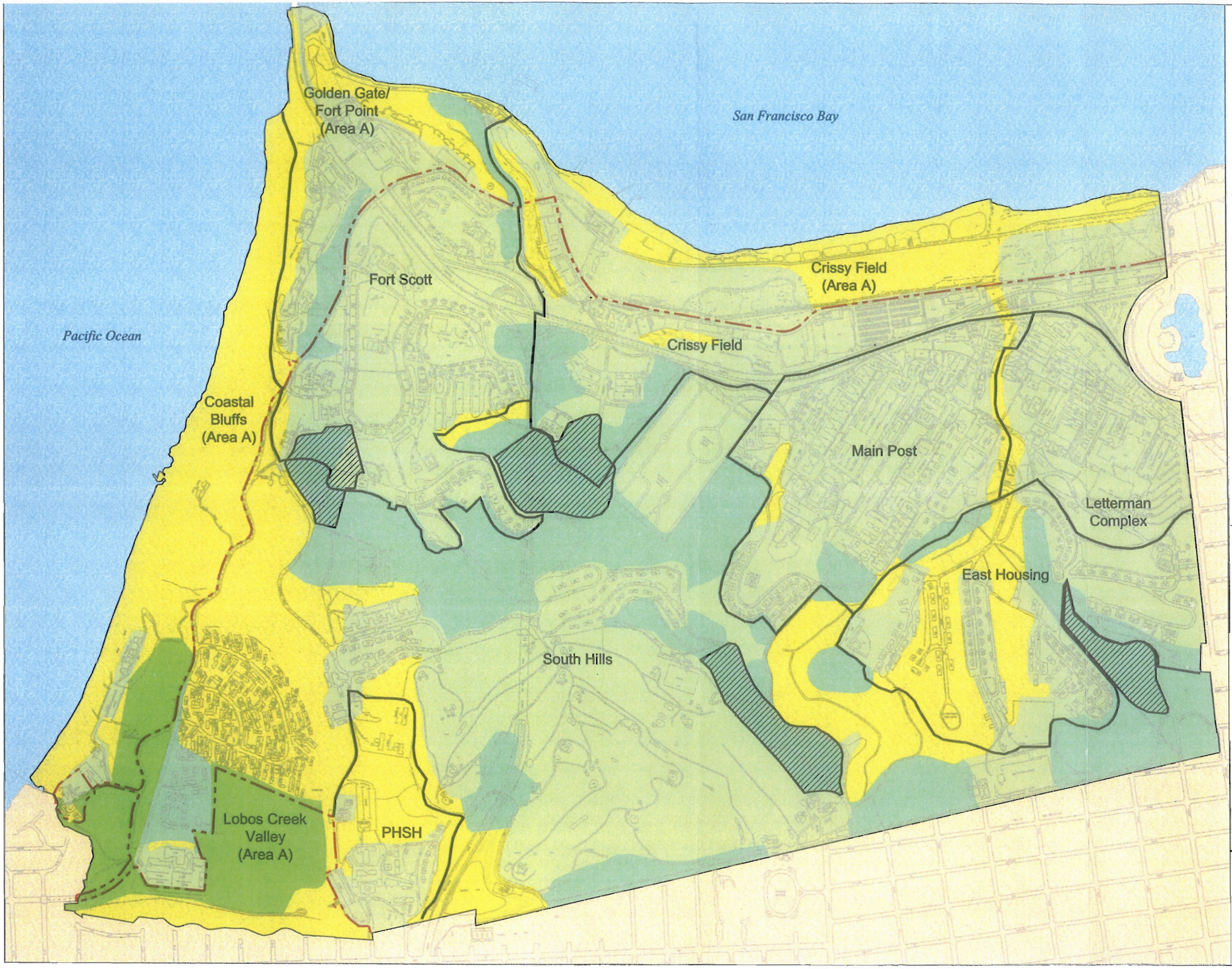
Figure 7-2



N

0 800 1600

(Approximate Scale in Feet)

LEGEND

- Area A/B Boundary
- Presidio Planning Area or District Boundary
- Native Plant Communities Zone
- Historic Forest Zone
- Landscape Vegetation Zone
- Special Management Zone
- Key Historic Forest Stands

Notes:

1. All locations are approximate.
2. Basemap developed from site plan provided by the Presidio Trust.
3. PHSH is the Public Health Service Hospital Planning Area.
4. Figure taken from Vegetation Management Plan and Environmental Staff Report, NPS and Presidio Trust, October 2000, and Vegetation Management Plan and Environmental Assesment, December 2001.

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Planned Vegetation Types at the Presidio

Presidio Trust
San Francisco, CA
October 2002
EKI A000003.04

Figure 7–3

8. REFERENCES

8. REFERENCES

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APPENDICES

APPENDIX A

LEAD SPREAD VERSION 7.0

COMPUTER SPREADSHEETS

APPENDIX A

LEAD SPREAD VERSION 7.0
COMPUTER SPREADSHEETS

October 2002

TABLE A-1
LEAD INTAKE SUMMARY FOR RESIDENTIAL, RECREATIONAL, AND COMMERCIAL/INDUSTRIAL USERS (a)

Presidio of San Francisco, California

Potentially Exposed Population	Exposure Frequency (days/week)	Exposure Media/Lead Concentration					Blood Lead (f) (µg/dl)
		Air (b) ($\mu g/m^3$)	Water (b) (µg/L)	Food Intake (c) (kg/day)	Background Soil (d) (mg/kg)	Presidio Soil (e) (mg/kg)	
Residential (child)	7 (Presidio)	0.028	2.4	1.9	0	**370**	10
Recreational (child)	7 (Background)	0.028	15	1.1	0	0	4.6
	4 (Background)	0	0	0	66	0	0.8
	3 (Presidio)	0	0	0	0	**500**	4.6
							10
Commercial/Industrial (adult)	5 (Presidio)	0.028	15	1.9	0	**3,500**	10

Notes:

(a) Lead concentration in blood calculated using California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") Lead Spread Version 7.0 (beta test version) computer model.

(b) Air, water and food intake concentrations are based on DTSC default factors, except for lead in residential tap water. A value of 2.4 ug/L is based on the 95% upper confidence limit of the average lead concentration measured in residential tap water at the Presidio in 1998, 1999, and 2000 (see data in Appendix A).

(c) Food intake is based on DTSC default factor. The lead concentration in food is assumed to be 3.1 µg/kg, which is also a DTSC default factor.

(d) Background concentrations of lead in soil at the Presidio are used for background in Lead Spread. A value of 66 mg/kg of lead corresponds to the background concentration in serpentinite, which is the maximum background concentration calculated by EKI for the four lithologies at the Presidio.

TABLE A-1
LEAD INTAKE SUMMARY FOR RESIDENTIAL, RECREATIONAL, AND COMMERCIAL/INDUSTRIAL USERS (a)

Presidio of San Francisco, California

Notes (continued):

(e) The concentration of lead in Presidio soil corresponds to the value that results in a cumulative blood lead concentration of 10 µg/dl. This value is the proposed cleanup level for the scenario indicated.

(f) See Appendix A for the computer spreadsheets in which blood lead concentration is calculated.

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF RESIDENTIAL POPULATIONS TO LEAD IN SOIL AT PROPOSED CLEANUP LEVEL

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	**370.0**
Lead in Water (ug/l)	2.4
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	0.8	1.4	1.6	2.0	2.3	3184	4575
BLOOD Pb, CHILD	3.4	6.1	7.3	8.8	**10.0**	368	549
BLOOD Pb, PICA CHILD	6.0	10.9	12.9	15.7	17.8	185	276
BLOOD Pb, OCCUPATIONA	0.4	0.7	0.8	1.0	1.1	#DIV/0!	#DIV/0!

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational			
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	166.5	

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PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.01	2%	0.0E+0	0.00	0%
Soil Ingestion	8.8E-4	0.33	43%	0.0E+0	0.00	0%
Inhalation, bkgrnd		0.05	6%		0.00	0%
Inhalation	2.5E-6	0.00	0%	0.0E+0	0.00	0%
Water Ingestion		0.13	18%		0.13	37%
Food Ingestion, bkgrnd		0.23	31%		0.23	63%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.02	1%		0.02	0%
Soil Ingestion	7.0E-3	2.60	78%	1.4E-2	5.21	87%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	1%		0.04	1%
Water Ingestion		0.15	5%		0.15	3%
Food Ingestion, bkgrnd		0.54	16%		0.54	9%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF CHILDREN TO BACKGROUND LEAD IN AIR, WATER, AND FOOD UNDER A RECREATIONAL SCENARIO

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

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INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	**0.028**
Lead in Soil/Dust (ug/g)	0.0
Lead in Water (ug/l)	**15**
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.0	2.4	2.9	3.3	2417	3809
BLOOD Pb, CHILD	1.5	2.8	3.3	4.0	**4.6**	255	435
BLOOD Pb, PICA CHILD	1.5	2.8	3.3	4.0	4.6	128	219
BLOOD Pb, OCCUPATIONAL	1.1	2.0	2.4	2.9	3.3	3475	5464

EXPOSURE PARAMETERS	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	0.0	

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PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.00	0%	1.4E-5	0.00	0%
Soil Ingestion	8.8E-4	0.00	0%	6.3E-4	0.00	0%
Inhalation, bkgrnd		0.05	4%		0.03	3%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	75%		0.84	76%
Food Ingestion, bkgrnd		0.23	21%		0.23	21%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.00	0%		0.00	0%
Soil Ingestion	7.0E-3	0.00	0%	1.4E-2	0.00	0%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	2%		0.04	2%
Water Ingestion		0.96	62%		0.96	62%
Food Ingestion, bkgrnd		0.54	35%		0.54	35%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF CHILDREN TO BACKGROUND LEAD IN SOIL UNDER A RECREATIONAL SCENARIO

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

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INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.0
Lead in Soil/Dust (ug/g)	**66.0**
Lead in Water (ug/l)	0.0
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	0.3	0.5	0.6	0.7	0.8	5914	8349
BLOOD Pb, CHILD	0.3	0.5	0.6	0.7	**0.8**	825	1141
BLOOD Pb, PICA CHILD	0.5	1.0	1.2	1.4	1.6	414	573
BLOOD Pb, OCCUPATIONAL	0.3	0.5	0.6	0.7	0.8	4830	6819

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	4	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	0.0
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	29.7	

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PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	2.2E-5	0.00	1%	1.4E-5	0.00	0%
Soil Ingestion	5.0E-4	0.03	12%	6.3E-4	0.04	15%
Inhalation, bkgrnd		0.00	0%		0.00	0%
Inhalation	1.4E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.00	0%		0.00	0%
Food Ingestion, bkgrnd		0.23	87%		0.23	85%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.2E-5	0.00	1%		0.00	0%
Soil Ingestion	4.0E-3	0.27	99%	8.0E-3	0.53	100%
Inhalation	1.1E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.00	0%		0.00	0%
Water Ingestion		0.00	0%		0.00	0%
Food Ingestion, bkgrnd		0.00	0%		0.00	0%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF CHILDREN TO LEAD IN SOIL AT PROPOSED CLEANUP LEVEL UNDER A RECREATIONAL SCENARIO

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

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INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.0
Lead in Soil/Dust (ug/g)	**510.0**
Lead in Water (ug/l)	0.0
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	0.4	0.8	0.9	1.1	1.3	7885	11133
BLOOD Pb, CHILD	1.6	2.8	3.4	4.1	**4.6**	1100	1521
BLOOD Pb, PICA CHILD	3.1	5.6	6.7	8.1	9.2	552	764
BLOOD Pb, OCCUPATIONAL	0.6	1.0	1.2	1.5	1.7	4830	6819

EXPOSURE PARAMETERS	units	adults	children
Days per week	days/wk	3	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	0.0
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	229.5	

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PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.6E-5	0.01	2%	1.4E-5	0.01	1%
Soil Ingestion	3.8E-4	0.19	44%	6.3E-4	0.32	57%
Inhalation, bkgrnd		0.00	0%		0.00	0%
Inhalation	1.1E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.00	0%		0.00	0%
Food Ingestion, bkgrnd		0.23	54%		0.23	42%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	2.4E-5	0.01	1%		0.01	0%
Soil Ingestion	3.0E-3	1.54	99%	6.0E-3	3.08	100%
Inhalation	8.4E-7	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.00	0%		0.00	0%
Water Ingestion		0.00	0%		0.00	0%
Food Ingestion, bkgrnd		0.00	0%		0.00	0%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF COMMERCIAL/INDUSTRIAL POPULATIONS TO LEAD IN SOIL AT PROPOSED CLEANUP LEVEL

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	3450.0
Lead in Water (ug/l)	15.0
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	3.4	6.2	7.3	8.9	10.1	3404	5353
BLOOD Pb, CHILD	19.0	34.7	41.1	50.0	56.9	359	611
BLOOD Pb, PICA CHILD	36.4	66.4	78.6	95.5	108.7	180	307
BLOOD Pb, OCCUPATIONA	3.3	6.1	7.2	8.7	10.0	3475	5464

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	5	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	1552.5	

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PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	2.7E-5	0.09	3%	1.4E-5	0.05	1%
Soil Ingestion	6.3E-4	2.17	64%	6.3E-4	2.17	65%
Inhalation, bkgrnd		0.03	1%		0.03	1%
Inhalation	1.8E-6	0.01	0%	1.8E-6	0.01	0%
Water Ingestion		0.84	25%		0.84	25%
Food Ingestion, bkgrnd		0.23	7%		0.23	7%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	4.0E-5	0.14	1%		0.14	0%
Soil Ingestion	5.0E-3	17.35	91%	1.0E-2	34.70	95%
Inhalation	1.4E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.03	0%		0.03	0%
Water Ingestion		0.96	5%		0.96	3%
Food Ingestion, bkgrnd		0.54	3%		0.54	1%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

TABLE A-2
SUMMARY OF LEAD RESULTS FROM SAMPLING IN RESIDENCES

Presidio of San Francisco, California

Street Address / Sample ID	Lead Concentration (µg/L) (a)		
	12/1/98	4/27/99	9/12/00
PR-1	2.8	4.7	NA (b)
PR-2	4.6	3.1	NA
PR-3	1.5	NA	NA
PR-4	-- (c)	1.2	NA
PR-5	10.2	5.9	NA
PR-6	1.1	3.8	NA
PR-7	<1.0	1.7	NA
PR-8	<1.0	<1.0	NA
PR-9	--	3.3	NA
PR-10	2.1	2.4	NA
PR-11	<1.0	<1.0	NA
PR-12	1.2	<1.0	NA
PR-13	--	<1.0	NA
PR-14	--	1.6	NA
PR-15	<1.0	<1.0	NA
PR-16	1.4	1.4	NA
PR-17	--	NA	NA
PR-18	1.1	<1.0	NA
PR-19	1.9	3.3	NA
PR-20	1.5	2.2	NA
PR-21	1.8	NA	NA
PR-22	1.1	NA	NA
PR-23	NA	1.1	NA
PR-28	NA	NA	2.3
PR-29	NA	NA	<1.0
PR-30	NA	NA	1.5
PR-31	NA	NA	<1.0
PR-32	NA	NA	3.6
PR-33	NA	NA	<1.0
PR-34	NA	NA	<1.0
PR-35	NA	NA	27 (d)
PR-36	NA	NA	<1.0
PR-37	NA	NA	<1.0
95% Upper Confidence Limit of the Mean	2.4 µg/L		

Notes:

(a) Samples were collected to comply with the monitoring requirements of the Lead and Copper Rule. Water samples collected by the Trust for lead analysis were from the first draw of the day. For the 12/1/98 and 4/27/99 monitoring events, the Presidio was using 100% Lobos Creek water. For the 9/12/00 monitoring event the Presidio was using 75-80% Lobos Creek water and 20-25% City water.

(b) NA = Not analyzed or no data available.

(c) "--" indicates sample data not valid due to faucet use before sample collection.

(d) It is EKI's understanding that the tap was significantly corroded; tap has been replaced. This data point is not included in statistical analysis of lead data, as it is not considered representative of the actual water.

APPENDIX B

CRYSTAL BALL INPUT PARAMETERS AND MONTE CARLO METHOD OUTPUT

APPENDIX B

CRYSTAL BALL™ INPUT PARAMETERS AND MONTE CARLO METHOD OUTPUT

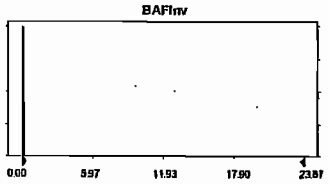
Uncertainty Analysis for Birds Based on Low and High BTAG TRVs
Presidio of San Francisco
San Francisco, California

Assumption: BAFinv **Cell: K2**

Lognormal distribution with parameters:

Mean	0.27
Standard Dev.	18.82

Selected range is from 0.00 to +Infinity
Mean value in simulation was 0.22

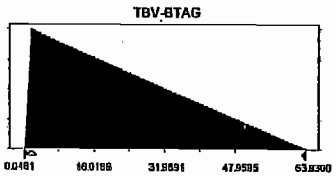


Assumption: TBV-BTAG **Cell: B3**

Triangular distribution with parameters:

Minimum	0.0481
Likeliest	1.7500
Maximum	63.9300

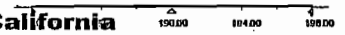
Selected range is from 0.0481 to 63.9300
Mean value in simulation was 21.8493



Uncertainty Analysis for Birds Based on Low and High BTAG TRVs

Presidio of San Francisco

San Francisco, California

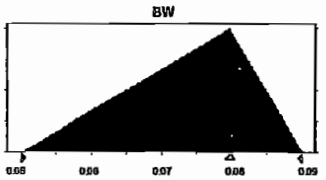


Selected range is from 182.00 to 198.00
Mean value in simulation was 190.02

Assumption: BW **Cell: J2**

Triangular distribution with parameters:

Minimum	0.06
Likeliest	0.08
Maximum	0.09



Selected range is from 0.06 to 0.09
Mean value in simulation was 0.07

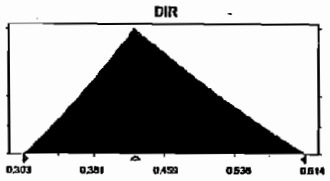
Uncertainty Analysis for Birds Based on Low and High BTAG TRVs
Presidio of San Francisco
San Francisco, California

Assumption: DIR **Cell: D2**

Triangular distribution with parameters:

Minimum	0.303
Likeliest	0.426
Maximum	0.614

Selected range is from 0.303 to 0.614
Mean value in simulation was 0.447

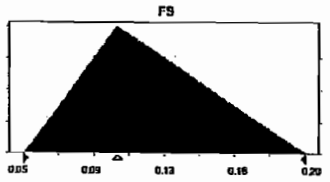


Assumption: FS **Cell: E2**

Triangular distribution with parameters:

Minimum	0.05
Likeliest	0.10
Maximum	0.20

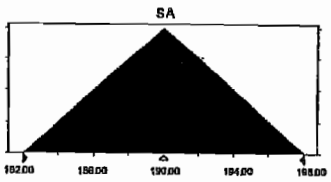
Selected range is from 0.05 to 0.20
Mean value in simulation was 0.12



Assumption: SA **Cell: G2**

Triangular distribution with parameters:

Minimum	182.00
Likeliest	190.00
Maximum	198.00



Uncertainty Analysis for Birds Based on Low and High BTAG TRVs
Presidio of San Francisco
San Francisco, California

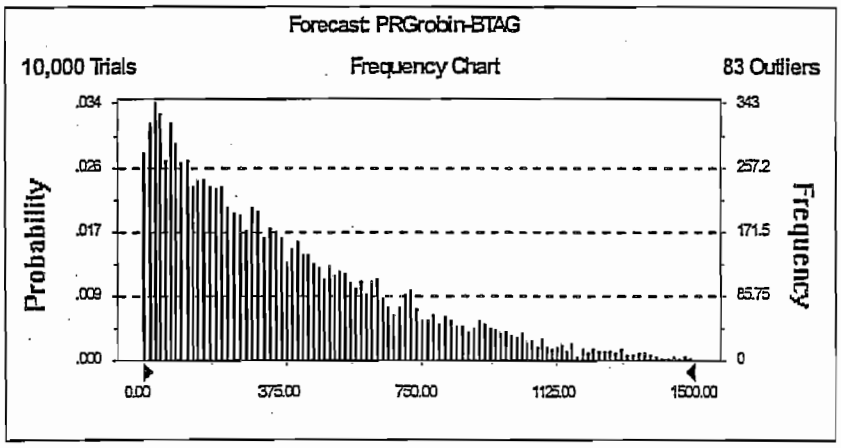
Forecast: PRGrobin-BTAG

Summary:

Display Range is from 0.00 to 1500.00
Entire Range is from 0.08 to 2386.91
After 10,000 Trials, the Std. Error of the Mean is 3.34

Statistics:

	Value
Trials	10,000
Mean	386
Median	297
Mode	---
Standard Deviation	334
Variance	111,420
Skewness	1.35
Kurtosis	5.18
Coeff. of Variability	0.87
Range Minimum	0.08
Range Maximum	2,387
Range Width	2,387
Mean Std. Error	3.34



Percentile	Value	Percentile	Value
0%	0	55%	338
5%	25	60%	385
10%	48	65%	436
15%	73	70%	495
20%	98	75%	559
25%	126	80%	633
30%	156	85%	724
35%	189	90%	853
40%	220	95%	1033
45%	257	100%	2387
50%	297		

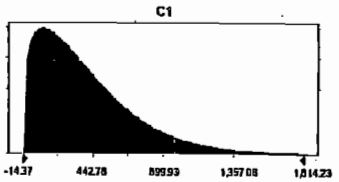
Assumptions for Uncertainty Analysis for Plants
Presidio of San Francisco
San Francisco, California

Assumption: Non-lethal NOECs

Weibull distribution with parameters:

Location	-14.37
Scale	442.21
Shape	1.26122401

Selected range is from -14.37 to +Infinity
Mean value in simulation was 396.27



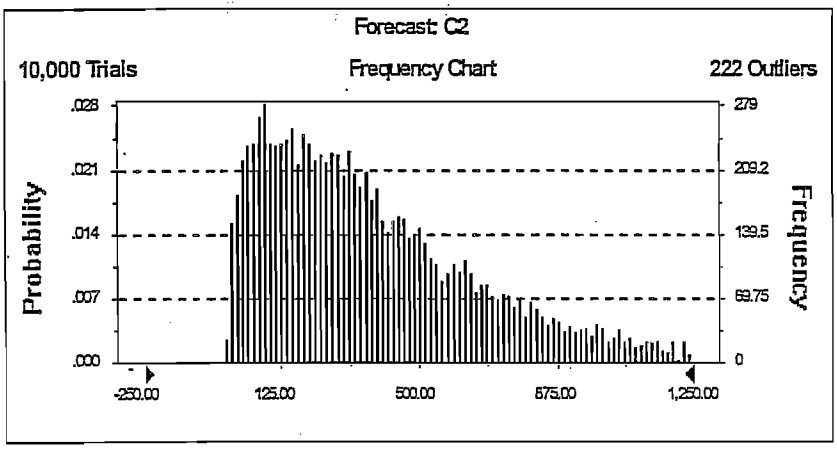
Uncertainty Analysis for Plants
Presidio of San Francisco
San Francisco, California

Forecast: Non-lethal effects on plants

Summary:

Display Range is from 0.00 to 1,250.00
Entire Range is from 0.03 to 2,503.82
After 10,000 Trials, the Std. Error of the Mean is 3.25

Statistics:	Value
Trials	10000
Mean	403.93
Median	324.17
Mode	---
Standard Deviation	325.43
Variance	105,902.02
Skewness	1.33
Kurtosis	5.24
Coeff. of Variability	0.81
Range Minimum	0.03
Range Maximum	2,735.80
Range Width	2,735.80
Mean Std. Error	3.25



Percentile	Value	Percentile	Value
0%	0.03	55%	360.65
5%	33.57	60%	403.57
10%	66.90	65%	452.63
15%	97.89	70%	509.64
20%	128.11	75%	568.32
25%	157.08	80%	644.91
30%	186.04	85%	730.93
35%	219.55	90%	856.43
40%	254.06	95%	1,047.45
45%	289.09	100%	2,735.80
50%	324.17		

APPENDIX C

BACKGROUD MEETALS DATA SETS FOR SERPENTINITE, COLMA FORMATION, BEACH/DUNE AND CHERT/SHALE SAMPLES

APPENDIX C

BACKGROUND METALS DATA SETS FOR SERPENTINITE, COLMA FORMATION, BEACH/DUNE, AND CHERT/SHALE SAMPLES

October 2002

TABLE C-1
BACKGROUND DATA SET - SERPENTINITE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
1a	NA (c)	10/16/96	NEIC	78,900	18,100	95,900	1,260
1b	NA	10/16/96	NEIC	72,400	15,900	95,200	1,200
1c	NA	10/16/96	NEIC	73,500	15,600	88,200	1,200
1d	NA	10/16/96	NEIC	80,000	16,800	85,200	1,280
BKGDSB04	0	09/02/92	ED	36,000	5,260	160,000	505
BKGDSB10	18	12/07/94	QA	56,800	7,610	15,300	594
BKGDSB14	1.5	12/08/94	QA	80,700	8,660	89,200	590
BKGDSB15	14.5	12/08/94	QA	73,100	3,500	124,000	2,090
BKGDSB15	20.5	12/08/94	QA	58,300	2,530	179,000	825
BKGSO03A	0.3	11/27/90	UB	52,700	3,560	270,000	791
UBR01SB02	COMP (d)	02/24/99	CALLAB	47,100	7,380	193,000	595
UBR02SB02	COMP (d)	02/25/99	CALLAB	44,700	1,130	213,000	671
1261 WEST	10	06/21/93	UNKNOWN	56,600	NA	NA	3,450
1351SO01B	17	10/26/90	UB	63,000	7,720	140,000	988
1351SO02B	15	10/29/90	UB	94,000	33,100	120,000	1,020
GCEX01	3	10/19/98	QUANT	120,000	20,300	33,500	1,150
GCEX02	3	10/19/98	QUANT	102,000	10,000	72,500	1,330
GCEX03	3	10/19/98	QUANT	71,800	3,520	174,000	1,260
GGSB05	2	08/07/92	ED	54,000	21,000	12,000	811
TRENCH II	1	09/16/93	UNKNOWN	36,700	NA	NA	667
UST 1221.3 EAST	14	09/29/93	UNKNOWN	50,600	NA	NA	1,130
UST 1221.4 EAST	14	09/29/93	UNKNOWN	32,300	NA	NA	452

TABLE C-1
BACKGROUND DATA SET - SERPENTINITE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Title 22 Metals (mg/kg)																
	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
1a	<4	NA	63.8	0.15	<0.5	1,380	118	32.3	<1	NA	<0.9	2,590	<6	<1	0.077	29.3	80
1b	<4	NA	63.8	0.11	<0.5	1,310	115	29.9	16	NA	<0.9	2,290	<6	<1	0.064	34.7	85
1c	<4	NA	66.1	<0.09	<0.5	1,520	117	45.2	64	NA	<0.9	2,210	<6	<1	0.069	38.6	109
1d	<4	NA	67.6	0.1	<0.5	1,680	122	33	52	NA	<0.9	2,290	<6	<1	0.067	39.7	114
BKGDSB04	<41.3	1.290	NA	<0.50	<0.515	750	59.8	12.6	NA	<0.027	NA	1,120	<0.25	<0.521	<14.7	27.7	17.7
BKGDSB10	<0.1	<0.250	16.5	<0.10	<0.80	1,290	73.1	64.6	4.48	<0.059	NA	1,940	<0.416	<0.500	<0.162	36.2	42.6
BKGDSB14	<0.1	2.49	92.3	NA	NA	1,050	135	44.2	NA	<0.059	NA	3,670	<0.416	1.67	<0.162	27	20.8
BKGDSB15	<0.1	0.507	62.4	NA	NA	672	140	51.4	NA	<0.059	NA	3,950	<0.416	<0.644	<0.162	40.2	95
BKGDSB15	<0.1	0.320	18.7	<1.0	NA	910	111	17.3	4.01	<0.059	NA	2,530	<0.416	<5.00	<0.162	34.2	50.6
BKGSO03A	<19.6	<2.5	<3.29	<0.427	<1.2	812	85.3	5.08	3.72	<0.05	NA	2,190	<0.449	<0.803	<34.3	11.8	6.64
UBR01SB02	<13.6	NA	30.5	<1.1	0.94	1,160	101	11.1	NA	NA	NA	2,070	<56.7	<2.3	<454	35.2	17
UBR02SB02	<21.6	NA	NA	<1.8	<1.8		97.6	4.6	NA	NA	NA	1,950	<90.1	<3.6	<721	10.4	21.6
1261 WEST	NA	2.9	NA	0.35	1.5	493	NA	59.4	76.8	NA	NA	1,430	NA	NA	NA	50.2	139
1351SO01B	NA	<2.5	56.0	<0.427	NA	753	106	13.3	3.72	0.058	NA	2,600	NA	NA	NA	28.4	33.6
1351SO02B	NA	<2.5	149	0.774	NA	1,270	82.4	41	3.72	<0.05	NA	2,530	NA	NA	NA	56.0	60.5
GCEX01	NA	NA	81.4	NA	NA	1,350	146	29.9	2.6	NA	NA	3,510	NA	NA	NA	48.7	58.3
GCEX02	NA	NA	49.7	NA	NA	1,090	165	21.4	0.67	NA	NA	4,290	NA	NA	NA	28.8	52.5
GCEX03	NA	NA	20.2	NA	NA	586	153	18.5	NA	NA	NA	2,880	NA	NA	NA	25.3	28.4
GGSB05	<41.3	4.09	106	1.07	1.85	556	103	40.50	6.29	0.069	NA	1,020	<0.25	<0.521	NA	84.4	67.2
TRENCH II	NA	NA	NA	NA	0.86	914	NA	45.6	NA	NA	NA	1,430	NA	NA	NA	35.8	45.4
UST 1221.3 EAST	NA	1.2	NA	NA	NA	786	NA	49.4	3.5	NA	NA	882	NA	NA	NA	61	79.3
UST 1221.4 EAST	NA	2.4	NA	NA	NA	527	NA	30.9	11.3	NA	NA	686	NA	NA	NA	54.4	55.8

TABLE C-1
BACKGROUND DATA SET - SERPENTINITE LITHOLOGY
Presidio of San Francisco, California

Abbreviations:

NA	Not Analyzed or Rejected Data

Notes:

a) Depth in feet below ground surface.

b) Laboratory Abbreviations:

CALLAB	Caltest Analytical Laboratory, Napa, California
ED	Environmental Science and Engineering, Inc., Englewood, Colorado
NEIC	U.S. EPA National Enforcement Investigations Center
UB	DataChem, Inc., Salt Lake City, Utah
QA	Quality Assurance Laboratories, San Diego, California
QUANT	Quanterra, Sacramento, California

c) See text for discussion of data.

d) COMP = Composite Sample

TABLE C-2

BACKGROUND DATA SET - COLMA FORMATION LITHOLOGY

Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
BKGDSB01	2	08/21/92	ED	26,000	14,000	4,220	390
BKGDSB01	5	08/21/92	ED	20,000	9,900	4,230	NA (c)
BKGDSB11	5	12/07/94	QA	31,200	25,900	3,540	270
BKGDSB12	5	12/07/94	QA	14,700	10,300	3,470	227
BKGDSB12	9.5	12/07/94	QA	16,800	9,480	4,060	271
BKGDSB13	5	12/07/94	QA	17,400	13,000	3,910	231
BKGDSB13	9.5	12/07/94	QA	15,400	8,910	4,090	232
LF10BK01	21.5	09/06/94	UNKNOWN	18,800	9,690	2,870	374
LF10BK03	57.5	09/06/94	UNKNOWN	35,600	18,400	7,380	400
LF10BK1BDUP	0	09/06/94	UNKNOWN	NA	NA	NA	NA
CFLSSB01	4	11/18/94	QA	12,300	8,600	2,430	88.1
CFLSSB02	3	11/18/94	QA	12,100	7,010	3,020	227
DAEGW04	8	10/19/92	ED	19,000	9,100	3,310	261
DAESB03	28	08/26/92	ED	17,000	7,200	3,110	243
LF6SB01	20	11/20/94	SU	7,560	4,200	2,640	81.6
LF6SB01	9	11/20/94	SU	20,200	6,160	3,810	224
LF6SB02	20	11/20/94	SU	10,900	4,800	3,160	120
LF6SB02	3	11/20/94	SU	18,100	7,230	3,950	373
LF6SB02	8	11/20/94	SU	14,300	5,170	3,740	154
LF6SB03	20	11/20/94	SU	16,700	6,950	4,310	167
LF6SB03	3	11/20/94	SU	35,500	11,100	4,330	422
LF6SB03	8	11/20/94	SU	16,400	6,540	3,490	207
LF6SB04	20.5	11/20/94	SU	11,400	3,830	3,710	110
LF6SB04	8	11/20/94	SU	9,790	5,170	2,970	132
LF6SB05	20	11/20/94	SU	9,630	4,030	2,580	91.8
LF6SB05	3.5	11/20/94	SU	16,800	6,940	3,470	224
LF6SB05	8.5	11/20/94	SU	11,900	5,290	3,460	216
LF6SB06	20	11/20/94	SU	15,500	5,120	3,810	131
LF6SB06	3	11/20/94	SU	30,200	13,400	4,700	381
LF6SB06	8	11/20/94	SU	34,900	5,130	3,490	164
LF6SO03B	7.5	11/08/90	UB	30,000	15,100	5,250	368
LF8SO02B	19	10/01/90	UB	35,400	25,700	6,500	922

TABLE C-2
BACKGROUND DATA SET - COLMA FORMATION LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Table 22 Metals (mg/kg)																
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
BKGDSB01	2	08/21/92	<41.3	5	100	<0.50	<0.515	100	17	17.3	4.95	0.031	NA	97.5	0.456	<0.521	NA	63.3	36.9
BKGDSB01	5	08/21/92	<41.3	3.27	58.6	<0.50	<0.515	90.2	14	13.9	4.55	<0.027	NA	89.1	0.400	<0.521	<14.7	55.4	33.9
BKGDSB11	5	12/07/94	<0.40	<2.50	121	0.681	<0.80	78.3	13.0	20.9	5.61	<0.059	NA	34.6	<1.66	<0.500	<0.162	64.9	47.3
BKGDSB12	5	12/07/94	<0.50	<2.50	36.9	0.251	<0.80	51.8	11.3	13.0	3.04	<0.059	NA	63.0	<0.416	<0.500	<0.162	37.2	29.1
BKGDSB12	9.5	12/07/94	<0.40	<2.50	43.7	0.256	<0.80	64.6	12.9	80.8	3.84	<0.059	NA	69.3	<0.416	<0.500	<0.162	43.3	61.6
BKGDSB13	5	12/07/94	<0.40	<2.50	41.1	0.301	<0.80	78.4	12.2	10.4	3.99	<0.059	NA	78.5	<0.416	<0.500	<0.162	43.7	29.1
BKGDSB13	9.5	12/07/94	<0.40	<2.50	26.9	0.248	<0.80	67.8	12.3	20.3	3.34	<0.059	NA	38.5	<0.416	<0.500	<0.162	41.6	40.8
LF10BK01	21.5	09/06/94	NA	2.6	61.0	NA	NA	55.6	11.8	11.9	2.9	<0.11	NA	34.1	NA	NA	NA	43.4	27.7
LF10BK03	57.5	09/06/94	NA	2.1	175	NA	NA	103	19.0	28.2	3.4	<0.12	NA	123	NA	NA	NA	49.4	50.4
LF10BK1BDUP	0	09/06/94	NA	3.4	89.4	NA	NA	41.4	9.9	13.5	4.7	<0.12	NA	40.6	NA	NA	NA	42.6	31.9
CFLSSB01	4	11/18/94	<0.40	1.58	35.2	0.207	<0.80	58.0	12.0	9.03	3.94	<0.059	NA	31.2	<0.416	<0.500	<0.162	42.4	22.9
CFLSSB02	3	11/18/94	NA	3.86	55.7	0.178	NA	58.3	8.21	10.9	7.06	<0.059	NA	48.1	<0.416	NA	NA	35.0	25.2
DAEGW04	8	10/19/92	<41.3	3.78	43.8	<0.50	<0.515	96.9	10.2	24.4	3.24	<0.027	NA	67.8	<0.250	<0.521	NA	43.1	33.1
DAESB03	28	08/26/92	<41.3	3.14	29.4	<0.50	<0.515	58.9	9.77	19.5	8.18	<0.027	NA	59.1	<0.250	<0.521	<14.7	40.3	40.6
LF6SB01	20	11/20/94	NA	NA	15.6	0.348	<0.5	24	6.36	3.36	1.8	NA	NA	37.2	NA	<2.76	NA	12	16.8
LF6SB01	9	11/20/94	NA	NA	40.3	0.123	<0.1	43.7	7.73	4.93	2.58	NA	NA	43.7	NA	<7.73	NA	34.7	21.3
LF6SB02	20	11/20/94	NA	NA	18.5	<0.1	<0.1	30.5	7.85	4.03	2.18	NA	NA	43.6	NA	<4.36	NA	19.6	18.5
LF6SB02	3	11/20/94	NA	NA	47.5	0.124	<0.1	49.7	8.14	5.2	2.6	NA	NA	61	NA	<7.01	NA	31.6	22.6
LF6SB02	8	11/20/94	NA	NA	27.5	<0.1	0.22	41.8	8.8	4.62	2.42	NA	NA	53.9	NA	<6.05	NA	27.5	22
LF6SB03	20	11/20/94	<0.5	NA	23.6	<0.1	<0.1	51.5	12.1	5.84	3.06	NA	NA	64	NA	<7.09	NA	29.2	26.4
LF6SB03	3	11/20/94	<0.5	NA	68.8	0.222	0.444	81	15.5	9.54	3.44	NA	NA	72.1	NA	<11.1	NA	49.9	31.1
LF6SB03	8	11/20/94	NA	NA	39.3	0.24	<0.5	50.2	8.83	4.91	2.73	NA	NA	50.2	NA	<7.09	NA	32.7	21.8
LF6SB04	20.5	11/20/94	NA	NA	13.9	<0.1	0.371	41.8	6.73	3.02	1.97	NA	NA	32.5	NA	<6.38	NA	29	17.4
LF6SB04	8	11/20/94	NA	NA	31.9	<0.1	<0.1	26.4	5.83	3.74	2.42	NA	NA	37.4	NA	<3.96	NA	16.5	18.7
LF6SB05	20	11/20/94	NA	NA	14.6	<0.1	0.235	28	6.83	3.47	2.35	NA	NA	40.3	NA	<4.03	NA	19	16.8
LF6SB05	3.5	11/20/94	NA	NA	39.2	0.123	0.493	41.4	9.85	5.82	1.68	NA	NA	51.5	NA	<6.94	NA	29.1	22.4
LF6SB05	8.5	11/20/94	NA	NA	27	<0.1	<0.1	42.1	6.48	4.32	2.48	NA	NA	42.1	NA	<5.08	NA	23.8	20.5
LF6SB06	20	11/20/94	NA	NA	21.4	<0.1	<0.5	36.9	9.64	4.52	2.26	NA	NA	47.6	NA	<6.79	NA	31	20.2
LF6SB06	3	11/20/94	NA	NA	56	0.504	<0.5	91.8	12.3	9.74	3.02	NA	NA	71.7	NA	<12.3	NA	54.9	31.4
LF6SB06	8	11/20/94	NA	3.16	30.5	<0.1	<0.5	52.3	8.94	5.67	1.2	NA	NA	62.2	NA	<9.81	NA	48	20.7
LF6SO03B	7.5	11/08/90	NA	NA	68.8	NA	NA	149	13.5	7.97	3.72	<0.05	NA	77.4	NA	NA	NA	NA	37.2
LF8SO02B	19	10/01/90	<19.6	<2.5	172	<0.427	<1.2	79.2	17.6	22	3.72	<0.05	NA	77	<0.449	<0.803	<34.3	73.1	49.2

TABLE C-2

BACKGROUND DATA SET - COLMA FORMATION LITHOLOGY

Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
LF8SO03B	19	10/02/90	UB	37,800	17,900	4,870	423
NKSB13	10	12/05/94	QA	10,800	5,130	NA	NA
NKSB14	9.5	12/07/94	QA	16,600	14,500	2,910	589
NKSB15	5	12/07/94	QA	19,000	15,300	4,630	382

TABLE C-2
BACKGROUND DATA SET - COLMA FORMATION LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Table 22 Metals (mg/kg)																
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
LF8SO03B	19	10/02/90	<19.6	<2.5	95.4	<0.427	<1.2	120	17.7	15.7	3.72	0.118	NA	84.2	<0.449	<0.803	<34.3	85	35.9
NKSB13	10	12/05/94	NA	2.20	14.6	0.429	NA	40.2	6.78	3.92	NA	NA	NA	NA	NA	NA	NA	34.1	15.5
NKSB14	9.5	12/07/94	NA	1.49	95.8	0.481	NA	53.6	14.2	24.4	3.97	<0.059	NA	31.2	NA	NA	NA	45.8	39.7
NKSB15	5	12/07/94	NA	2.38	95.8	0.460	NA	53.8	14.7	20.8	5.02	0.104	NA	51.8	NA	NA	NA	44.8	39.5

BACKGROUND DATA SET - COLMA FORMATION LITHOLOGY
Presidio of San Francisco, California

Abbreviations:

NA Not Analyzed or Rejected Data

Notes:

a) Depth in feet below ground surface.

b) Laboratory Abbreviations:

ED	Environmental Science and Engineering, Inc., Englewood, Colorado
QA	Quality Assurance Laboratories, San Diego, California
SU	Superior Precision Analytical, Inc., Maritime, California
UB	DataChem, Inc., Salt Lake City, Utah

c) See text for discussion of data.

Table C-3
CHERT/SHALE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
950CR	NA (c)	9/24/98	CHROMALA	2,200	460	NA	130
950CT002	NA	10/6/98	CHROMALA	4,500	1,200	NA	4,100
950CT004	NA	10/6/98	CHROMALA	420	160	NA	24
950CT005	NA	10/6/98	CHROMALA	2,400	460	NA	570
950CT006	NA	10/6/98	CHROMALA	1,300	340	NA	100
950CT007	NA	10/6/98	CHROMALA	1,900	360	NA	260
950CT009	NA	10/6/98	CHROMALA	2,900	720	NA	2,200
950CT010	NA	10/6/98	CHROMALA	770	220	NA	700
950CT011	NA	10/15/98	CHROMALA	4,200	1,500	NA	150
950CT012	NA	10/15/98	CHROMALA	18,000	4,600	NA	390
950CT014	NA	10/15/98	CHROMALA	1,300	280	NA	110
950CT015	NA	10/15/98	CHROMALA	3,000	810	NA	180
950CT016	NA	10/15/98	CHROMALA	2,900	390	NA	150
950CT017	NA	10/15/98	CHROMALA	3,700	670	NA	51
950CT018	NA	10/15/98	CHROMALA	7,800	700	NA	150
950CT019	NA	10/15/98	CHROMALA	2,800	650	NA	40
950CT020	NA	10/15/98	CHROMALA	6,600	1,300	NA	1,400
950CT021	NA	10/15/98	CHROMALA	6,400	1,500	NA	600
950CT022	NA	10/15/98	CHROMALA	1,700	240	NA	230
950CT023	NA	10/15/98	CHROMALA	510	220	NA	120
950CT024	NA	10/15/98	CHROMALA	1,100	190	NA	<1.0
950CT025	NA	10/15/98	CHROMALA	1,300	340	NA	1,300
950CT026	NA	10/15/98	CHROMALA	840	240	NA	550
950CT027	NA	10/15/98	CHROMALA	4,400	350	NA	<1.0
950CT028	NA	10/15/98	CHROMALA	880	170	NA	1,000
950CT029	NA	10/15/98	CHROMALA	3,200	530	NA	480
950CT030	NA	10/15/98	CHROMALA	9,700	2400	NA	1,100
950CT031	NA	10/15/98	CHROMALA	2,000	450	NA	630
950CT032	NA	10/15/98	CHROMALA	3,800	500	NA	300

Table C-3

CHERT/SHALE LITHOLOGY

Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Title 22 Metals (mg/kg)															
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
950CR	NA (c)	9/24/98	<3.0	<2.5	36	<0.20	<0.50	2.6	2.0	9.4	<10	<0.21	<2.0	5.4	<25	<1.0	<5.0	2.4	5.4
950CT002	NA	10/6/98	<3.0	<2.5	280	<0.20	<0.50	52	6.3	86	<10	<0.20	<2.0	110	<25	<1.0	<5.0	6.8	16
950CT004	NA	10/6/98	<3.0	<2.5	23	<0.20	<0.50	<1.0	<2.0	3.1	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	<1.0	<2.0
950CT005	NA	10/6/98	<3.0	<2.5	96	<0.20	<0.50	1.5	13	20	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	2.8	5.5
950CT006	NA	10/6/98	<3.0	<2.5	12	<0.20	<0.50	1.4	<2.0	9.2	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	1.2	<2.0
950CT007	NA	10/6/98	<3.0	<2.5	13	<0.20	<0.50	6.9	2.2	24	<10	<0.20	<2.0	4.0	<25	<1.0	<5.0	2.9	2.6
950CT009	NA	10/6/98	<3.0	<2.5	160	<0.20	<0.50	<1.0	2.7	35	<10	<0.20	<2.0	7.0	<25	<1.0	<5.0	3.4	5.3
950CT010	NA	10/6/98	<3.0	<2.5	42	<0.20	<0.50	1.2	<2.0	13	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	6.3	2.4
950CT011	NA	10/15/98	<3.0	<2.5	17	<0.20	<0.50	2.4	2.8	12	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	11	8.1
950CT012	NA	10/15/98	<3.0	<2.5	96	<0.20	0.61	15	7.8	50	<10	<0.20	<2.0	25	<25	<1.0	<5.0	38	56
950CT014	NA	10/15/98	<3.0	<2.5	13	<0.20	<0.50	<1.0	<2.0	6.1	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	2.2	<2.0
950CT015	NA	10/15/98	<3.0	<2.5	31	<0.20	<0.50	1.6	<2.0	26	<10	<0.20	<2.0	4.3	<25	<1.0	<5.0	2.9	7.1
950CT016	NA	10/15/98	<3.0	<2.5	18	<0.20	<0.50	6.3	<2.0	16	<10	<0.20	<2.0	4.2	<25	<1.0	<5.0	3.0	7.9
950CT017	NA	10/15/98	<3.0	<2.5	12	<0.20	<0.50	2.4	<2.0	15	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	4.4	3.0
950CT018	NA	10/15/98	<3.0	<2.5	36	<0.20	<0.50	6.2	<2.0	18	<10	<0.20	<2.0	4.4	<25	<1.0	<5.0	7.7	10
950CT019	NA	10/15/98	<3.0	<2.5	12	<0.20	<0.50	2.5	<2.0	11	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	3.3	2.7
950CT020	NA	10/15/98	<3.0	<2.5	160	<0.20	<0.51	2.2	9.8	36	<10	<0.20	<2.0	22	<25	<1.0	<5.1	12	8.2
950CT021	NA	10/15/98	<3.0	<2.5	92	<0.20	<0.50	4.3	3.9	26	<10	<0.20	<2.0	5.1	<25	<1.0	<5.0	9.6	4.4
950CT022	NA	10/15/98	<3.0	<2.5	25	<0.20	<0.50	<1.0	<2.0	14	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	2.9	<2.0
950CT023	NA	10/15/98	<3.0	<2.5	10	<0.20	<0.50	<1.0	<2.0	3.2	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	<1.0	2.0
950CT024	NA	10/15/98	<3.0	<2.5	190	<0.20	<0.50	<1.0	<2.0	4.6	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	4.9	4.8
950CT025	NA	10/15/98	<3.0	<2.5	110	<0.20	<0.50	<1.0	2.5	22	<10	<0.20	<2.0	6.2	<25	<1.0	<5.0	2.7	6
950CT026	NA	10/15/98	<3.0	<2.5	46	<0.20	<0.50	<1.0	3.7	13	<10	<0.20	<2.0	4.0	<25	<1.0	<5.0	1.3	3.8
950CT027	NA	10/15/98	<3.0	3.2	250	<0.20	0.64	<1.0	16	140	<10	<0.20	<2.0	33	<25	<1.0	<5.0	7.9	30
950CT028	NA	10/15/98	<3.0	<2.5	31	<0.20	<0.50	<1.0	2.3	15	<10	<0.20	<2.0	6.2	<25	<1.0	<5.0	1.6	14
950CT029	NA	10/15/98	<3.0	<2.5	52	<0.20	<0.50	1.8	2	22	<10	<0.20	<2.0	4.8	<25	<1.0	<5.0	3.6	4.2
950CT030	NA	10/15/98	<3.0	<2.5	120	<0.20	<0.50	4.1	10	52	<10	<0.20	<2.0	9.0	<25	<1.0	<5.0	9.4	16
950CT031	NA	10/15/98	<3.0	<2.5	120	<0.20	<0.50	1.1	5.4	58	<10	<0.20	<2.0	11	<25	<1.0	<5.0	3.7	9
950CT032	NA	10/15/98	<3.0	<2.5	50	<0.20	<0.50	1.9	2.2	25	<10	<0.20	<2.0	5.5	<25	<1.0	<5.0	4.5	4.6

Table C-3
CHERT/SHALE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
950CT033	NA	10/15/98	CHROMALA	3,900	970	NA	77
950CT034	NA	10/15/98	CHROMALA	5,800	1,500	NA	400
950SH001	NA	12/21/98	CHROMALA	27,000	7,600	NA	2,000
950SH002	NA	12/21/98	CHROMALA	46,000	7,800	NA	10,000
950SH003	NA	10/15/98	CHROMALA	30,000	6,100	NA	4,600
950SH004	NA	10/15/98	CHROMALA	14,000	5,000	NA	2,600
950SH005	NA	10/15/98	CHROMALA	13,000	3,800	NA	2,900
950SH006	NA	10/15/98	CHROMALA	26,000	4,000	NA	3,300
950SH007	NA	10/15/98	CHROMALA	34,000	3,700	NA	2,300
950SH008	NA	10/15/98	CHROMALA	29,000	3,300	NA	3,000
950SH009	NA	10/15/98	CHROMALA	43,000	3,700	NA	11,000
950SH010	NA	10/15/98	CHROMALA	7,200	2,300	NA	56
950SH011	NA	10/15/98	CHROMALA	34,000	5,200	NA	420
950SH012	NA	10/15/98	CHROMALA	17,000	3,700	NA	1,300
950SH013	NA	10/15/98	CHROMALA	14,000	3,000	NA	340
950SH014	NA	10/15/98	CHROMALA	18,000	4,000	NA	800
950SH015	NA	10/15/98	CHROMALA	14,000	4,400	NA	260
BKGDSB03	0.1	9/2/92	ED	31,000	9,500	4270	853

Table C-3

CHERT/SHALE LITHOLOGY

Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Title 22 Metals (mg/kg)															
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
950CT033	NA	10/15/98	<3.0	<2.5	32	<0.20	<0.50	4.0	<2.0	28	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	3.2	5.9
950CT034	NA	10/15/98	<3.0	<2.5	79	0.25	<0.50	3.5	3.1	88	<10	<0.20	<2.0	15	<25	<1.0	<5.0	7.2	20
950SH001	NA	12/21/98	<3.1	<2.6	60	0.31	0.67	12	25	51	<10	<0.21	<2.1	9.2	<26	<1.0	<5.2	25	7.9
950SH002	NA	12/21/98	<3.1	<2.6	210	0.44	1.0	13	87	210	<10	<0.21	<2.0	58	<26	<1.0	<5.1	47	17
950SH003	NA	10/15/98	<3.0	<2.5	190	0.55	0.76	12	22	150	12	<0.21	<2.0	15	<25	<1.0	<5.0	34	10
950SH004	NA	10/15/98	<3.0	<2.5	320	0.27	<0.50	5.9	16	310	<10	<0.21	<2.0	22	<25	<1.0	<5.0	7.6	47
950SH005	NA	10/15/98	<3.0	<2.5	280	<0.20	<0.50	6.9	6.5	110	<10	<0.20	<2.0	18	<25	<1.0	<5.0	14	36
950SH006	NA	10/15/98	<3.0	<2.5	270	0.39	0.96	11	8.2	110	20	<0.21	<2.0	19	<25	<1.0	<5.0	17	51
950SH007	NA	10/15/98	<3.0	<2.5	220	0.53	1.3	7.0	14	110	17	<0.21	<2.0	16	<25	<1.0	<5.0	12	32
950SH008	NA	10/15/98	<3.0	<2.5	250	0.34	1.1	6.7	6.1	110	13	<0.21	<2.0	16	<25	<1.0	<5.0	12	34
950SH009	NA	10/15/98	<3.0	<2.5	1,100	0.72	1.7	6.8	8.7	120	37	<0.20	<2.0	38	<25	<1.0	<5.0	17	140
950SH010	NA	10/15/98	<3.0	NA	50	<0.20	<0.50	4.5	<2.0	39	<10	<0.20	<2.0	<4.0	<25	<1.0	<5.0	15	7.9
950SH011	NA	10/15/98	<3.0	<2.5	170	0.40	0.98	7.2	2.4	76	<10	<0.21	<2.0	4.5	<25	<1.0	<5.1	34	12
950SH012	NA	10/15/98	<3.0	<2.5	400	0.37	<0.51	6.4	8.5	100	<10	<0.21	<2.0	24	<25	<1.0	<5.1	12	39
950SH013	NA	10/15/98	<3.0	<2.5	220	0.32	<0.51	6.4	3.9	140	<10	<0.21	<2.0	16	<25	<1.0	<5.1	7.4	46
950SH014	NA	10/15/98	<3.1	<2.6	280	0.43	0.52	8.8	4.5	160	<10	<0.20	<2.0	18	<26	<1.0	<5.1	12	44
950SH015	NA	10/15/98	<3.1	<2.6	280	0.40	<0.51	9.1	4.5	100	<10	<0.21	<2.0	23	<26	<1.0	<5.1	11	51
BKGDSB03	0.1	9/2/92	<41.3	2.460	229	<0.50	<0.515	48.4	15.3	49.4	45	0.036	NA	32.5	<0.250	<0.521	<14.7	71.3	64.5

Table C-3
CHERT/SHALE LITHOLOGY
Presidio of San Francisco, California

Abbreviations:

NA	Not Analyzed or Rejected Data

Notes:

a) Depth in feet below ground surface.

b) Laboratory Abbreviations:

CHROMALA	ChromaLab, Pleasanton, California
ED	Environmental Science and Engineering, Inc., Englewood, Colorado

c) See text for discussion of data.

TABLE C-4

BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
BKGDSB05	5	12/07/94	QA	7,210	3,030	2,040	226
BKGDSB05	9.5	12/07/94	QA	13,100	3,990	1,740	248
BKGDSB06	2	12/07/94	QA	11,400	4,690	3,860	185
BKGDSB06	9.5	12/07/94	QA	10,200	4,640	4,040	171
BKGDSB07	5	12/08/94	QA	18,600	5,480	2,270	180
BKGDSB07	9.5	12/08/94	QA	12,500	5,600	2,480	148
BKGDSB08	5.5	12/08/94	QA	7,580	4,640	1,860	109
BKGDSB08	9.5	12/08/94	QA	14,700	4,670	2,150	151
BKGDSB10	3.5	12/07/94	QA	8,580	5,080	2,140	123
BKGDSB10	7.5	12/07/94	QA	6,030	3,260	1,520	91.5
BKGSO01B	4.5	11/26/90	UB	12,800	5,580	3,680	104
BKGSO02A	0.8	11/27/90	UB	21,800	6,580	2,810	178
BKGSO02B	3.5	11/27/90	UB	19,900	7,660	3,070	176
1065SB02	10	12/14/94	SU	NA	NA	NA	NA
1065SB04	5	01/12/95	SU	NA	NA	NA	NA
1167SB02	6.5	11/19/94	QA	15,800	16,500	5,880	162
1167SB03	10	11/19/94	QA	14,300	11,200	6,320	127
1351SO03B	5	11/29/90	UB	28,000	11,900	2,960	237
1351SO04B	4.5	11/29/90	UB	26,500	16,200	3,280	302
1351SO05B	4.5	11/29/90	UB	31,600	17,400	3,310	588
1351SO06B	4.5	11/29/90	UB	30,800	19,300	3,480	709
231GW04B	6	10/22/90	UB	34,900	25,700	6,740	588
231GW05B	5.5	10/23/90	UB	19,800	10,600	4,305	357
231GW06B	12	10/24/90	UB	29,300	20,000	3,860	440
231GW07B	7	10/25/90	UB	29,800	18,700	7,360	515
231SB16	4	12/06/94	SU	NA	NA	NA	NA
231SB28	4	04/06/95	SU	NA	NA	NA	NA
268SO02	3	12/11/90	UB	32,200	17,800	8,750	432
268SO05	3.5	12/12/90	UB	21,100	10,300	7,030	346
269SB01	2.5	11/19/94	QA	17,700	NA	10,500	174
283SO01B	5	12/10/90	UB	14,900	7,220	4,550	201

TABLE C-4
BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Title 22 Metals (mg/kg)															
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
BKGDSB05	5	12/07/94	<0.10	<2.50	11.3	0.170	<0.800	19.9	4.75	21.2	1.59	<0.059	NA	19.7	<0.416	<0.500	<0.162	16.4	19.2
BKGDSB05	9.5	12/07/94	<0.10	<2.50	8.12	0.198	<0.800	72.8	6.07	24.1	2.54	<0.059	NA	20.5	<0.416	<0.500	<0.162	42.0	27.5
BKGDSB06	2	12/07/94	<0.10	3.80	22.8	0.201	<0.800	39.5	7.14	16.7	4.87	<0.059	NA	25.3	<0.416	<0.500	<0.162	29.1	25.4
BKGDSB06	9.5	12/07/94	<0.10	5.43	13.2	0.180	<0.800	32.8	7.12	21.2	2.73	<0.059	NA	26.3	<0.416	<0.500	<0.162	23.5	22.9
BKGDSB07	5	12/08/94	<0.10	1.66	13.1	0.202	<0.800	60.3	8.43	12.9	3.96	<0.059	NA	22.9	<0.416	<0.500	<0.162	64.1	26.5
BKGDSB07	9.5	12/08/94	<0.10	2.29	10.5	0.201	<0.800	50.4	7.23	57.2	3.28	<0.059	NA	24.0	<0.416	<0.500	<0.162	39.1	35.6
BKGDSB08	5.5	12/08/94	<0.10	1.78	11.9	0.134	<0.800	27.7	4.95	34.3	1.93	<0.059	NA	21.1	<0.416	<0.500	<0.162	20.6	32.0
BKGDSB08	9.5	12/08/94	<0.10	1.68	11.8	0.208	<0.800	49.5	7.16	46.5	2.83	<0.059	NA	20.6	<0.416	<0.500	<0.162	48.6	40.3
BKGDSB10	3.5	12/07/94	<0.10	<2.50	13.2	0.172	<0.800	28.3	5.73	8.61	2.65	<0.059	NA	15.1	<0.416	<0.500	<0.162	23.2	19.6
BKGDSB10	7.5	12/07/94	<0.10	<2.50	10.8	0.172	<0.800	17.9	3.99	18.4	1.80	<0.059	NA	15.0	<0.416	<0.500	<0.162	15.7	16.2
BKGSO01B	4.5	11/26/90	<19.6	4.18	21.8	<0.427	<1.2	40.8	5.6	4.84	3.72	<0.05	NA	30.1	<0.449	<0.803	<34.3	21.4	17.2
BKGSO02A	0.8	11/27/90	<19.6	2.76	15.5	0.7	<1.2	69.3	7.07	5	11.8	<0.05	NA	24.4	<0.449	<0.803	<34.3	58.9	25.4
BKGSO02B	3.5	11/27/90	<19.6	2.85	14.6	0.646	<1.2	57.4	7.4	4.6	3.72	<0.05	NA	25.3	<0.449	<0.803	<34.3	53.8	19.7
1065SB02	10	12/14/94	NA	NA	NA	NA	NA	NA	NA	NA	4.93	NA	NA	NA	NA	NA	NA	NA	NA
1065SB04	5	01/12/95	NA	NA	NA	NA	NA	NA	NA	NA	4.12	NA	NA	NA	NA	NA	NA	NA	NA
1167SB02	6.5	11/19/94	NA	3.67	31.8	0.389	<0.800	66.2	9.76	NA	17.6	<0.059	NA	64.7	NA	NA	NA	37.4	47.5
1167SB03	10	11/19/94	NA	5.96	17.7	0.297	<0.800	46.2	9.05	14.0	4.18	<0.059	NA	39.7	NA	NA	NA	30.1	38.0
1351SO03B	5	11/29/90	NA	<2.50	54.9	0.720	NA	92.1	11.8	12.5	13.9	<0.050	NA	31.6	NA	NA	NA	68.8	51.7
1351SO04B	4.5	11/29/90	NA	<2.50	81.5	0.914	NA	85.4	9.35	13.7	3.72	<0.050	NA	36.1	NA	NA	NA	61.8	38.1
1351SO05B	4.5	11/29/90	NA	<2.50	103	1.05	NA	89.1	15.8	14.1	3.72	0.059	NA	45.2	NA	NA	NA	77.4	36.0
1351SO06B	4.5	11/29/90	NA	<2.50	132	1.27	NA	91.2	24.2	16.6	3.72	0.063	NA	50.6	NA	NA	NA	68.1	39.2
231GW04B	6	10/22/90	NA	<2.50	251	0.695	NA	95.5	19.5	35.2	52.6	0.646	NA	68.6	NA	<0.803	NA	74.6	62.3
231GW05B	5.5	10/23/90	NA	<2.50	64.6	<0.427	NA	NA	8.84	9.71	20.9	0.070	NA	40.9	NA	<0.803	NA	40.2	49.6
231GW06B	12	10/24/90	NA	<2.50	118	0.738	NA	NA	15	15.6	13.8	0.053	NA	47.7	NA	<0.803	NA	64.0	38.6
231GW07B	7	10/25/90	NA	2.96	111	0.752	NA	NA	15.6	21.9	75.1	0.083	NA	82.9	NA	<0.803	NA	57.2	74.3
231SB16	4	12/06/94	NA	NA	NA	NA	NA	NA	NA	NA	13	NA	NA	NA	NA	NA	NA	NA	NA
231SB28	4	04/06/95	NA	NA	NA	NA	NA	NA	NA	NA	81	NA	NA	NA	NA	NA	NA	NA	NA
268SO02	3	12/11/90	NA	4.57	161	<0.427	<1.20	49.2	14.9	40.6	44.6	0.107	NA	50.6	NA	<0.803	NA	39.8	92.6
268SO05	3.5	12/12/90	NA	2.51	59.7	<0.427	<1.20	142	9.97	24.1	37.4	NA	NA	51.6	NA	<0.803	NA	36.4	36.8
269SB01	2.5	11/19/94	NA	3.01	15.4	0.194	NA	105	15.8	14.2	17.3	NA	NA	80.8	0.532	NA	NA	44.7	32.2
283SO01B	5	12/10/90	NA	2.83	25.3	<0.427	<1.20	64.2	6.76	5.47	3.72	NA	NA	31.1	NA	<0.803	NA	25.7	18.5

TABLE C-4

BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY

Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
283SO02B	5	12/11/90	UB	15,100	6,920	4,790	178
286SB06	5	12/01/94	QA	64,20	3,200	2,440	86.6
286SB07	5	12/01/94	QA	8,240	3,850	4,570	116
293SB01	2.5	11/15/94	SU	NA	NA	NA	NA
293SB01	4.5	11/15/94	SU	NA	NA	NA	NA
293SB02	4	11/15/94	SU	NA	NA	NA	NA
293SB03	4	11/15/94	SU	NA	NA	NA	NA
30S3R	1	10/11/94	PA	NA	NA	NA	NA
30S3R	1.5	10/11/94	PA	NA	NA	NA	NA
30S3R	2	10/11/94	PA	NA	NA	NA	NA
30S3R	3	10/11/94	PA	NA	NA	NA	NA
60S1R	1.5	10/11/94	PA	NA	NA	NA	NA
60S1R	2	10/11/94	PA	NA	NA	NA	NA
60S1R	3	10/11/94	PA	NA	NA	NA	NA
BBSB11	2	08/05/92	ED	9,500	4,110	3,670	<128
BBSB20	2	08/05/92	ED	12,000	4,900	2,270	<160
BBSB21	2	08/30/92	ED	26,000	13,000	3,210	323
BBSB22	2	08/30/92	ED	24,000	6,900	2,600	<173
CGGW02	2	08/12/92	ED	9,200	3,490	3,680	<131
CGGW02	3.5	08/12/92	ED	11,000	4,030	4,570	<178
CGSO01A	2	11/08/90	UB	14,100	6,230	7,080	171
CGSO02A	1	11/08/90	UB	13,700	5,580	4,650	168
CGSO02B	2	11/08/90	UB	12,800	5,890	5,090	170
CGSO03A	2	11/09/90	UB	12,400	5,080	4,420	151
CGSO03B	3	11/09/90	UB	12,000	5,640	4,700	145
CGSO04A	1	11/14/90	UB	13,600	5,270	4,290	180
CGSO04B	5	11/14/90	UB	13,500	5,480	4,070	152
DEHGW02	5	08/24/92	ED	17,000	6,310	8,310	<214
DEHSB01	3	08/07/92	ED	11,000	4,020	4,510	<139
DEHSB01	5	08/07/92	ED	16,000	4,120	3,740	99.6
EOMSB01	4.5	11/15/94	QA	6,950	3,290	2,330	102
EOMSB02	4.5	11/15/94	QA	9,050	3,690	3,380	118

TABLE C-4
BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Title 22 Metals (mg/kg)															
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
283SO02B	5	12/11/90	NA	<2.50	18.9	<0.427	1.68	59.5	6.81	4.81	3.72	<0.050	NA	34.4	NA	<0.803	NA	26.1	18.9
286SB06	5	12/01/94	NA	3.16	7.87	0.135	NA	26.6	4.43	11.3	1.60	NA	NA	21.1	NA	<0.500	NA	14.2	18.6
286SB07	5	12/01/94	NA	3.94	9.13	0.149	NA	35.3	5.88	13.0	2.25	NA	NA	36.5	NA	<0.500	NA	16.2	27.5
293SB01	2.5	11/15/94	NA	1.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
293SB01	4.5	11/15/94	NA	1.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
293SB02	4	11/15/94	NA	1.11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
293SB03	4	11/15/94	NA	1.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
30S3R	1	10/11/94	NA	NA	NA	NA	NA	41	NA	NA	42	NA	NA	NA	NA	NA	NA	NA	NA
30S3R	1.5	10/11/94	NA	NA	NA	NA	NA	40.6	NA	NA	25.1	NA	NA	NA	NA	NA	NA	NA	NA
30S3R	2	10/11/94	NA	NA	NA	NA	NA	45.7	NA	NA	24.4	NA	NA	NA	NA	NA	NA	NA	NA
30S3R	3	10/11/94	NA	NA	NA	NA	NA	50.7	NA	NA	88.7	NA	NA	NA	NA	NA	NA	NA	NA
60S1R	1.5	10/11/94	NA	NA	NA	NA	NA	65.9	NA	NA	44.8	NA	NA	NA	NA	NA	NA	NA	NA
60S1R	2	10/11/94	NA	NA	NA	NA	NA	55	NA	NA	65.9	NA	NA	NA	NA	NA	NA	NA	NA
60S1R	3	10/11/94	NA	NA	NA	NA	NA	37.6	NA	NA	27.4	NA	NA	NA	NA	NA	NA	NA	NA
BBSB11	2	08/05/92	<41.3	2.81	8.1	0.558	<0.515	38.4	8.2	3.605	9.95	<0.027	NA	29.2	<0.25	0.682	NA	30.1	45.4
BBSB20	2	08/05/92	<41.3	2.55	9.0	<0.500	<0.515	44.4	9.75	3.64	21	<0.027	NA	24.2	<0.25	0.805	NA	40.3	31.8
BBSB21	2	08/30/92	<41.3	3.51	94.9	<0.500	<0.515	86.8	11	20.9	16	0.031	NA	56.3	<0.25	<0.521	<14.7	58.4	44.4
BBSB22	2	08/30/92	<41.3	2.73	19.1	<0.500	<0.515	111	9.88	8.64	2.08	<0.027	NA	51.2	<0.25	<0.521	<14.7	62.8	10.4
CGGW02	2	08/12/92	NA	4.48	5.5	<0.500	<0.515	36.8	7.25	3.11	3.95	0.028	NA	35.5	<0.25	<0.521	NA	21	9.75
CGGW02	3.5	08/12/92	NA	5.33	5.4	<0.500	0.690	50.5	8.55	4.68	4.11	<0.027	NA	42.3	<0.25	<0.521	NA	24.3	11.05
CGSO01A	2	11/08/90	NA	NA	22.8	NA	NA	60.2	7.06	6.29	8.26	0.054	NA	50.8	NA	NA	NA	28.1	21.1
CGSO02A	1	11/08/90	NA	NA	15.3	NA	NA	75.4	6.00	5.23	3.72	<0.05	NA	32.5	NA	NA	NA	27.6	18.0
CGSO02B	2	11/08/90	NA	NA	23.3	NA	NA	82.8	6.09	5.04	3.72	<0.050	NA	32.6	NA	<0.803	NA	26.3	19.8
CGSO03A	2	11/09/90	NA	NA	14.7	NA	NA	52.7	5.58	4.53	3.72	<0.050	NA	30.7	NA	NA	NA	23.3	16.9
CGSO03B	3	11/09/90	NA	NA	14.8	NA	NA	51.6	5.31	4.41	3.72	0.098	NA	30.3	NA	NA	NA	22.3	17.2
CGSO04A	1	11/14/90	NA	2.82	20.4	NA	NA	46.3	6.32	5.52	3.72	<0.050	NA	29.0	NA	NA	NA	25.2	20.4
CGSO04B	5	11/14/90	NA	2.72	14.4	NA	NA	34.8	5.97	4.95	3.72	<0.050	NA	27.0	NA	NA	NA	25.2	22.4
DEHGW02	5	08/24/92	<41.3	4.2	28.7	<0.500	<0.515	86.9	10.1	24	23	<0.027	NA	77.8	0.751	<0.521	NA	37.1	42
DEHSB01	3	08/07/92	<41.3	3.52	7.35	<0.500	<0.515	62.5	8.05	5.2	6.33	<0.027	NA	49.8	<0.25	<0.521	NA	24.2	11.4
DEHSB01	5	08/07/92	<41.3	3.52	5.45	<0.500	<0.515	44.7	7.5	5.55	7.01	<0.027	NA	40.2	<0.25	<0.521	NA	23.2	12.25
EOMSB01	4.5	11/15/94	NA	2.64	7.28	0.126	NA	20.7	4.35	4.55	20.9	<0.059	NA	19.3	NA	NA	NA	14.6	12.7
EOMSB02	4.5	11/15/94	NA	3.80	7.18	0.134	NA	23.1	5.77	3.93	2.47	<0.059	NA	25.5	NA	NA	NA	16.2	15.0

TABLE C-4
BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Laboratories (b)	Major Elements (mg/kg)			
				Iron	Aluminum	Magnesium	Manganese
EOMSB03	4.9	11/15/94	QA	9,500	4,140	3,770	205
EOMSB05	4.5	11/16/94	QA	9,400	4,630	3,070	114
HWSB04	22	08/05/92	ED	8,200	3,600	1,820	97.4
LF10BK04	3	07/19/94	UNKNOWN	16,600	6,840	2,480	208
LF10BK05	3.5	07/19/94	UNKNOWN	29,000	7,790	2,750	231
LF10SB02	35	09/02/94	UNKNOWN	15,900	8,390	3,450	244
LF10SB03	29.5	08/27/96	CALLAB	13,000	4,880	3,420	258
LF10SB04	20	08/27/96	CALLAB	18,000	8,960	3,090	243
LF10SB04	25	08/27/96	CALLAB	9,370	4,060	1,620	103
LF3SB03	5	08/25/92	ED	12,000	4,480	2,060	<140
LF3SB04	5	08/25/92	ED	29,000	6,100	2,280	<220
LF4SB03	13	08/19/92	ED	14,000	5,120	1,860	133
LF4SB06	5	12/01/94	SU	NA	NA	NA	NA
LF4SB20	10	04/06/95	SU	NA	NA	NA	NA
LF4SO01	10	10/08/90	UB	14,400	9,780	3,180	172
LF4SO02	10	10/08/90	UB	17,200	10,800	2,990	246
LF8SO01B	19	10/01/90	UB	18,100	7,150	2,850	172
LF9SB01	4	08/19/92	ED	11,000	5,800	2,060	<156
LF9TP102	6	06/20/00	C&T	NA	NA	NA	NA
NKSB11	4.5	11/20/94	QA	7,010	4,090	1,820	106
NKSB12	4.5	11/20/94	QA	9,780	5,230	1,760	156
NKSB12	9	11/20/94	QA	6,110	3,920	1,530	85.9
NKSB13	5	12/05/94	QA	9,960	5,240	NA	NA
NKSB14	5	12/07/94	QA	11,600	5,940	2,270	138

TABLE C-4
BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Sample ID	Depth (ft.) (a)	Sample Date	Title 22 Metals (mg/kg)															
			Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vandium	Zinc
EOMSB03	4.9	11/15/94	NA	3.85	14.5	0.171	NA	50.9	8.94	5.21	3.65	<0.059	NA	32.8	NA	NA	NA	19.7	20.3
EOMSB05	4.5	11/16/94	NA	2.73	29.7	0.166	NA	32.6	5.72	6.98	7.08	<0.059	NA	24.7	NA	NA	NA	19.4	26.3
HWSB04	22	08/05/92	<41.3	2.6	16	<0.500	<0.515	40.6	12.6	6.39	1.53	<0.027	NA	21.8	<0.25	0.864	NA	25	7.45
LF10BK04	3	07/19/94	NA	2.3	23.1	NA	NA	62.4	6.6	4.7	13.9	<0.10	NA	21.1	NA	NA	NA	52.0	26.5
LF10BK05	3.5	07/19/94	NA	2.4	18.7	NA	NA	94.9	9.2	5.2	9.0	<0.10	NA	26.9	NA	NA	NA	98.9	28.7
LF10SB02	35	09/02/94	NA	3.2	33.4	NA	NA	43.4	7.7	6.6	2.8	<0.11	NA	30.4	NA	NA	NA	45.6	23.4
LF10SB03	29.5	08/27/96	NA	3.0	20.2	NA	NA	43.4	5.4	7.3	3.8	<0.11	NA	34.2	NA	NA	NA	31.6	20.2
LF10SB04	20	08/27/96	NA	3.4	57.1	NA	NA	74.4	7.0	10.2	43.0	<0.11	NA	45.4	NA	NA	NA	46.8	30.7
LF10SB04	25	08/27/96	NA	1.8	8.6	NA	NA	33.7	4.1	4.2	1.3	<0.10	NA	17.6	NA	NA	NA	25.6	11.9
LF3SB03	5	08/25/92	NA	2.86	7.0	NA	NA	46.3	2.885	14.1	<1.72	<0.027	NA	21.1	NA	NA	<14.7	37.9	11.65
LF3SB04	5	08/25/92	NA	2.24	36.3	NA	NA	86.7	4.19	6.35	2.15	<0.027	NA	25.1	NA	NA	NA	100	29.8
LF4SB03	13	08/19/92	<41.3	4.61	16.1	0.598	NA	58.2	9	13.3	2.12	<0.027	NA	23.2	0.552	0.814	NA	53.5	25.5
LF4SB06	5	12/01/94	NA	NA	NA	NA	NA	NA	NA	NA	1.17	NA	NA	NA	NA	NA	NA	NA	NA
LF4SB20	10	04/06/95	NA	NA	NA	NA	NA	NA	NA	NA	3.4	NA	NA	NA	NA	NA	NA	NA	NA
LF4SO01	10	10/08/90	NA	NA	29.0	<0.427	NA	46.5	7.08	<2.84	3.72	<0.050	NA	23.3	NA	NA	NA	40.5	NA
LF4SO02	10	10/08/90	NA	<2.50	45.6	<0.427	NA	60.6	6.99	<2.84	3.72	<0.050	NA	18.3	NA	NA	NA	48.8	NA
LF8SO01B	19	10/01/90	<19.6	<2.5	15.4	<0.427	<1.2	57.7	6.75	3.652	3.72	<0.05	NA	22.5	<0.449	<0.803	<34.3	48.7	16.984
LF9SB01	4	08/19/92	NA	2.52	30.9	0.564	NA	40.4	3.785	11.3	2.57	<0.027	NA	22.3	<0.25	0.688	NA	41.3	12.5
LF9TP102	6	06/20/00	<2.9	1.7	52	0.13	0.84	26	4.4	5.3	4	<0.02	<0.98	19	<0.25	<0.25	0.37	20	21
NKSB11	4.5	11/20/94	NA	2.38	9.56	0.165	NA	25.2	4.91	3.12	1.89	<0.059	NA	17.8	NA	NA	NA	19.5	13.5
NKSB12	4.5	11/20/94	NA	1.79	20.8	0.191	NA	37.7	6.08	13.7	3.22	<0.059	NA	16.6	NA	NA	NA	31.4	21.2
NKSB12	9	11/20/94	NA	2.23	10.4	0.129	NA	21.1	4.34	33.5	2.29	<0.059	NA	15.7	NA	NA	NA	15.7	38.6
NKSB13	5	12/05/94	NA	1.25	12.9	0.209	NA	36.9	5.77	3.80	NA	NA	NA	NA	NA	NA	NA	32.0	17.1
NKSB14	5	12/07/94	NA	1.51	16.2	0.275	NA	41.5	6.74	8.45	7.25	<0.059	NA	21.5	NA	NA	NA	37.8	25.8

TABLE C-4
BACKGROUND DATA SET - BEACH/DUNE LITHOLOGY
Presidio of San Francisco, California

Abbreviations:

NA	Not Analyzed or Rejected Data

Notes:

a) Depth in feet below ground surface.

b) Laboratory Abbreviations:

C&T	Curtis & Tompkins, Berkeley, California
CALLAB	Caltest Analytical Laboratory, Napa, California
ED	Environmental Science and Engineering, Inc., Englewood, Colorado
PA	Precision Analytical Labs, Milwaukee, Wisconsin
SU	Superior Precision Analytical, Inc., Martinez, California
QA	Quality Assurance Laboratories, San Diego, California
UB	DataChem, Inc., Salt Lake City, Utah

c) See text for discussion of data.

APPENDIX D

RESULTS OF ARMY'S HEXAVALENT CHROMIUM STUDIES: MONTGOMERY WATSON, HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS, JULY 1999

APPENDIX D

RESULTS OF ARMY'S HEXAVALENT CHROMIUM STUDIES: MONTGOMERY WATSON, HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS, JULY 1999

October 2002

TECHNICAL MEMORANDUM

HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS

PRESIDIO OF SAN FRANCISCO, CALIFORNIA

Contract No. DACW05-98-D-0033

Montgomery Watson Job No. 1212067.011804

Prepared for:

U.S. Army Corps of Engineers
Sacramento District
Sacramento, California

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July 1999

APPENDIX G

ANALYTICAL RESULTS

Analytical data for the Cr(VI) investigation are presented in the following tables:

- **Table G-1:** Summary of Analytes in Bedrock Samples
- **Table G-2:** Summary of Analytes in Groundwater Samples
- **Table G-3:** Summary of Analytes in Leachate
- **Table G-4:** Summary of Analytes in Leached Bedrock

Table G-5 describes the nomenclature used for the sample identification scheme. The analytical results tables present both the sample and the associated duplicate results (i.e., "A" and "B" fractions). Data referenced throughout this technical memorandum are the average value of the "A" and "B" fractions. Table G-6 lists data validation qualifiers reported on the analytical results tables. A more detailed description of the data validation qualifiers is found in Appendix H.

TABLE G-1

SUMMARY OF ANALYTES IN BEDROCK SAMPLES
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01SB01	UBR02SB01	UBR03SB01	UBR01SB01
Sample Date:	2/24/99	2/25/99	2/23/99	2/24/99
Depth (feet):	Composite	Composite	Composite	24.0
Metals (mg/kg)				
Aluminum	7,380	1,130	13,200	NA
Antimony	<13.6 (U9)	<21.6 (U9)	<7.1	NA
Arsenic	<68.1	<108	<35.3	NA
Barium	30.5	<72.1	130	NA
Beryllium	<1.1	<1.8	0.59	NA
Cadmium	0.94	<1.8	0.54 (J28)	NA
Calcium	1,110	1,410 (J28)	2,440	NA
Chromium	1,160	371	83.5	NA
Cobalt	101	97.6	19.9	NA
Copper	11.1	4.6 (J28)	23.4	NA
Iron	47,100	44,700	35,900	NA
Lead	<22.7	<36.1	8.8 (J28)	NA
Magnesium	193,000	213,000	5,400	NA
Manganese	595	671	216	NA
Nickel	2,070	1,950	69.1	NA
Potassium	<1130	<1800	1,520	NA
Selenium	<56.7	<90.1	<29.4	NA
Silicon	178 (J9, J12)	161 (J9, J12)	201	NA
Silver	<2.3	<3.6	<1.2	NA
Sodium	<1130	<1800	<588	NA
Thallium	<454	<721	<235	NA
Titanium	61.6 (J9)	<18.0	551	NA
Vanadium	35.2	10.4 (J28)	64.6	NA
Zinc	17.0	21.6	44.0	NA
Soil Chemistry Parameters (mg/kg)				
Cr(VI) by Alkaline Digestion	0.064	0.463	0.231	0.54
Cr(VI) by DI Leach	0.0102 (J28)	0.0103 (J28)	0.0137	NA
Easily Reducible Manganese	136	102	15	601
Quick Oxidation Test	1.6	1.01	<0.08	3.9
Total Organic Carbon by Walkley-Black	268	253	572	NA
Total Organic Carbon by Method 9060	329	452	897	NA
Miscellaneous Parameters (mV)				
Eh (mV)[a]	454	421	441	NA
pH	8.85	8.0	8.44	NA
Percent Moisture (%)	11.9	16.8	14.9	45.7

TABLE G-1

SUMMARY OF ANALYTES IN BEDROCK SAMPLES
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01SB01	UBR02SB01	UBR02SB01	UBR03SB01
Sample Date:	2/24/99	2/25/99	2/25/99	2/23/99
Depth (feet):	34.0	47.0	48.0	33.0
Metals (mg/kg)				
Aluminum	NA	**230**	**96.1**	**6,730**
Antimony	NA	<13.5	<19.8	<7.1 (U9)
Arsenic	NA	<67.3	<99.0	<35.6
Barium	NA	<44.9	<66.0	**105**
Beryllium	NA	<1.1	<1.6	<0.59
Cadmium	NA	<1.1	<1.6	<0.59
Calcium	NA	**14,100**	<1650	**1,890**
Chromium	NA	**89.5**	**71.0**	**55.6 (J10)**
Cobalt	NA	**108**	**114**	**24.1**
Copper	NA	<5.6	<8.2	**8.1**
Iron	NA	**49,000**	**49,900**	**20,100**
Lead	NA	<22.4	<33.0	<11.9
Magnesium	NA	**203,000**	**235,000**	**2,640**
Manganese	NA	**764**	**751**	**1,040**
Nickel	NA	**2,210**	**2,420**	**59.8**
Potassium	NA	<1120	<1650	**423 (J28)**
Selenium	NA	<56.1	<82.5	<29.7
Silicon	NA	**196**	**251**	**199 (J9)**
Silver	NA	<2.2	<3.3	<1.2
Sodium	NA	<1120	<1650	<593
Thallium	NA	<449	<660	<237
Titanium	NA	<11.2	<16.5	**520**
Vanadium	NA	<11.2	<16.5	**46.4**
Zinc	NA	**25.8**	**29.1**	**23.5**
Soil Chemistry Parameters (mg/kg)				
Cr(VI) by Alkaline Digestion	**0.602**	NA	NA	NA
Cr(VI) by DI Leach	NA	**0.0104 (J28)**	NA	**0.0264**
Easily Reducible Manganese	**1,235**	NA	NA	**891**
Quick Oxidation Test	**13.21**	NA	NA	NA
Total Organic Carbon by Walkley-Black	NA	NA	NA	NA
Total Organic Carbon by Method 9060	NA	NA	NA	**602**
Miscellaneous Parameters (mV)				
Eh (mV)[a]	NA	NA	NA	NA
pH	NA	NA	NA	NA
Percent Moisture (%)	**38.7**	**10.9**	**9.1**	**15.7**

[a] Eh values corrected for reference electrode and temperature
mV - millivolts
% - percent

TABLE G-2

SUMMARY OF ANALYTES IN GROUNDWATER SAMPLES
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01GW01	UBR02GW01	UBR02GW02	UBR03GW01
Sample Date:	3/22/99	3/22/99	3/22/99	3/23/99
Dissolved Metals (µg/l)				
Aluminum	<200	<200	<200	<200
Antimony	<60	<60	<60	<60
Arsenic	<300	<300	<300	<300
Barium	**260**	<200	<200	<200
Beryllium	<5.0	<5.0	<5.0	<5.0
Cadmium	<5.0	<5.0	<5.0	<5.0
Calcium	**35,700**	**12,500**	**27,100**	**40,300**
Chromium	**66**	**49**	**100**	<10
Cobalt	<50	<50	<50	<50
Copper	<25	<25	<25	<25
Iron	<100	<100	<100	<100
Lead	<100	<100	<100	<100
Magnesium	**119,000**	**133,000**	**139,000**	**46,400**
Manganese	**13 (J28)**	<15	**10 (J28)**	**280**
Nickel	<40	<40	<40	<40
Potassium	<5000	<5000	<5000	**5,900**
Selenium	<250	<250	<250	<250
Silicon	**24,300**	**9,100**	**23,600**	**16,800**
Silver	<10	<10	<10	<10
Sodium	**51,200**	**247,000**	**257,000**	**81,300**
Thallium	<2000	<2000	<2000	<2000
Titanium	<50	<50	<50	<50
Vanadium	<50	<50	<50	<50
Zinc	**24**	<20	<20	**11 (J28)**
Hexavalent Chromium	**65.4 (J29)**	**52.1 (J29)**	**98.3 (J29)**	<0.50 (U29)
General Water Chemistry Parameters (µg/l)				
Alkalinity, Total	**491,000**	**323,000**	**347,000**	**260,000**
Bicarbonate	**491,000**	**292,000**	**347,000**	**260,000**
Carbonate	<5000	**31,000**	<5000	<5000
Chloride	**93,600**	**526,000**	**568,000**	**81,900**
Fluoride	<2500	<2500	<2500	<2500
Nitrate	**330 (J29)**	**2,700 (J29)**	**2,700 (J29)**	**11,000**
Nitrite	<250 (U29)	<2500 (U29)	<2500 (U29)	<250
pH	**7.7**	**8.3**	**7.7**	**7.3**
Sulfate	**46,800**	**20,100**	**29,700**	**60,400**
Total Dissolved Solids	**673,000**	**1,180,000**	**1,310,000**	**953,000**
Field Parameters				
Salinity (%)	**0.70**	**1.37**	**1.48**	**0.56**
pH	**8.31**	**9.18**	**8.36**	**7.53**
Temperature (°C)	**15.12**	**14.86**	**14.17**	**16.91**
Specific Conductivity (mS/cm)	**1.384**	**2.625**	**2.839**	**1.132**
Eh (mV)[a]	**423**	**348**	**308**	**464**
Turbidity (NTU)	**12.8**	**0.8**	**2.0**	**945.7**
Dissolved Oxygen (mg/l)	**3.17**	**2.81**	**3.77**	**4.28**

TABLE G-2

SUMMARY OF ANALYTES IN GROUNDWATER SAMPLES
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR03GW02	UBR01GW01	UBR01GW01	UBR01GW01
Sample Date:	3/23/99	2/24/99	3/4/99	3/4/99
Dissolved Metals (µg/l)				
Aluminum	<200	120 (J28)	<200	<200
Antimony	<60	<60	<60	<60
Arsenic	<300	<300	<300	<300
Barium	<200	270	260	260
Beryllium	<5.0	<5.0	<5.0	<5.0
Cadmium	<5.0	<5.0	<5.0	<5.0
Calcium	30,000	38,700	34,200	33,600
Chromium	<10	25	66	65
Cobalt	<50	<50	<50	<50
Copper	<25	<25	<25	<25
Iron	<100	140	<100	<100
Lead	<100	<100	<100	<100
Magnesium	42,900	129,000	115,000	112,000
Manganese	59	71	<15	<15
Nickel	<40	27 (J28)	<40	<40
Potassium	<5000	<5000	<5000	<5000
Selenium	<250	<250	<250	<250
Silicon	16,600	25,700	23,900	23,400
Silver	<10	<10	<10	<10
Sodium	50,400	49,500	51,400	50,300
Thallium	<2000	<2000	<2000	<2000
Titanium	<50	<50	<50	<50
Vanadium	<50	<50	<50	<50
Zinc	<20	<20	<20	<20
Hexavalent Chromium	0.64 (J29)	26.6 (J29)	57.9	58.4
General Water Chemistry Parameters (µg/l)				
Alkalinity, Total	172,000	NA	468,000	459,000
Bicarbonate	172,000	NA	468,000	459,000
Carbonate	<5000	NA	<5000	<5000
Chloride	57,500	NA	98,800	98,400
Fluoride	<500	NA	<1000	<1000
Nitrate	6,800	NA	290	290
Nitrite	<250	NA	<250	<250
pH	6.4	NA	8.1	8.2
Sulfate	65,300	NA	48,800	48,000
Total Dissolved Solids	556,000	NA	689,000	699,000
Field Parameters				
Salinity (%)	0.40	NA	0.63	NA
pH	6.62	NA	8.32	NA
Temperature (°C)	15.89	NA	15.10	NA
Specific Conductivity (mS/cm)	0.807	NA	1.252	NA
Eh (mV)[a]	422	NA	-24	NA
Turbidity (NTU)	979.7	NA	1.5	NA
Dissolved Oxygen (mg/l)	0.68	NA	3.46	NA

TABLE G-2

SUMMARY OF ANALYTES IN GROUNDWATER SAMPLES
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR02GW01	UBR02GW02
Sample Date:	3/4/99	3/4/99
Dissolved Metals (µg/l)		
Aluminum	<200	<200
Antimony	<60	<60
Arsenic	<300	<300
Barium	<200	<200
Beryllium	<5.0	<5.0
Cadmium	<5.0	<5.0
Calcium	**13,500**	**27,900**
Chromium	**48**	**98**
Cobalt	<50	<50
Copper	<25	<25
Iron	<100	<100
Lead	<100	<100
Magnesium	**130,000**	**143,000**
Manganese	<15	**16**
Nickel	<40	<40
Potassium	<5000	<5000
Selenium	<250	<250
Silicon	**10,300**	**24,100**
Silver	<10	<10
Sodium	**239,000**	**271,000**
Thallium	<2000	<2000
Titanium	<50	<50
Vanadium	<50	<50
Zinc	<20	<20
Hexavalent Chromium	**45.0**	**89.2**
General Water Chemistry Parameters (µg/l)		
Alkalinity, Total	**316,000**	**340,000**
Bicarbonate	**290,000**	**340,000**
Carbonate	**26,600**	<5000
Chloride	**552,000**	**601,000**
Fluoride	<10000	<10000
Nitrate	**2,800**	**2,700**
Nitrite	<1000	<1000
pH	**8.6**	**8.2**
Sulfate	**21,200**	**36,800**
Total Dissolved Solids	**1,140,000**	**1,270,000**
Field Parameters		
Salinity (%)	**1.25**	**1.37**
pH	**9.14**	**8.33**
Temperature (°C)	**14.83**	**14.09**
Specific Conductivity (mS/cm)	**2.420**	**2.638**
Eh (mV)[a]	**-15**	**-33**
Turbidity (NTU)	**1.4**	**0.1**
Dissolved Oxygen (mg/l)	**2.81**	**3.56**

[a] Eh values are corrected for reference electrode and temperature
mg/l - milligrams per liter
mS/cm - millisiemens per centimeter
mV - millivolts
NTU - nephelometric turbidity units
% - percent

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T01S01A	UBR01T01S01B	UBR01T01S02A	UBR01T01S02B	UBR01T01S03A	UBR01T01S03B	UBR01T01S04A
Sample Date:	3/16/99	3/16/99	3/16/99	3/16/99	3/17/99	3/17/99	3/23/99
Sampling Interval:	1 hour	1 hour	4 hours	4 hours	24 hours	24 hours	7 days
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	<200	<200	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	<5000	<5000	NA	NA	NA	NA	NA
Chromium	<10	<10	<10	<10	<10	<10	<10
Cobalt	<50	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	<5000	<5000	<5000	<5000	<5000	<5000	<5000
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	<200	<200	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	<5000	<5000	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	<50	<50	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
General Water Chemistry Parameters							
pH	**6.93**	**6.85**	**6.39**	**7.38**	**6.52**	**6.72**	**6.84**
Eh (mV)[a]	**434**	**447**	**464**	**447**	**443**	**421**	**451**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T01S04B	UBR01T01S05A	UBR01T01S05B	UBR01T01S06A	UBR01T01S06B	UBR01T01S07A	UBR01T01S07B
Sample Date:	3/23/99	3/30/99	3/30/99	4/6/99	4/6/99	4/13/99	4/13/99
Sampling Interval:	7 days	14 days	14 days	21 days	21 days	28 days	28 days
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	<200	<200
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	<5000	<5000
Chromium	<10	<10	<10	<10	<10	<10	<10
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	<5000	<5000	<5000	<5000	<5000	<5000	<5000
Manganese	<15	<15	<15	<15	**8.8 (J28)**	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**1,600**	**1,100**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	<5000	<5000
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
General Water Chemistry Parameters							
pH	**6.89**	**7.26**	**7.10**	**7.54**	**7.36**	**7.36**	**6.34**
Eh (mV)[a]	**447**	**403**	**442**	**469**	**485**	**454**	**442**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T02S01A	UBR01T02S01B	UBR01T02S02A	UBR01T02S02B	UBR01T02S03A	UBR01T02S03B	UBR01T02S04A
Sample Date:	3/16/99	3/16/99	3/16/99	3/16/99	3/17/99	3/17/99	3/23/99
Sampling Interval:	1 hour	1 hour	4 hours	4 hours	24 hours	24 hours	7 days
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	**220**	**210**	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	**40,500**	**40,500**	NA	NA	NA	NA	NA
Chromium	**63**	**63**	**62**	**58**	**64**	**56**	**64**
Cobalt	<50	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	**101,000**	**101,000**	**101,000**	**92,200**	**99,000**	**89,400**	**97,900**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	**23,600**	**23,600**	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	**50,800**	**49,600**	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	<50	<50	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	**69.5**	**67.7**	**63.9**	**62.6**	**69.9**	**70.7**	**66.6**
General Water Chemistry Parameters							
pH	**7.88**	**7.92**	**7.83**	**7.79**	**8.00**	**7.97**	**7.85**
Eh (mV)[a]	**432**	**429**	**458**	**438**	**404**	**407**	**394**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T02S04B	UBR01T02S05A	UBR01T02S05B	UBR01T02S06A	UBR01T02S06B	UBR01T02S07A	UBR01T02S07B
Sample Date:	**3/23/99**	**3/30/99**	**3/30/99**	**4/6/99**	**4/6/99**	**4/13/99**	**4/13/99**
Sampling Interval:	**7 days**	**14 days**	**14 days**	**21 days**	**21 days**	**28 days**	**28 days**
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	**160 (J28)**	**150 (J28)**
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	**28,000**	**27,200**
Chromium	**65**	**64**	**63**	**56 (J33)**	**33 (J33)**	**8.6 (J28)**	**8.4 (J28)**
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	**97,400**	**94,700**	**96,600**	**80,800**	**90,500**	**83,300**	**82,000**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**24,200**	**23,900**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	**47,200**	**47,300**
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	**68.8**	**54.7**	**57.1**	**34.9 (J33)**	**19.0 (J33)**	**5.3**	**5.2**
General Water Chemistry Parameters							
pH	**7.83**	**7.86**	**7.87**	**8.09**	**7.93**	**7.86**	**7.96**
Eh (mV)[a]	**393**	**429**	**428**	**464**	**442**	**418**	**424**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T03S01A	UBR01T03S01B	UBR01T03S02A	UBR01T03S02B	UBR01T03S03A	UBR01T03S03B	UBR01T03S04A
Sample Date:	3/16/99	3/16/99	3/16/99	3/16/99	3/17/99	3/17/99	3/23/99
Sampling Interval:	1 hour	1 hour	4 hours	4 hours	24 hours	24 hours	7 days
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	<200	<200	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	**2,800 (J28)**	**3,300 (J28)**	NA	NA	NA	NA	NA
Chromium	<10	<10	<10	<10	<10	**7.7 (J28)**	<10
Cobalt	<50	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	**110**	<100	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	**4,200 (J28)**	**4,800 (J28)**	**6,900**	**6,100**	**6,800**	**6,400**	**8,900**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	**9,200**	**9,200**	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	**7,200**	**6,700**	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	<50	<50	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	**3.5**	**3.3**	**3.7**	**3.3**	**4.1**	**4.2**	**5.2**
General Water Chemistry Parameters							
pH	**8.78**	**8.84**	**8.38**	**8.38**	**8.75**	**8.74**	**8.29**
Eh (mV)[a]	**396**	**389**	**455**	**449**	**416**	**429**	**391**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T03S04B	UBR01T03S05A	UBR01T03S05B	UBR01T03S06A	UBR01T03S06B	UBR01T03S07A	UBR01T03S07B
Sample Date:	**3/23/99**	**3/30/99**	**3/30/99**	**4/6/99**	**4/6/99**	**4/13/99**	**4/13/99**
Sampling Interval:	**7 days**	**14 days**	**14 days**	**21 days**	**21 days**	**28 days**	**28 days**
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	<200	<200
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	**9,000**	**8,600**
Chromium	**6.7 (J28)**	**9.3 (J28)**	**6.0 (J28)**	**6.7 (J28)**	<10	<10	**5.0 (J28)**
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	**260**	<100	<100	<100	<100	<100	**83 (J28)**
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	**8,900**	**11,000**	**8,700**	**10,300**	**10,100**	**11,000**	**10,100**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**18,300**	**17,400**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	**7,100**	**7,100**
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	**5.2**	**4.4**	**6.4**	**3.4**	**2.3**	**0.36 (J28)**	**2.0**
General Water Chemistry Parameters							
pH	**8.29**	**8.06**	**7.95**	**8.06**	**8.01**	**8.26**	**8.21**
Eh (mV)[a]	**396**	**416**	**425**	**442**	**450**	**403**	**403**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T04S01A	UBR01T04S01B	UBR01T04S02A	UBR01T04S02B	UBR01T04S03A	UBR01T04S03B	UBR01T04S04A
Sample Date:	**3/24/99**	**3/24/99**	**3/24/99**	**3/24/99**	**3/25/99**	**3/25/99**	**3/31/99**
Sampling Interval:	**1 hour**	**1 hour**	**4 hours**	**4 hours**	**24 hours**	**24 hours**	**7 days**
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	<200	<200	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	**4,400 (J28)**	**4,600 (J28)**	NA	NA	NA	NA	NA
Chromium	**79**	**82**	**110**	**110**	**140**	**130**	**180**
Cobalt	<50	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	<100	**96 (J28)**	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	**6,300**	**6,700**	**5,400**	**6,000**	**6,600**	**6,100**	**8,900**
Manganese	**59**	**24**	<15	**8.3 (J28)**	**16**	<15	**10 (J28)**
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	**8,400**	**8,700**	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	**4,500 (J28)**	**4,600 (J28)**	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	**88**	**92**	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	**554**	**556**	**108**	**105**	**144**	**132**	**125**
General Water Chemistry Parameters							
pH	**8.59**	**8.57**	**8.68**	**8.61**	**7.98**	**8.39**	**8.30**
Eh (mV)[a]	**333**	**332**	**334**	**336**	**395**	**397**	**431**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T04S04B	UBR01T04S05A	UBR01T04S05B	UBR01T04S06A	UBR01T04S06B	UBR01T04S07A	UBR01T04S07B
Sample Date:	3/31/99	4/7/99	4/7/99	4/14/99	4/14/99	4/21/99	4/21/99
Sampling Interval:	7 days	14 days	14 days	21 days	21 days	28 days	28 days
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	<200	<200
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	**8,700**	**10,600**
Chromium	**200**	**190 (J33)**	**91 (J33)**	**180**	**190**	**190**	**170**
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	**9,100**	**9,300**	**10,800**	**10,200**	**10,000**	**11,000**	**12,900**
Manganese	<15	**12 (J28)**	<15	<15	<15	**28**	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**19,400**	**20,400**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	**6,700**	**6,800**
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	**133**	**139 (J33)**	**67.7 (J33)**	**151**	**152**	**182**	**156**
General Water Chemistry Parameters							
pH	**8.19**	**8.20**	**8.07**	**8.31**	**8.25**	**7.91**	**7.87**
Eh (mV)[a]	**425**	**460**	**450**	**437**	**438**	**399**	**411**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T05S01A	UBR01T05S01B	UBR01T05S02A	UBR01T05S02B	UBR01T05S03A	UBR01T05S03B	UBR01T05S04A
Sample Date:	3/24/99	3/24/99	3/24/99	3/24/99	3/25/99	3/25/99	3/31/99
Sampling Interval:	1 hour	1 hour	4 hours	4 hours	24 hours	24 hours	7 days
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	<200	<200	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	**3,000 (J28)**	**2,900 (J28)**	NA	NA	NA	NA	NA
Chromium	**22 (J33)**	**14 (J33)**	**7.2 (J28)**	**6.6 (J28)**	**5.0 (J28)**	**5.5 (J28)**	**8.3 (J28)**
Cobalt	<50	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	**4,200 (J28)**	**4,200 (J28)**	**5,200**	**4,100 (J28)**	**6,300**	**6,200**	**8,500**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	**6,200**	**6,200**	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	**4,300 (J28)**	**4,400 (J28)**	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	<50	<50	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	**4.9**	**4.9**	**4.7**	**4.5**	**5.1**	**5.1**	**4.6**
General Water Chemistry Parameters							
pH	**8.73**	**8.77**	**8.52**	**8.44**	**8.43**	**8.37**	**8.20**
Eh (mV)[a]	**432**	**441**	**373**	**378**	**397**	**407**	**422**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T05S04B	UBR01T05S05A	UBR01T05S05B	UBR01T05S06A	UBR01T05S06B	UBR01T05S07A	UBR01T05S07B
Sample Date:	3/31/99	4/7/99	4/7/99	4/14/99	4/14/99	4/21/99	4/21/99
Sampling Interval:	7 days	14 days	14 days	21 days	21 days	28 days	28 days
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	<200	<200
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	**11,100**	**10,800**
Chromium	**8.1 (J28)**	**7.5 (J28)**	**7.3 (J28)**	**9.8 (J28, J33)**	**31 (J33)**	**6.2 (J28)**	**7.2 (J28)**
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	**8,600**	**9,500**	**9,400**	**10,600**	**11,700**	**12,400**	**12,800**
Manganese	<15	<15	<15	<15	<15	<15	<15
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**20,600**	**20,800**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	**7,100**	**7,800**
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	**4.7**	**5.2**	**5.1**	**5.1**	**6.3**	**4.3**	**6.1**
General Water Chemistry Parameters							
pH	**8.39**	**8.05**	**7.96**	**8.25**	**8.16**	**7.93**	**7.94**
Eh (mV)[a]	**419**	**446**	**449**	**436**	**440**	**418**	**420**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T06S01A	UBR01T06S01B	UBR01T06S02A	UBR01T06S02B	UBR01T06S03A	UBR01T06S03B	UBR01T06S04A
Sample Date:	3/24/99	3/24/99	3/24/99	3/24/99	3/25/99	3/25/99	3/31/99
Sampling Interval:	1 hour	1 hour	4 hours	4 hours	24 hours	24 hours	7 days
Dissolved Metals (µg/l)							
Aluminum	<200	<200	NA	NA	NA	NA	NA
Antimony	<60	<60	NA	NA	NA	NA	NA
Arsenic	<300	<300	NA	NA	NA	NA	NA
Barium	**260**	**210**	NA	NA	NA	NA	NA
Beryllium	<5.0	<5.0	NA	NA	NA	NA	NA
Cadmium	<5.0	<5.0	NA	NA	NA	NA	NA
Calcium	**29,000**	**27,000**	NA	NA	NA	NA	NA
Chromium	**8,600**	**8,700**	**1,800**	**2,100**	**300**	**290**	**210**
Cobalt	**29 (J28)**	<50	NA	NA	NA	NA	NA
Copper	<25	<25	NA	NA	NA	NA	NA
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	<100	<100	NA	NA	NA	NA	NA
Magnesium	**43,100**	**39,000**	**42,600**	**43,300**	**43,600**	**42,000**	**47,600**
Manganese	**780**	**190**	**240**	**130**	**88**	**60**	**29**
Nickel	**97**	**37 (J28)**	**38 (J28)**	**20 (J28)**	**24 (J28)**	<40	<40
Potassium	<5000	<5000	NA	NA	NA	NA	NA
Selenium	<250	<250	NA	NA	NA	NA	NA
Silicon	**5,100**	**4,800**	NA	NA	NA	NA	NA
Silver	<10	<10	NA	NA	NA	NA	NA
Sodium	**7,200**	**6,400**	NA	NA	NA	NA	NA
Thallium	<2000	<2000	NA	NA	NA	NA	NA
Titanium	<50	<50	NA	NA	NA	NA	NA
Vanadium	**33 (J28)**	<50	NA	NA	NA	NA	NA
Zinc	<20	<20	NA	NA	NA	NA	NA
Hexavalent Chromium	**3,590 (J33)**	**210 (J33)**	**117**	**156**	**73.7**	**108**	**147**
General Water Chemistry Parameters							
pH	**5.33**	**5.27**	**5.52**	**5.63**	**6.18**	**6.02**	**7.16**
Eh (mV)[a]	**541**	**459**	**493**	**491**	**443**	**407**	**439**

TABLE G-3

SUMMARY OF ANALYTES IN LEACHATE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T06S04B	UBR01T06S05A	UBR01T06S05B	UBR01T06S06A	UBR01T06S06B	UBR01T06S07A	UBR01T06S07B
Sample Date:	3/31/99	4/7/99	4/7/99	4/14/99	4/14/99	4/21/99	4/21/99
Sampling Interval:	7 days	14 days	14 days	21 days	21 day	28 days	28 days
Dissolved Metals (µg/l)							
Aluminum	NA	NA	NA	NA	NA	<200	<200
Antimony	NA	NA	NA	NA	NA	<60	<60
Arsenic	NA	NA	NA	NA	NA	<300	<300
Barium	NA	NA	NA	NA	NA	**150 (J28)**	**130 (J28)**
Beryllium	NA	NA	NA	NA	NA	<5.0	<5.0
Cadmium	NA	NA	NA	NA	NA	<5.0	<5.0
Calcium	NA	NA	NA	NA	NA	**37,900**	**37,300**
Chromium	**240**	**470 (J33)**	**230 (J33)**	**220**	**220**	**190 (J33)**	**120 (J33)**
Cobalt	NA	NA	NA	NA	NA	<50	<50
Copper	NA	NA	NA	NA	NA	<25	<25
Iron	<100	<100	<100	<100	<100	<100	<100
Lead	NA	NA	NA	NA	NA	<100	<100
Magnesium	**48,800**	**48,500**	**47,100**	**47,700**	**48,000**	**47,800**	**48,900**
Manganese	**30**	**51**	**27**	**67**	**22**	**47**	**17**
Nickel	<40	<40	<40	<40	<40	<40	<40
Potassium	NA	NA	NA	NA	NA	<5000	<5000
Selenium	NA	NA	NA	NA	NA	<250	<250
Silicon	NA	NA	NA	NA	NA	**22,600**	**23,500**
Silver	NA	NA	NA	NA	NA	<10	<10
Sodium	NA	NA	NA	NA	NA	**8,700**	**8,600**
Thallium	NA	NA	NA	NA	NA	<2000	<2000
Titanium	NA	NA	NA	NA	NA	<50	<50
Vanadium	NA	NA	NA	NA	NA	<50	<50
Zinc	NA	NA	NA	NA	NA	<20	<20
Hexavalent Chromium	**160**	**344 (J33)**	**169 (J33)**	**184**	**176**	**171 (J33)**	**104 (J33)**
General Water Chemistry Parameters							
pH	**7.04**	**7.25**	**7.08**	**7.31**	**7.24**	**6.93**	**7.07**
Eh (mV)[a]	**421**	**472**	**472**	**463**	**467**	**463**	**453**

[a] Eh values corrected for reference electrode and temperature by adding 244 mV
µg/l - micrograms per liter
mV - millivolts

TABLE G-4

SUMMARY OF ANALYTES IN LEACHED BEDROCK
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample ID:	UBR01T02S01A	UBR01T02S01B	UBR01T02S07A	UBR01T02S07B	UBR01T03S01A	UBR01T03S01B
Sample Date:	3/16/99	3/16/99	4/13/99	4/13/99	3/16/99	3/16/99
Sampling Interval:	1 hour	1 hour	28 days	28 days	1 hour	1 hour
Metals (mg/kg)						
Chromium	NA	NA	**592**	**619**	NA	NA
Iron	NA	NA	**29,300**	**30,600**	NA	NA
Magnesium	NA	NA	**128,000**	**133,000**	NA	NA
Manganese	NA	NA	**335**	**364**	NA	NA
Nickel	NA	NA	**1,360**	**1,370**	NA	NA
Soil Chemistry Parameters						
Cr(VI) by Alkaline Digestion (mg/kg)	**0.088**	**0.092**	**0.255**	**0.220**	**0.100**	**0.086**
Easily Reducible Manganese (mg/kg)	**109**	**101**	**94**	**109**	**96**	**94**
Quick Oxidation Test (mg/kg)	**1.34**	**1.31**	**0.24**	**0.24**	**1.60**	**1.73**
Percent Moisture (%)	**23.1**	**21.4**	**26.2**	**24.2**	**18.6**	**21.0**

TABLE G-4

SUMMARY OF ANALYTES IN LEACHED BEDROCK
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample ID:	UBR01T03S07A	UBR01T03S07B	UBR01T04S01A	UBR01T04S01B	UBR01T04S07A	UBR01T04S07B
Sample Date:	4/13/99	4/13/99	3/24/99	3/24/99	4/21/99	4/21/99
Sampling Interval:	28 days	28 days	1 hour	1 hour	28 days	28 days
Metals (mg/kg)						
Chromium	827	691	NA	NA	931	686
Iron	32,700	32,100	NA	NA	33,000	32,900
Magnesium	145,000	137,000	NA	NA	139,000	139,000
Manganese	377	359	NA	NA	402	383
Nickel	1,500	1,420	NA	NA	1,420	1,440
Soil Chemistry Parameters						
Cr(VI) by Alkaline Digestion (mg/kg)	0.162	0.148	0.788	1.032	0.315	0.312
Easily Reducible Manganese (mg/kg)	90	111	115	95	88	99
Quick Oxidation Test (mg/kg)	0.72	1.06	0.53	0.56	0.44	0.46
Percent Moisture (%)	24.6	28.6	20.2	20.8	21.9	21.2

TABLE G-4

SUMMARY OF ANALYTES IN LEACHED BEDROCK
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T05S01A	UBR01T05S01B	UBR01T05S07A	UBR01T05S07B	UBR01T06S01A	UBR01T06S01B
Sample Date:	3/24/99	3/24/99	4/21/99	4/21/99	3/24/99	3/24/99
Sampling Interval:	1 hour	1 hour	28 days	28 days	1 hour	1 hour
Metals (mg/kg)						
Chromium	NA	NA	**908**	**837**	NA	NA
Iron	NA	NA	**31,900**	**33,200**	NA	NA
Magnesium	NA	NA	**132,000**	**148,000**	NA	NA
Manganese	NA	NA	**23,700**	**8,420**	NA	NA
Nickel	NA	NA	**1,430**	**1,420**	NA	NA
Soil Chemistry Parameters						
Cr(VI) by Alkaline Digestion (mg/kg)	**0.163**	**0.151**	**0.173**	**0.114**	**18.15**	**9.615**
Easily Reducible Manganese (mg/kg)	**7,883**	**11,073**	**12,981**	**11,331**	**89**	**106**
Quick Oxidation Test (mg/kg)	**1.88**	**1.97**	**1.27**	**1.65**	**1.92**	**0.35**
Percent Moisture (%)	**18.6**	**23.0**	**21.2**	**21.2**	**21.3**	**19.7**

TABLE G-4

SUMMARY OF ANALYTES IN LEACHED BEDROCK
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Sample Location ID:	UBR01T06S07A	UBR01T06S07B
Sample Date:	4/21/99	4/21/99
Sampling Interval:	28 days	28 days
Metals (mg/kg)		
Chromium	965	909
Iron	28,600	32,600
Magnesium	131,000	144,000
Manganese	316	359
Nickel	1,370	1,480
Soil Chemistry Parameters		
Cr(VI) by Alkaline Digestion (mg/kg)	3.714	3.075
Easily Reducible Manganese (mg/kg)	66	72
Quick Oxidation Test (mg/kg)	0.12	0.09
Percent Moisture (%)	17.9	22.3

mg/kg - milligrams per kilogram

% - percent

TABLE G-5

SAMPLE IDENTIFICATION NOMENCLATURE
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

BEDROCK SAMPLE IDs

UBR01SB01	Composite of bedrock samples taken from bedrock core at location UBR01 at 36.5, 40, 44, and 47 feet below ground surface (bgs)
UBR02SB01	Composite of bedrock samples taken from bedrock core at location UBR02 at 22, 27.5, and 32 feet bgs
UBR03SB02	Composite of bedrock samples taken from bedrock core at location UBR03 at 68 and 71 feet bgs

GROUNDWATER SAMPLE IDs

UBR01GW01	groundwater monitoring well at site UBR01
UBR02GW01	deep groundwater monitoring well at site UBR02
UBR02GW02	shallow groundwater monitoring well at site UBR02
UBR03GW01	deep groundwater monitoring well at site UBR03
UBR03GW02	shallow groundwater monitoring well at site UBR03

LEACHATE SAMPLE IDs

Note: Sampling Intervals:	S01 = 1 hour	Test Conditions:	T01 = DI water only
	S02 = 24 hrs		T02 = Bedrock + Groundwater
	S03 = 7 days		T03 = Bedrock + DI water
	S04 = 14 days		T04 = Bedrock + DI water + H_2O_2
	S05 = 21 days		T05 = Bedrock + DI water + MnO_2
	S06 = 28 days		T06 = Bedrock + DI water + $CrCl_3$

Example of leachate sample IDs

UBR01T01S01A	UBR01 = Bedrock composite used , T01 = First test condition, S01 = First sampling interval
UBR01T01S01B	Duplicate of UBR01T01S01
UBR01T01S02A	UBR01 = Bedrock composite used, T01 = First test condition, S02 = Second sampling interval, etc.

TABLE G-6

DATA VALIDATION QUALIFIER SUMMARY
HEXAVALENT CHROMIUM IN SERPENTINITE BEDROCK AND GROUNDWATER IN UPLAND AREAS
PRESIDIO OF SAN FRANCISCO

Data Validation Qualifiers:

J - Qualified as estimated U - Qualified as not detected R - Qualified as rejected

Data Validation Comments:

1 Qualified due to detected concentration in associated method blank sample.
2 Qualified due to detected concentration in associated trip blank sample.
3 Qualified due to detected concentration in associated filter blank sample.
4 Qualified due to detected concentration in associated equipment rinsate blank sample.
5 Qualified as positively biased due to surrogate recoveries above the established acceptance limits.
6 Qualified as negatively biased due to surrogate recoveries below the established acceptance limits.
7 Qualified due to surrogate recoveries outside the established acceptance limits; bias cannot be determined.
8 Qualified as positively biased due to MS/MSD recoveries above the established acceptance limits.
9 Qualified as negatively biased due to MS/MSD recoveries below the established acceptance limits.
10 Qualified due to MS/MSD recoveries outside the established acceptance limits; bias cannot be determined.
11 Qualified as positively biased due to LCS recoveries above the established acceptance limits.
12 Qualified as negatively biased due to LCS recoveries below the established acceptance limits.
13 Qualified due to LCS recoveries outside the established acceptance limits; bias cannot be determined.
14 Qualified as positively biased due to calibration nonconformances.
15 Qualified as negatively biased due to calibration nonconformances.
16 Qualified due to calibration nonconformances; bias cannot be determined.
17 Qualified as negatively biased due to holding time nonconformances.
18 Qualified as negatively biased due to sample receipt nonconformances.
19 Qualified as positively biased due to sample receipt nonconformances.
20 Qualified due to sample receipt nonconformances; bias can not be determined.
21 Qualified as positively biased due to other criteria.
22 Qualified as negatively biased due to other criteria.
23 Qualified due to other criteria; bias cannot be determined.
24 Qualified due to detected concentration in associated source water sample.
25 Qualified due to chromatographic pattern of the sample does not match the calibration pattern.
26 Reported value determined by method of standard addition; bias cannot be determined.
27 Qualified as negatively biased due to post-digest spike recovery between 40% to 85%.
28 Estimated value; result is detected between the method detection limit (MDL) and the reporting limit.
29 Qualified due to holding times exceeded.
30 Qualified as estimated; compound is a common laboratory contaminant.
31 Reported value determined by GC/MS library search; compound is tentatively identified and quantitation is estimated.
32 Qualified data explained further in the report associated with the sampling event.
33 Qualified due to field duplicate RPD outside of established limits; bias cannot be determined.
34 Final purge readings are not representative of site conditions. The reported readings are taken from earlier purge log entries.
35 Questionable field parameter results; readings do not appear to be representative of site conditions.

APPENDIX E

COPIES OF JOHNSON AND ETTINGER MODEL FUNS FOR VOLATILE ORGANIC CHEMICALS

APPENDIX E

COPIES OF JOHNSON AND ETTINGER MODEL RUNS FOR VOLATILE ORGANIC CHEMICALS

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
78933		Methyl ethyl ketone

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
9.18E-02	9.40E-06	5.16E-05	25	7,862	352.75	529.13	3.16E+01	2.85E+05	0.0E+00	5.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R (µg/kg)**	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	8,775	4.00E-05	1.66E-03	1.78E-04	7.22E-03	0.00E+00	0.00E+00	7.22E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	**Finite source β term (unitless)**	**Finite source ψ term $(sec)^{-1}$**	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.90E-01	5.74E+00	0.10	6.74E+01	7.22E-03	3.84E+02	1.65E+158	NA	NA	9.99E+01	2.76E-05	5.70E+09	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(µg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.52E-04	NA	8.75E-04	8.75E-04	NA	5.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	5.96E+05	5.96E+05	8.26E+07	5.96E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
78933		Methyl ethyl ketone

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	5		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
9.18E-02	9.40E-06	5.16E-05	25	7,862	352.75	529.13	3.16E+01	2.85E+05	0.0E+00	5.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R** (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm·m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm·s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	8,775	4.00E-05	1.66E-03	1.78E-04	7.22E-03	0.00E+00	0.00E+00	7.22E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	**Finite source β term** (unitless)	**Finite source ψ term** $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.90E-01	5.74E+00	0.10	6.74E+01	7.22E-03	3.84E+02	1.65E+158	NA	NA	9.99E+01	2.76E-05	5.70E+09	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(µg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
6.43E-05	NA	3.69E-04	3.69E-04	NA	5.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.98E+06	1.98E+06	8.26E+07	1.98E+06

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75150		Carbon disulfide

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	4.57E+01	1.19E+03	0.0E+00	7.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R** (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,604	2.50E-02	1.04E+00	1.78E-04	8.11E-03	0.00E+00	0.00E+00	8.11E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, η (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	**Finite source β term** (unitless)	**Finite source ψ term** $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.74E-01	1.83E+03	0.10	6.74E+01	8.11E-03	3.84E+02	6.04E+140	NA	NA	1.12E+02	9.88E-03	1.65E+07	YES

Finite source indoor attenuation coefficient, <η> (unitless)	**Mass limit** bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(µg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	2.75E-03	NA	2.75E-03	NA	7.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	2.66E+05	2.66E+05	6.76E+05	2.66E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75150		Carbon disulfide

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_1 (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_1 (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
1.04E-01	1.00E-05	3.02E-02	25	6,391	319.00	552.00	4.57E+01	1.19E+03	0.0E+00	7.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,604	2.50E-02	1.04E+00	1.78E-04	8.11E-03	0.00E+00	0.00E+00	8.11E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
2.74E-01	1.83E+03	0.10	6.74E+01	8.11E-03	3.84E+02	6.04E+140	NA	NA	1.12E+02	9.88E-03	1.65E+07	YES

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	1.32E-03	NA	1.32E-03	NA	7.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	7.75E+05	7.75E+05	6.76E+05	6.76E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
106467		1,4-Dichlorobenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
6.90E-02	7.90E-06	2.43E-03	25	9,271	447.21	684.75	6.17E+02	7.38E+01	1.1E-05	8.0E-01	S

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	11,140	1.76E-03	7.33E-02	1.78E-04	5.38E-03	0.00E+00	0.00E+00	5.38E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
3.70E+00	1.92E+01	0.10	6.74E+01	5.38E-03	3.84E+02	1.42E+212	NA	NA	7.48E+01	6.89E-05	2.11E+09	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.95E-05	NA	1.72E-03	1.72E-03	1.1E-05	8.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS: INCREMENTAL RISK CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.29E+02	4.85E+05	1.29E+02	2.82E+05	1.29E+02	NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
106467		1,4-Dichlorobenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρb^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρb^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρb^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
6.90E-02	7.90E-06	2.43E-03	25	9,271	447.21	684.75	6.17E+02	7.38E+01	1.1E-05	8.0E-01	S

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R** (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	11,140	1.76E-03	7.33E-02	1.78E-04	5.38E-03	0.00E+00	0.00E+00	5.38E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	**Finite source β term** (unitless)	**Finite source ψ term** $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
3.70E+00	1.92E+01	0.10	6.74E+01	5.38E-03	3.84E+02	1.42E+212	NA	NA	7.48E+01	6.89E-05	2.11E+09	NO

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	**Mass limit bldg. conc., $C_{building}$** (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(µg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
3.85E-05	NA	7.39E-04	7.39E-04	1.1E-05	8.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
5.03E+02	1.58E+06	5.03E+02	2.82E+05	5.03E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
99876		Isopropyltoluene (p-Cymene)

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
6.01E-02	5.28E-06	9.30E-03	15	9,365	450.00	675.00	5.01E+03	2.80E+01	0.0E+00	8.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	11,434	1.31E-02	5.43E-01	1.78E-04	4.69E-03	0.00E+00	0.00E+00	4.69E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
3.01E+01	1.80E+01	0.10	6.74E+01	4.69E-03	3.84E+02	4.16E+243	NA	NA	6.52E+01	5.61E-05	2.52E+09	NO

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
8.70E-05	NA	1.56E-03	1.56E-03	NA	8.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	5.33E+05	5.33E+05	8.48E+05	5.33E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
99876		Isopropyltoluene (p-Cymene)

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm \cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
6.01E-02	5.28E-06	9.30E-03	15	9,365	450.00	675.00	5.01E+03	2.80E+01	0.0E+00	8.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\cdot m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	11,434	1.31E-02	5.43E-01	1.78E-04	4.69E-03	0.00E+00	0.00E+00	4.69E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m³)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
3.01E+01	1.80E+01	0.10	6.74E+01	4.69E-03	3.84E+02	4.16E+243	NA	NA	6.52E+01	5.61E-05	2.52E+09	NO

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m³)	Finite source bldg. conc., $C_{building}$ (µg/m³)	Final finite source bldg. conc., $C_{building}$ (µg/m³)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m³)
3.74E-05	NA	6.72E-04	6.72E-04	NA	8.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.73E+06	1.73E+06	8.48E+05	8.48E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75092		Methylene chloride

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm \cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
1.01E-01	1.17E-05	2.19E-03	25	6,706	313.00	510.00	1.17E+01	1.30E+04	4.7E-07	3.0E+00	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R** (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,927	1.79E-03	7.46E-02	1.78E-04	7.88E-03	0.00E+00	0.00E+00	7.88E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	**Finite source β term** (unitless)	**Finite source ψ term** $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
7.02E-02	4.05E+02	0.10	6.74E+01	7.88E-03	3.84E+02	8.64E+144	NA	NA	1.09E+02	2.13E-03	7.60E+07	YES

Finite source indoor attenuation coefficient, <α> (unitless)	**Mass limit bldg. conc., $C_{building}$** (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	2.75E-03	NA	2.75E-03	4.7E-07	3.0E+00

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS: INCREMENTAL RISK CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.88E+03	1.14E+06	1.88E+03	2.39E+06	1.88E+03	NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75092		Methylene chloride

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm \cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
1.01E-01	1.17E-05	2.19E-03	25	6,706	313.00	510.00	1.17E+01	1.30E+04	4.7E-07	3.0E+00	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,927	1.79E-03	7.46E-02	1.78E-04	7.88E-03	0.00E+00	0.00E+00	7.88E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
7.02E-02	4.05E+02	0.10	6.74E+01	7.88E-03	3.84E+02	8.64E+144	NA	NA	1.09E+02	2.13E-03	7.60E+07	YES

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	1.32E-03	NA	1.32E-03	4.7E-07	3.0E+00

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
6.59E+03	3.32E+06	6.59E+03	2.39E+06	6.59E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box) — SL-ADV Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
120821		1,2,4-Trichlorobenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm·s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
3.00E-02	8.23E-06	1.42E-03	25	10,471	486.15	725.00	1.78E+03	3.00E+02	0.0E+00	2.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm \cdot m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	13,115	9.73E-04	4.05E-02	1.78E-04	2.34E-03	0.00E+00	0.00E+00	2.34E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m³)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.07E+01	3.75E+00	0.10	6.74E+01	2.34E-03	3.84E+02	#NUM!	NA	NA	3.31E+01	5.86E-06	2.15E+10	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m³)	Finite source bldg. conc., $C_{building}$ (µg/m³)	Final finite source bldg. conc., $C_{building}$ (µg/m³)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.20E-04	NA	4.52E-04	4.52E-04	NA	2.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	4.62E+05	4.62E+05	3.24E+06	4.62E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
120821		1,2,4-Trichlorobenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm·s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
3.00E-02	8.23E-06	1.42E-03	25	10,471	486.15	725.00	1.78E+03	3.00E+02	0.0E+00	2.0E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm·m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm·s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	13,115	9.73E-04	4.05E-02	1.78E-04	2.34E-03	0.00E+00	0.00E+00	2.34E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
1.07E+01	3.75E+00	0.10	6.74E+01	2.34E-03	3.84E+02	#NUM!	NA	NA	3.31E+01	5.86E-06	2.15E+10	NO

Finite source indoor attenuation coefficient, <α> (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
5.13E-05	NA	1.92E-04	1.92E-04	NA	2.0E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final Indoor exposure soil conc., (µg/kg)
NA	1.52E+06	1.52E+06	3.24E+06	1.52E+06

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75694		Trichlorofluoromethane

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm \cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	2

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based soil concentration.	

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
8.62E-02	9.30E-06	8.21E-02	25	6,805	296.78	445.17	1.46E+02	1.24E+03	0.0E+00	1.1E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
9.46E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	2.50E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,867	6.74E-02	2.80E+00	1.78E-04	6.73E-03	0.00E+00	0.00E+00	6.73E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
8.77E-01	1.87E+03	0.10	6.74E+01	6.73E-03	3.84E+02	5.78E+169	NA	NA	9.32E+01	8.37E-03	1.84E+07	YES

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m^3)	Finite source bldg. conc., $C_{building}$ (µg/m^3)	Final finite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	2.75E-03	NA	2.75E-03	NA	1.1E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	3.98E+04	3.98E+04	1.86E+06	3.98E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75694		Trichlorofluoromethane

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
20	15	15	485	15	0	0	S		

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.15	0.006								

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm·s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	961	961	488	0.1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
8.62E-02	9.30E-06	8.21E-02	25	6,805	296.78	445.17	1.46E+02	1.24E+03	0.0E+00	1.1E-01	L

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R (µg/kg)**	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.280	ERROR	ERROR	0.257	1.01E-07	0.703	7.10E-08	3,844	1.00E+00	6.26E+05

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm \cdot m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
9.24E+05	4.16E-04	15	6,867	6.74E-02	2.80E+00	1.78E-04	6.73E-03	0.00E+00	0.00E+00	6.73E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (µg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe') (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m³)	**Finite source β term (unitless)**	**Finite source ψ term $(sec)^{-1}$**	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
8.77E-01	1.87E+03	0.10	6.74E+01	6.73E-03	3.84E+02	5.78E+169	NA	NA	9.32E+01	8.37E-03	1.84E+07	YES

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ (µg/m³)	Finite source bldg. conc., $C_{building}$ (µg/m³)	Final finite source bldg. conc., $C_{building}$ (µg/m³)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m³)
NA	1.32E-03	NA	1.32E-03	NA	1.1E-01

END

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.16E+05	1.16E+05	1.86E+06	1.16E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

APPENDIX F

RESPONSES TO COMMENT LETTERS FROM THE DTSC AND RWQCB

APPENDIX F

RESPONSES TO COMMENT LETTERS FROM THE DTSC AND RWQCB

October 2002

30 October 2002

James D. Ponton, R.G.
Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, California 94612

Subject: Response to RWQCB Comments on *Draft Development of Presidio-wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water*
Presidio of San Francisco, California
Regional Water Quality Control Board Letter, dated 22 January 2002

Dear Mr. Ponton:

The Presidio Trust ("Trust") has received draft comments by the Regional Water Quality Control Board ("RWQCB"), in a letter dated 22 January 2002, regarding the document entitled *Draft Development of Presidio-wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water*, Presidio of San Francisco, California and dated August 2001. The RWQCB comments have been reproduced in *italics* in this letter.

Comment No. 1 – Table 3-1, reference to Note (l)

Note (l) refers back to Tables 1 through 5 of RWQCB Order No. 96-070, Site Cleanup Requirements of Petroleum Impacted Soils, U.S. Army, Presidio of San Francisco, dated October 1995 (the Order). Regional Board staff have reviewed the Tables 1 through Table 5 of the Order and do not see soil cleanup levels for motor oil as is shown throughout Table 3-1.

Please fix Table 3-1 so that it accurately reflects the petroleum cleanup numbers for soil presented in the Order. It is Regional Board staff's understanding that soil cleanup numbers presented in the Order are for gasoline, diesel and fuel oil range hydrocarbons.

The Trust has revised all tables in this document to reflect the fact that fuel oil, rather than motor oil, is the regulated compound in the RWQCB's Order 96-070. The listing of Site Cleanup Requirements of Petroleum Impacted Soils in former Table 3–1 have been moved to a new Table 3-3 (note b) and the references to motor oil have been changed to fuel oil.

Comment No. 2 – Table 3-1, reference to Note (m)

Note (m) refers back to Table E-12 of the Final Fuel Product Action Level Development Report (FPALDR), Presidio of San Francisco, California, dated October 1995.

Table E-12 presents water quality goals for total petroleum hydrocarbons (TPH) qualified as gasoline, diesel, fuel oil and other specific chemicals. There is no mention of TPH as motor oil as shown on Table 3-1.

Please fix Table 3-1 so that it accurately reflects the water quality goals for hydrocarbons presented in the FPALDR. It is Regional Board staff's understanding that the water quality goals presented in the FPALDR are for gasoline, diesel and fuel oil range hydrocarbons.

As mentioned in response to comment 1, the Trust has revised all tables in this document to reflect the fact that fuel oil, rather than motor oil, is the referenced compound in the FPALDR. The values in new Table 3-3 (note d) have been corrected.

Comment No. 3 – Table 3-1, Note (n)

Note (n) refers back to Table 16 of the Petroleum Hydrocarbon Bioassay and Point-of-Compliance Concentration Determinations, Saltwater Ecological Protection Zone, Presidio of San Francisco, California, dated December 1997. Table 16 presents a summary of the point of compliance concentrations in soil and water for petroleum hydrocarbons, BTEX and MTBE for saltwater ecological protection zone.

Although Table 3-1 lists numeric cleanup values for TPH as diesel, gasoline and motor oil, the point of compliance values on Table 16 list only TPH as gasoline and fuel oil. Furthermore, Table 3-1 does not list MTBE as is shown on Table 16. Please fix Table 3-1 so that it accurately reflects the saltwater ecological protection values presented on Table 16.

Table 3-3 has been revised to accurately reflect the saltwater ecological protection values presented in Table 16 of the *Petroleum Hydrocarbon Bioassay and Point-of-Compliance Concentration Determinations* document. The changes include the values for gasoline, fuel oil, and MTBE. New note (e) reflects the source of these changes.

Verbal Comment

Cleanup levels for volatile organic compounds ("VOCs") should consider the protection of groundwater resources through the leaching pathway.

The soil cleanup levels for VOCs have been modified to reflect the more stringent value based on the protection of human health (through direct contact and volatilization to indoor air pathways) or protection of groundwater resources (leaching to groundwater), as described in Sections 4.2.7 and 4.2.9. The soil cleanup levels for protection of groundwater were obtained from the RWQCB Risk-Based Screening Levels ("RBSLs")

guidance document (December 2001). If a compound was not listed in the RBSL document, then values were calculated using the same assumptions as the compounds included in the guidance document. These values are presented in new Table 4-7 of the revised Cleanup Level Document.

Recognizing that the groundwater protection RBSLs are not site-specific, the text states that if VOCs are found at a Presidio site, VOC cleanup levels may be re-calculated to be site-specific. Factors that could affect a site-specific calculation include the type of soil, depth to groundwater, among others. Any recalculation of cleanup levels for VOCs would be conducted in conjunction with discussions with regulatory agencies.

We trust these revisions address your concerns. If you have any questions, please do not hesitate to call.

Very truly yours,

Craig Cooper

Craig Cooper
THE PRESIDIO TRUST

cc: Brian Ullensvang, P.E., NPS
Robert Boggs, Jr., P.E.
Doug Kern, Presidio RAB
Mark Youngkin, Presidio RAB
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30 October 2002

THE PRESIDIO TRUST

Mr. Robert Boggs, Jr., P.E.
Department of Toxic Substances Control
700 Heinz, Building F, Suite 200
Berkeley, California 94710-2721

Subject: Response to Comments re: Draft Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water
Department of Toxic Substances Control Letters, dated 9 November 2001

Dear Mr. Boggs:

The Presidio Trust ("Trust") has reviewed comments by the Department of Toxic Substances Control ("DTSC"), dated 9 November 2001, regarding the document, entitled *Draft Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water* and dated August 2001. The comments consisted of three separate documents: (1) The 9 November 2001 transmittal letter to Sharron Reackhof of the Trust from Robert Boggs; (2) a 26 October 2001 memorandum from James M. Polisini, Ph.D., Human and Ecological Risk Division ("HERD") to Robert Boggs regarding ecological issues; and (3) a 26 October 2001 memorandum from Kimiko Klein, Ph.D., HERD, to Robert Boggs regarding human health issues.

On 12 December 2001, the Trust hosted a meeting and teleconference that included the authors of the comment letters from DTSC, and representatives of the Trust, the National Park Service ("NPS"), Harding ESE, and Erler & Kalinowski, Inc. ("EKI"). Many of the comments were discussed in the course of the meeting. However, several additional meetings and telephone conversations were held to discuss the cleanup levels, including a 4 March 2002 meeting at DTSC's Berkeley office. Through these follow-up meetings and discussions, the Trust and DTSC reached agreements regarding cleanup levels. Although many of the issues presented in this letter have been resolved verbally and through changes in the document, this letter provides responses to address specific DTSC comments, which are printed in italics.

Comments from Mr. Robert Bogg's 9 November 2001 Transmittal Letter

DTSC has concerns regarding the calculation of background metals concentrations. DTSC has been unable to duplicate EKI's calculation for the Serpentinite lithology. In addition, one of our risk assessors has pointed out that some of the "site" data used to calculate background metals concentrations may not be appropriate for use in the calculations.

EKI recalculated the background metals concentrations based on the data set provided in Table C-1 of Appendix C. EKI arrives at the same concentrations presented in Table 6-1. EKI's calculations were performed using MINITAB Version 12, with the program Probability Plot. A lognormal distribution was assumed, as agreed in previous meetings. Based on our telephone discussion on 14 January 2002, we identified the discrepancy between the Trust's and DTSC's calculations, and no changes are proposed for Table 6-1 or the tables in Appendix C.

The site data set was agreed to in a series of 6 meetings and 4 conference calls in the winter and spring of 2001 between the Trust and the DTSC Remediation Project Manager ("RPM"). The Trust understood that the RPM was receiving feedback from appropriate personnel within DTSC regarding the background metals concentrations discussions and analyses.

Comments from Dr. James M. Polisini's Memorandum Dated 26 October 2001

General Comment

Some of the risk-based Ecological Preliminary Remediation Goals ("PRGs") are extremely high. The methodology for evaluation of potential action should include some comparison of a 'background' concentration to the risk-based PRG. For example, if the soil concentration is less than a risk-based concentration, but exceeds the 'background' concentration by some factor (e.g., 2 or 5), then the evaluation area should be more carefully assessed.

Dr. Polisini has commented that some of the Ecological Preliminary Remediation Goals ("PRGs") are extremely high and that the methodology for potential action should include a comparison to background concentrations, or some factor greater than background to determine if additional assessment is required. As discussed in Section 6.2.3 of the Cleanup Level Document, the Trust has developed metals "screening" levels and metals "threshold" levels, as requested by DTSC. All metals data are initially screened against the "screening levels" to identify potential chemicals of concern ("PCOCs"). The PCOC data set is then qualitatively evaluated to determine if a release has potentially occurred, or if we may be at the edge of a release, etc. The next level of screening is for chemicals of concern ("COCs"), which is accomplished by screening against the site-specific cleanup levels that may be based on the background threshold levels, as discussed in the Cleanup Level Document (Section 7). The two-step screening process is intended to identify sites that may require potential action (e.g., additional investigation to better characterize a site), even if the concentrations are less than the site-specific cleanup levels.

Specific Comments

1. *The federal Ambient Water Quality Criterion (AWQC) value for water with salinity less than 5 parts per thousand (Table 3-1) are adjusted for a calcium carbonate concentration of 100 mg/l. Please provide the actual water hardness as calcium carbonate equivalents of the Presidio water surface waters evaluated in this report. Hardness for each particular water source should be used rather than a default value.*

   The Trust reviewed available hardness data, and found that the use of 100 mg/L results in conservative water quality criteria. Hardness concentrations at the Presidio have ranged from 93 to 772 mg/L, with an average of 325 mg/L. A footnote has been added to the table to clarify this point.

2. *HERD does not agree that potential habitat damage due to extensive remedial efforts is an appropriate criterion for selecting the ecological risk level used to develop Ecological RAOs (ERAOs) (Section 5.1, page 5-1 and Section 5.4, page 5-6). Consideration of the potential negative ecological impact of any remedial action is a risk management function, not a risk assessment function. HERD has advised DTSC Risk Managers regarding the potential negative ecological impacts associated with proposed remedial actions at Department of Defense (DoD) sites in California and has sometimes recommended no remedial action.*

   The Trust agrees with DTSC that the negative ecological impacts of implementing a remedial action should be considered as part of risk management. The Ecological PRGs were not adjusted in any way to protect against habitat damage during remediation. Rather, these statements were made in the text to indicate that ultimately habitat damage should be considered in the process (i.e., referenced statement on p. 5-1). The similar statement in Section 5.4 (p. 5-7) has been deleted because it could be interpreted to mean that the Ecological PRGs were somehow modified to reflect potential habitat damage.

3. *We understand the logical argument being made by the Presidio Trust, that protection of populations is the assessment endpoint for species and communities which are not Rare, Threatened or Endangered (RTE) or California Species of Special Concern (CSSC) (Section 5.1, page 5-2). However, no justification for the specific uncertainty factors are supplied, nor have any site-specific studies been proposed or reported and conducted, which document the steady-state population levels of any non-protected, RTE, or CSSC at the Presidio of San Francisco. Please see the subsequent comments regarding the uncertainty factors applied for terrestrial vertebrate species.*

Uncertainty factors used by the Army were carried through to the cleanup level development process. The Army applied uncertainty factors to the Low Toxicity Benchmark Value ("TBV_{low}") only, as agreed to in discussions with the regulatory agencies. An additional factor of 10 was added by the Trust to convert from a LD50 to a No Observed Adverse Effects Level ("NOAEL") (see Response to Comment 5). In assessing RTE species, TBVs were further evaluated (see Sections 5.8.2 and 5.9.2 of the text). A table that describes the uncertainty factors is presented below. This table and the accompanying text have been added to Section 5.5.2 of the document.

Insert for Section 5.5.2, 2nd paragraph, following sentence 4: "Uncertainty factors ("UFs") developed by the Army are shown in the table below. UFs were used to convert all toxicity endpoints to chronic NOAELs based on sensitive endpoints (e.g., growth, reproduction, development)."

Insert for Section 5.5.2, following 2nd paragraph:

"Uncertainty Factors Used in the Calculation of TBV_{low} values (a)

Type of UF	UF	Comments
Study Duration	5	Converts acute to chronic
	2	Converts subchronic to chronic
Endpoint	2	Converts from less to more sensitive endpoint
	5	Converts LOAEL to NOAEL
	10	Converts LD50 to NOAEL (Army)
	10	Additional factor 10 for mortality endpoints (LD50s) was applied to <u>both</u> the TBV_{low} and TBV_{high} by the Trust
Intertaxon	3	Converts between species in same family, different genus
	4	Converts between species in same order, different families
	5	Converts between species in different orders
	10	Converts between species in different orders with an additional factor of 2 for special-status species (raptors)

(a) Uncertainty factors were those developed by the Army, except where noted.

4. *HERD agrees that '...complete or potentially complete exposure pathways should be evaluated quantitatively.' (Section 5.3, page 5-5). We agree that dermal exposure should be evaluated (Section 5.3.1, page 5-6) for terrestrial receptors. Dermal uptake of pesticides has been shown to be significant for raptors in certain exposure scenarios and should be considered for inclusion on a site by site basis.*

   As indicated in Section 5.3.1 and 5.3.2, the dermal contact pathway was included in the development of the ecological PRGs.

5. *HERD will require additional time to evaluate the Toxicity Based Value-High (TBV_{high}) values proposed by the Presidio Trust as cleanup concentrations. Toxicity experiments which reflect a lethal dose for 50 percent of the animals exposed (LD_{50}) are unacceptable to HERD without incorporation of uncertainty factors for definition of areas of ecological concern. For Contaminants of Concern (COCs) where the Biological Technical Assistance Group (BTAG) / Navy Toxicity Reference Values (TRVs) are used, the description of the level of concern is incorrect (Section 5.5, page 5-7). BTAG/NAVY TRV_{high} values are meant to indicate an [sic] dose which would be a high level of concern to regulatory agencies and natural resource trustees.*

   Dr. Polisini was contacted by email several times to request an estimate of when the HERD evaluation will be completed. Given the extent of discussions throughout the winter and spring of 2002 regarding ecological cleanup levels, which culminated in an agreement on the values as presented in Tables 5-24 and 7-2 of the revised Cleanup Level Document, the Trust assumes that no further review of the TBVs is warranted.

   Uncertainty factors used by the Army included a factor of 10 to convert from a LD50 to a NOAEL (see Response to Comment 3). An additional factor of 10 was added by the Trust (see Section 5.5.2 of the text). The Trust added this factor to both the TBV_{low} and TBV_{high}. The text in Section 5.5 that describes the level of concern associated with the TBV_{high} will be revised as follows:

   "According to the Army, the TBV_{high} was developed to represent the upper bound of 'acceptable or safe daily intakes'. Where BTAG high toxicity values (PRC, 1997) were used, the TBV_{high} is considered a level of high concern to regulatory agencies and natural resource trustees."

6. *Please provide the reference for use of an uncertainty factor (UF) of 10 for TBVs based on mortality (Section 5.5.2, page 5-9) to convert the TBV to a Lowest Observable Adverse Effect Level (LOAEL). HERD would normally require a UF*

greater than 10 for adjustment of mortality endpoints unless chemical-specific information is available regarding the dose-response curve.

See Responses to Comments 3 and 5. An additional factor of 10 was added for mortality endpoints (Section 5.5.2), making the total UF 100 for the TBV_{low} and 10 for the TBV_{high}.

7. *Please provide the source of the information used to set the dietary intake factors (Section 5.7.1, page 5-13) for terrestrial vertebrate receptors. If the dietary intake factor is meant to indicate the most conservative assumption, based on best scientific judgement, please indicate that in the text.*

Dietary intake factors developed by the Army were used. These values were 95th percentiles of data presented by USEPA (1993), as indicated in Section 5.7 (first bullet).

8. *Please provide the citations and scientific support for assuming the Bioaccumulation Factor (BAF) of 2 for invertebrates, 1 for birds, 0.5 omnivorous mammals and 0.1 for herbivorous mammals (Section 5.7.2, page 5-14) for pesticide and herbicide COCs without published BAFs.*

Not all chemicals evaluated had BAF values readily available from the literature. For these chemicals, the approach was to assign default BAF values for these chemicals, rather than not evaluating the food chain pathways and documenting uncertainties. Chemicals without BAFs included the following pesticides/herbicides: alpha-, beta-, delta-, and gamma-BHC, dicamba, endosulfan, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, MCPP, and methoxychlor. To set default values, the median of the available BAFs for pesticides/herbicides was calculated and a default value set based on the results of that calculation as shown in the table below. This table has been added to the footnotes of Table 5-11.

Calculation of BAFs for chemicals without literature based BAFs

Potential Chemical of Concern	Bioaccumulation Factor (unitless)				
		Soil		Mammal	
	Plant	Invertebrate	Bird	Omnivore	Herbivore
Pesticides/herbicides with BAFs					
Dieldrin	0.03	4.29	0.477	0.02	0.02
Chlordane	0.02	5	0.352	0.04	0.04
4,4'-DDT	0.01	1.98	0.905	0.45	0.45
Heptachlor	0.086	1.67	2.25	0.11	0.11
Statistics					
Range	0.01-0.09	1.67-5	0.35-2.25	0.02-0.45	0.02-0.45
Median	0.025	3.135	0.691	0.075	0.075
Assumed BAFs (for chemicals with no literature BAF)	**0 (a)**	**3 (b)**	**1 (c)**	**0.5 (d)**	**0.1 (e)**

(a) Assumed to be 0 based on BAFs for other pesticides all below 0.1.
(b) Assumed to be 3 based on median BAF for other pesticides of 3.1.
(c) Assumed to be 1 based on median BAF for other pesticides of 0.7.
(d) Assumed to be 0.5 based on median BAF for other pesticides of 0.075 and conservative assumption that omnivores should have a higher BAF.
(e) Assumed to be 0.1 based on median BAF for other pesticides of 0.075.

As a result of re-evaluation of these values, the soil invertebrate BAF has been revised from 2 to 3. This change is reflected in the cleanup level derivation tables.

9. *Using the arithmetic mean of the Ecological Preliminary Remediation Goal-Low (PRG_{low}) and the PRG_{high} (Section 5.8.1, page 5-14) for non-RTE species would seem to eliminate information which would be useful to the risk manager. At several Department of Defense (DoD) sites in the San Francisco area, the difference in area considered for remedial action was small when areas based on the PRG_{low} were compared to areas based on the PRG_{high}. The areas identified as areas of concern based on both the PRG_{low} and the PRG_{high} should be presented for evaluation by the risk managers.*

The Trust recognizes the DTSC's rationale for recommending a site-by-site assessment of the PRG_{low} and PRG_{high} as part of the decision making process. To assist in the risk manager's assessment, the Trust has prepared a new Table 7-2 that includes PRG_{low}, PRG_{high}, and PRG_{mean} for both plant and soil fauna and wildlife receptors. This table shows the proposed buffer zone PRGs and proposed special status species PRGs, as well as human health proposed PRGs and background metals concentrations. The Trust feels the risk manager has the necessary data to evaluate cleanup level selection with this table.

In further discussions with the DTSC, the Trust agreed to significantly modify the ecological PRGs originally presented in the Cleanup Level Document, as described in new Section 5.10 of the revised Cleanup Level Document. The modified values are presented in Tables 5-24 and 7-2 and are described below:

- The areas of the Presidio where non-special status species PRGs would be applied were renamed "buffer zone" areas because these areas are generally adjacent to special status species areas and developed areas of the Presidio where ecological PRGs are not applicable (see Section 7.1.2 and Figure 7-2). Proposed soil PRGs for these buffer zone areas were redefined as the lowest value of (1) the special status species PRG identified in Table 5-21, (2) the arithmetic mean of the PRG_{low} and PRG_{high} for plant and soil fauna, (3) the arithmetic mean of the PRG_{low} and PRG_{high} wildlife PRGs, or (4) 5 mg/kg for pesticides or herbicides for which not enough toxicological data exists to calculate a PRG_{low} and PRG_{high} (i.e., 2,4-D, Dicamba, and MCPP).

- Special status species PRGs were redefined as the lower value of (1) the PRG_{low} for plant and soil fauna or (2) the PRG_{low} for wildlife, unless the PRG_{low} is less than the laboratory method detection limit. In such cases, the method detection limit was established as the special status species PRG. If no PRG could be calculated for pesticides or herbicides due to a lack of toxicological data (i.e., 2,4-D, Dicamba, and MCPP), the special status species PRG was established as the method detection limit. For mercury, the special status species PRG was established as two times the typical method detection limit.

10. *The table listing the uncertainty factors (UFs) applied in development of the TBV_{low} and TBV_{high} for vertebrate receptors (Table 5-4) refers to Table 5-9 as the source of the varying uncertainty factors used in footnote a. Table 5-9 provides the formulae for calculation of the PRG, but does not outline the strategy for using differing UFs. The UFs appear to follow a taxonomic pattern. Please provide this information regarding the UFs.*

Footnote (a) has been revised as follows: "Toxicity values are obtained from studies described in Table 5-3; uncertainty factors are discussed in Section 5.5."

11. *The TBV_{low} and TBV_{high} do not appear to follow a similar pattern across the differing taxonomic groups of representative species (Tables 5-5 and 5-6). The TBV_{low} for arsenic, as an example, for the western harvest mouse is 1.27 mg/kg-day and for the valley pocket gopher is 0.95 mg/kg-day. This difference can be arithmetically tracked back to the differing UFs (Table 5-4). The TBV_{high} for these two species is 22.5 mg/kg-day (Table 5-6) respectively. It is difficult to believe that a varying UF is appropriate for the TBV_{low} but not for the TBV_{high}.*

As discussed in Response to Comment 3, the Army applied uncertainty factors to the TBV_{low} only, as agreed to in discussions with the regulatory agencies. The following footnotes have been added to Tables 5-5 and 5-6:

Table 5-5: "Low toxicity values incorporate uncertainty factors, as discussed in Section 5.5."
Table 5-6: "With the exception of the factor of 10 used for toxicity values based on mortality endpoints, high toxicity values do not incorporate the use of uncertainty factors (see Section 5.5)."

12. *The tables comparing the Preliminary Remediation Goals (PRGs) for non-special status species and special status species are somewhat confusing (e.g., Table 5-21). Footnote 'c', which refers to the column labeled 'Special Status PRGS Proposed for Use as Cleanup Levels', states that Non-special status species can be more sensitive to some of the potential chemicals of concern ("PCOCs") evaluated. For PCOCs where special status PRGs are not proposed as cleanup levels, soil PRGs for non-special status species will be applied as cleanup levels for protection of special status species as well." First, HERD does not agree that special status species can be categorized as less sensitive than non-special status species. Toxicological tests are not performed and special status species because of their listing, and therefore an apparent difference in PRGs may be an illusion based on the life history parameters. Second, use of a non-special species PRG as protective of special status species would be appropriate only if it is demonstrated that the range of seed dispersal for plants and the home range for vertebrates could not overlap from the current distribution of special status species onto the area where non-special species PRGs are proposed.*

For some chemicals, non-special status PRGs were lower than those for special status species. For example, for many chemicals, aquatic life toxicity values for sediment (Tables 5-7 and 5-8) were below the sediment PRGs for western sandpiper presented

in Table 5-20. In these cases, the final PRGs were the aquatic life values and not the higher western sandpiper values.

Footnotes [(c) on Table 5-21 and (b) on Tables 5-22 and 5-23] have been revised to clarify as follows: "PRGs for special status species that are proposed as soil/sediment PRGs for special status species. Receptors that are not special status species may have lower PRGs because of higher exposure or different sensitivity to potential chemicals of concern ("PCOCs"). For PCOCs where special status PRGs are not the lowest PRGs, soil/sediment PRGs for non-special status species will be applied as cleanup levels and considered protective of special status species as well."

The text in Section 5.8.2 has also been modified (5th paragraph 4th sentence) as follows: "Non-special status PRGs may be lower for some of the PCOCs evaluated because (1) the non-special status species evaluated may have higher exposure to chemicals than the special status species (e.g., American robin vs. peregrine falcon), or (2) the toxicity value for a non-special status species for a particular chemical is lower (e.g., mammal vs. bird toxicity values)."

The comment also discusses the issue of seed dispersal and the home range of special status species. The concern is the application of non-special status PRGs to sites and whether special status plants or wildlife, although not currently present at the site, be exposed to chemicals there in the future due to seed dispersal or expansion of their home range. It should be noted that most areas surrounding specific sites are not contaminated areas (see new Figure 2-2). Therefore, there is already a "buffer zone" of clean material around most, if not all sites. In addition, Figure 7-2 has been revised to depict areas where special status cleanup levels will be applied. As shown on Figure 7-2, special status species PRGs are applicable to the "undeveloped" areas of the Presidio and areas *planned* for habitat restoration (e.g., near the Baker Beach Apartments). Landscaped areas like the golf course, the cemetery, and the restored airfield at Crissy Field have been established as "buffer zone" ecological areas (Figure 7-2). These delineations on the map coupled with the revised, more stringent cleanup levels (the "buffer zone" PRGs are based on the old special status values) should address the issue of potential seed dispersion and expanded home ranges.

13. *Please indicate whether the figure presenting the surface distribution of the primary soil types of serpentinite, Colma Formation, and beach/dune (Section 6.1, page 6-1), and the five secondary geological units (Figure 6-1) has been 'ground truthed'. By this we mean, have the proposed boundaries between different soil types been checked to determine if the field observations by a registered geologist agree with the figure.*

The boundaries of the map have not been specifically ground-truthed. However, when environmental samples are collected at a Presidio site, the soil lithology is logged under the oversight of a registered geologist. The soil type at a given site may vary spatially, as a function of depth, or due the presence of fill. Figure 6-1 is intended to be used as a starting point to identify the site lithology. The actual field observations are used to determine site lithology. The text has been modified to this effect.

14. *Please identify the Department of Toxic Substance Control (DTSC) document in which it was agreed that selected site data could be included in the 'background' data set (Section 6.2.2, page 6-5) and agreement to the 'background' threshold levels (Section 6.2.4, page 6-7). This reviewer is unable to locate any member of HERD who reviewed the methodology or data used to set the 'background' concentrations.*

The Trust held a series of meetings (6 meetings, 4 conference calls) with the DTSC RPM (Robert Boggs), the RWQCB RPM, a representative of the NPS, and members of the Restoration Advisory Board ("RAB") to identify which site data were appropriate and to develop the methodology for calculating background screening and threshold levels. It was the Trust's understanding that the DTSC RPM was conferring with technical staff at HERD throughout this process. The agreement on the data set and the screening and threshold levels was made verbally during these meetings, after the DTSC had the opportunity to review all data, relevant scatter plots, and tables with results of calculations.

15. *A footnote annotation of '2' appears in the text with no footnote (Section 6.2.3, page 6-6) on the third line of the page. Please include the appropriate footnote referring the 95 percent upper confidence level of the 80th percentile of the data set used for screening levels.*

The footnotes have been renumbered to accurately reflect the item to which they refer.

16. *Please define the term 'common detection limit' as one method of establishing the 'background' threshold levels by soil type (Section 6.2.5, page 6-8).*

The "common detection limit" is the reporting limit typically achieved by analytical laboratories that have analyzed soil samples at the Presidio. During the series of meetings discussed in the response to Comment 14, the Trust, DTSC, and other stakeholders agreed on the "common detection limit" for metals that were generally

not detected above the laboratory reporting limit. A footnote has been added to the text clarifying the meaning of the common detection limit.

17. *The declaration that hexavalent chromium is 'naturally occurring' in groundwater and surface water at the Presidio of San Francisco (Section 6.4, pages 6-9 through 6-12) due to serpentinite soils is unconvincing. This mechanism has not been proposed to explain hexavalent chromium at DoD sites in the San Francisco Bay area. HERD defers to the DTSC Geological Services Unit regarding this explanation for hexavalent chromium in groundwater and surface waters.*

The discussion on the natural occurrence of hexavalent chromium in groundwater is intended to be a summary of available Presidio data that support this hypothesis. These data were presented to Mark Vest and Michael Kenning of DTSC's Geological Services Unit in a May 2000 meeting. Based on the data presented to the DTSC in May 2000 (which are summarized in Section 6.4 of the Cleanup Level Document), the DTSC sent the Trust a letter (dated 13 July 2000) concurring that the hexavalent chromium in groundwater that contacts serpentinite appears to be naturally occurring.

18. *The detection limit of 3.0 mg/kg for antimony (Table 6-1), which is adopted as the screening level and threshold level concentration, appears elevated. In comparison the most recent 'background' soil study, performed for the BRAC Property at Hamilton Army Airfield, lists a minimum detected value of 0.06 mg/kg (Table 6-6) and the California Soils study (Bradford, et al., 1996) achieved detected concentrations of antimony at 0.15 mg/kg. Please explain the reason for the apparently elevated antimony detection limits at the Presidio of San Francisco.*

The actual detection limits for antimony from the Hamilton Field data range from 0.06 to 19.6 mg/kg. EKI contacted Dr. Carla Kagel of KPrime Inc., a consulting and analytical laboratory in Santa Rosa, who indicated that a low detection limit of 0.06 mg/kg for antimony probably reflected a calculation error or could not be supported if the backup data were requested.

The Trust understands that a detection limit of less than 1 mg/kg is not routinely achievable. Under specialized conditions in a research setting, i.e., the conditions under which Bradford generated his California Soils data using ICP-MS, a detection limit of 0.15 mg/kg is likely the best detection limit achievable. For standard, commercial laboratory analyses, these low detection limits are not commonly achieved. This is reflected in the fact that a range of detection limits was produced for the existing data. A detection limit of 3 mg/kg was selected as typically achievable for antimony with the concurrence of representatives from the DTSC, RWQCB, NPS, and RAB.

19. *A bicoordinate plot of barium and manganese concentrations is offered as an example of the data evaluation methods employed to set the 'background' soil concentrations for the differing major and secondary soil types (Figure 6-2). The outlier value for barium and manganese is fairly obvious. However, all of the 'background' samples appear to lie at the lower concentrations of the proposed relationship, while the site-related samples cover the entire range and no 'background' barium or manganese concentrations appear to exceed 20 mg/kg for barium and 300 mg/kg for manganese. Please explain the apparent discrepancy between site-related and 'background' data for whichever soil type of which this is an example.*

    Based on the discussions during the 12 December 2001 teleconference, the Trust understands that DTSC is concerned that this Figure 6-2 does not support the argument the text is trying to make about outliers from the trend. Another figure that more clearly demonstrates outliers has been substituted in its place.

20. *Future land use which is not evaluated based on the residential use scenario (Section 7.1.1, page 7-1) must have a deed restriction in place restricting that area to recreational, institutional or industrial uses.*

    The Trust agrees that residential use is not appropriate for sites that are evaluated and/or remediated based on recreational or commercial/industrial cleanup levels. The Trust anticipates implementing institutional controls at locations where residual chemical concentrations exceed residential cleanup levels or in other cases where residual chemicals are left in place. However, Trust policy does not allow the use of deed restrictions or land use covenants; rather, the Trust adopts and enforces institutional controls through the implementation of land use restrictions. These land use restrictions are incorporated into the Trust's planning documents (e.g., the Presidio Trust Management Plan) and the Trust's leasing documents. For example, the Trust's Rules for Non-Residential Use and Occupancy, which must be followed by tenants at the non-residential buildings, states "Residency in or overnight use and occupancy of any portion of Buildings is strictly prohibited, unless specifically authorized in advance by the Trust."

    In addition, the Trust will prepare a Presidio-wide Institutional Control Management Plan ("ICMP"). A separate Institutional Control Plan ("ICP") will be prepared for each individual site that requires institutional controls. The ICP will include a figure depicting the site location and area and will summarize the specific COCs encountered at a site, the actions taken to remediate the site, and the levels of COCs remaining at the site that required the implementation of ICs. In addition, these ICPs

will discuss unallowed land uses at the site and any special requirements if residual chemicals are left in place in an inaccessible area (e.g., health and safety requirements if the area is disturbed in the future). The individual ICPs will become an attachment to the Trust's ICMP. As such, the ICMP will effectively be a "working document", supplemented with additional information as it becomes available.

21. *Concurrence should be obtained from State and Federal natural resource trustees regarding areas where '... a new site is identified in an area that is not currently designated for ecological cleanup levels on Figure 2...' (Section 7.1.2, page 7-3). Crissy field was once a paved site, prior to conversion to a wetland.*

The identification of sites that may be classified as buffer zone or special status ecological has been simplified by creating a map (Figure 7-2) that delineates such areas. As discussed above in the response to comment #12, special status species PRGs are applicable to the "undeveloped" areas of the Presidio and areas planned for habitat restoration (e.g., near the Baker Beach Apartments). Landscaped areas like the golf course, the cemetery, and the restored airfield at Crissy Field have been established as "buffer zone" ecological areas (Figure 7-2). This map was developed using the NPS and Trust's Vegetation Management Plan, which identifies zones that correlate to ecological land uses. The Native Plant Communities Zone, Historic Forest Zone, and Special Management Zone were all established as ecological special status species areas. The remaining zone (Landscape Vegetation Zone) was established as either a buffer zone area or as non-ecological, depending on the specific area. In the event that Trust or NPS natural resource staff indicate that a site should be classified differently, State and Federal natural resource trustees will be consulted, as appropriate.

22. *Species listed as California Species of Special Concern by the California Department of Fish and Game should be included in the definition of 'special status species' in footnote 5 (Section 7.1.2, page 7-3).*

The footnote in Section 7.1.2 has been modified to include California Species of Special Concern as defined by the California Department of Fish and Game; these species are also identified in Table 5-2.

23. *Please insert the word <u>inorganic</u> in the fourth line of the last paragraph to read '... remediated to concentration below <u>inorganic</u> background levels.' (Section 7.3, page 7-4).*

The text has been modified to include the word "inorganic" in the fourth line of the referenced paragraph.

24. Evaluation of Firing Range sites (Section 7.3, page 7-5) may require evaluation of the percentage of bulk lead pellets in addition to consideration of the lead soil concentration. Please advise HERD of the evaluation of Firing Range sites and the 'discovery' of additional Firing Range sites.

The Trust is planning to work with DTSC staff when it evaluates data from the Firing Range sites. The Trust would not proceed with the evaluation of Firing Ranges without DTSC input.

25. HERD is not concerned about levels set in the Toxic Substance Control Act (TSCA) when assessing risk or hazard (Section 7.3.1, page 7-6). Residential areas with soil concentrations of lead at 370 mg/kg should be deed restricted to exclude the home grown produce/fruit pathway and generation of fugitive dusts. Based on the HERD lead spreadsheet, HERD would recommend a maximum soil lead concentration of approximately 170 mg/kg to 180 mg/kg based on site specific criteria (e.g., tap water lead concentration) for unrestricted use.

The residential lead preliminary remediation goal ("PRG") calculated in Section 4.2.10 accounts for potential exposure to lead in soil, water, air, food, and fugitive dust. The text (Section 4.2.10) has been clarified to say that the calculation includes inhalation of lead in fugitive dust.

With regard to the home grown produce pathway, landscaping at the Presidio is maintained by the Trust; in-ground planting of vegetation by residents and tenants at the Presidio is prohibited in its lease agreements. The Trust and NPS control plantings at the Presidio because of their efforts to restore native plants and maintain historic plantings, as described in the Vegetation Management Plan, (NPS and Trust, May 2001). A copy of the Presidio Trust's planting guidelines for residents is attached. Presidio residents are required to follow these guidelines in accordance with their lease agreements. Thus, land use restrictions preventing in-ground planting of home grown produce are already in place. A footnote has been added to Section 4.2.10 that states: "Use restrictions prohibiting the in-ground planting of home grown produce are already in place at the Presidio."

Accounting for the above comments, the PRG of 370 mg/kg for lead in soil is appropriate for residential sites at the Presidio. Because 370 mg/kg is so close to the TSCA value of 400 mg/kg, the DTSC RPM agreed that from a risk management perspective, it was appropriate to use 400 mg/kg as a not-to-exceed value and 370 mg/kg as the maximum average value for lead at residential sites.

26. The presentation of the multiple HERD spreadsheets regarding the analysis for lead (Appendix A) is confusing. The heading of the second spreadsheet is 'Blood Lead Concentration for Exposure of Children to Background Lead in Air, Water and Food Under a Recreational Scenario'. However, the percent of home-grown produce is set at zero percent. This second spreadsheet cannot present the exposure from home-grown produce. The lead in soil and dust in this second sheet is set at 0.0 µg/g. Lead in soil and dust is included in the third spreadsheet (Appendix A) with a heading of 'Blood Lead Concentration for Exposure of Children to Background Lead Soil Under a Recreational Scenario', but no other pathways are addressed. Please provide a spreadsheet table which sums all the exposure pathways for the recreational scenario.

Multiple spreadsheets are used for lead for the recreational exposure scenario because the calculation cannot be completed on one spreadsheet. Former Table 4-6 (now renumbered as Table 4–8) summarizes all of the exposure pathways for the recreational scenario. This table has been added to Appendix A as new Table A–1 to facilitate review of the appendix. As summarized in Table A-1, the first spreadsheet addresses background exposures of the general population to lead in air, water, and food (which occurs 7 days a week, and is the same whether at the Presidio or in other parts of San Francisco).[1] The second spreadsheet quantifies the blood lead concentration due to background exposure to lead in soil when NOT at the Presidio (i.e., four days per week). As described in Section 4.2.10, a background lead value of 66 mg/kg was derived for serpentinite at the Presidio. This concentration may be found as background in other parts of San Francisco and, therefore, is used for the second spreadsheet. Based on the background exposures calculated in spreadsheets 1 and 2, the total blood lead concentration for background exposures is 5.4 µg/dl. Thus, there is a remaining 4.6 µg/dl blood lead concentration that can be attributed to a potential exposure of recreational users to lead in soil (including ingestion and inhalation of fugitive dust) three days a week at the Presidio. The lead concentration in soil corresponding to a blood lead concentration of 4.6 µg/dl is calculated to be 510 mg/kg in the third spreadsheet.

As described in the response to Comment 25, lead in home grown produce is not applicable to potential exposures to lead at the Presidio. For the recreational use scenario, off-site exposure to lead in food is assumed to be limited to "purchased" food because the majority of the regular recreational users of the Presidio are San Francisco residents. Urban populations are not likely to obtain a significant portion of their diet from homegrown produce.

[1] The lead concentration in tap water was not adjusted to the Presidio value for the recreational user because the recreational user may not drink Presidio water while participating in recreational activities at the Presidio. The lead concentration in tap water for the recreational user was therefore set at the default value of 15 µg/L.

27. *While an example of the outlier testing for 'background' concentrations is provided (Figure 6-2), some of the data sets for 'background' (Appendix D [sic]) contain samples which appear to be outliers for some elements. For example, for the Chert/Shale Lithology (Table C-3) the chromium concentration in sample 950CT002 is 52 mg/kg and BBKGDSB03 is 48.4 mg/kg. The next highest chromium concentration is 11.9 mg/kg at 950SH002 for Chert/Shale. Please identify any samples which were judged to be outliers and eliminated from determination of 'background' concentration in these tables (Tables C-1 through C-4).*

    All outliers were eliminated prior to the compilation of Tables C-1 through C-4. These tables present the data set that was agreed upon by representatives of DTSC, RWQCB, NPS, RAB, and the Trust based on the review of such scatter plots for the fit of the data to multiple chemical distributions, not just that for the range of concentrations of one chemical. Outliers were generally identified when the concentration fell outside the main mass of data or were not on the chemical distribution trend line. The referenced chromium data fall within the data trend lines for chromium and the other metals.

Comments from Dr. Kimiko Klein's Memorandum Dated 26 October 2001

General Comments

The HERD has two editorial comments. First, the numbering of the footnotes in this document is confusing. For example, on page 4-7 of Section 4, there is a footnote designated as footnote "2", but there is apparently no footnote "1". On page 6-7 of Section 6, there is a notation in the text for footnote "2", but there is no explanatory footnote for that notation, and there is no footnote "1" or "4". The numbering of the footnotes should be clarified or corrected. Second, reference is made throughout the text to various study areas, such as "Fill Site 1", "Building 1750", the "Nike facility", etc. However, there is no figure depicting all of these study areas in the document. Such a figure should be included and used as a citation when these study areas are discussed in the text.

The Trust revised the numbering of the footnotes as requested. A new figure, Figure 2-2, has been added to Section 2 that identifies the known sites in the operable units being addressed by the Presidio Trust.

Specific Comments

1. *Page 3-1 Section 3.1 Potential Chemical-Specific ARARS for Water; and Table 3-1 Numeric Values of Potential Chemical-Specific ARARs for Presidio Sites: a) Table 3-1 includes Applicable or Relevant and Appropriate Requirements (ARARs) for water from several different sources. The text summarizes these ARARs. However, the table contains a list of Maximum Contaminant Level Goals (MCLGs) which are not defined or discussed in the text. Since MCLGs are risk-based values, they should be discussed in the text. b) The drinking water standards for copper and lead are listed as MCLs. However, a footnote should be added to each, identifying the values for these metals as "Action Levels". c) A paragraph should be added to Section 3.1 briefly discussing the Public Health Goal for chromium published by the Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency (Cal/EPA) with regard to the oral carcinogenicity of hexavalent chromium. A footnote should also be included on Table 3-1.*

   (a) A brief discussion of Maximum Contaminant Level Goals ("MCLGs") has been added to the text in Section 3.1. (b) The footnotes to Table 3-1 have been re-organized to better clarify that the copper and lead values are Action Levels. (c) Additional information about the Public Health Goal for chromium has been included in Section 3.1.

2. *Page 4-2 Section 4.2.2 Potential Human Health Exposure Pathways: According to the text, less than two percent of the potential total exposure to potential chemicals of concern, metals and polycyclic aromatic hydrocarbons (PAHs), is via inhalation. Therefore, the inhalation exposure pathway is not included in the estimation of cleanup goals. a) Summarize the supporting documentation for this statement and provide a citation. b) For those areas of the site where large construction projects will occur, the inhalation of the increased dust generated may pose a risk. Therefore, in those areas, inhalation exposure of construction workers may have to be evaluated. c) Inhalation of vapors is an exceedingly important route of exposure for volatile chemicals and must be evaluated for the volatile chemicals listed in the tables of preliminary remediation goals in this section as well as the tables in Section 7.*

   (a) EKI calculated the residential PRG for arsenic including and excluding the inhalation pathway. Arsenic is a conservative test case because it is significantly more toxic via the inhalation route compared with the oral route (i.e., slope factor of 12 $(mg/kg\text{-}day)^{-1}$ for inhalation versus 1.5 $(mg/kg\text{-}day)^{-1}$ for ingestion). Assuming a fugitive dust concentration of 0.05 mg/m^3 and breathing rates of 10 and 20 m^3/day for children and adults, respectively, the inhalation pathway accounts for 3 percent of the total exposure. For other compounds where the ingestion and inhalation slope factors are the same, the inhalation

pathway comprises less than 1 percent of the exposure. The text in Section 4.2.2 has been changed to say that inhalation is estimated to be less than 3 percent of the total exposure to PCOCs and a footnote has been added summarizing the documentation presented above.

(b) EKI agrees that under the construction scenario, inhalation of fugitive dust can play a more significant role in exposure than for the residential and recreational scenarios. However, the residential and recreational cleanup levels being used throughout the Presidio should also be protective of construction workers (i.e., residential and recreational cleanup levels are applicable at all areas where potential future large construction projects would occur; commercial/industrial cleanup levels are only applicable at the water treatment plant and at Building 1750). Using arsenic as the test case, with a fugitive dust concentration of 1 mg/m^3, a soil ingestion rate of 480 mg/day, and a 1-year exposure duration, the inhalation pathway accounts for 20 percent of the total exposure to arsenic. The resulting arsenic PRG for this hypothetical construction scenario is 7.8 mg/kg. The residential and recreational PRGs calculated in the Cleanup Level Document are 0.36 and 0.88 mg/kg, respectively. These are both more stringent than the value calculated above for construction workers. Similarly, for non-carcinogens, such as mercury, the inhalation exposure under the construction scenario described above accounts for approximately 12 percent of the total exposure. The hypothetical construction PRG for mercury is 60 mg/kg, which is less stringent than the respective residential and recreational PRGs of 20 and 52 mg/kg. Based on the evaluation presented herein, no modification to the text or cleanup levels is proposed.

(c) The Trust recognizes the inhalation of vapors is an important exposure route for volatile chemicals. However, as discussed at the 12 December 2001 meeting, VOCs generally have not been detected in soil samples at the Presidio, with the exception of Crissy Field. Therefore, a protective set of screening levels has been added to the Cleanup Level Document to replace the residential and commercial/industrial cleanup levels for VOCs. The screening levels were based on the RWQCB Risk-Based Screening Levels ("RBSLs"), using lookup tables for available chemicals, and calculating values using the same assumptions for chemicals not listed in the RBSL guidance document. Available values came from the RBSL Table E-1a, Vadose-Zone Soil Screening Levels for Protection of Indoor Air Quality, assuming course soils Copies of the Johnson and Ettinger model output (version 2.3, 3/01) are included as a new Appendix E.

In addition, in response to your comment #8 and a request by the RWQCB, the PRGs for VOCs were modified to also consider protection of groundwater

through leaching. The Trust assessed the leaching pathway for VOCs through the use of the RBSLs. Tables 4-3, 4-4, and 4-5 have been revised to direct the reader to new Table 4-6, where potential impacts of indoor air exposures are calculated to generate human health PRGs for VOCs. These values are transferred to new Table 4-7, where the combined direct contact/indoor air PRGs are compared to the RBSLs for groundwater protection. The most stringent values are retained as the human health PRG in Table 4-7 and are carried forward to Table 7-2.

Recognizing that the PRGs calculated for indoor air and groundwater protection are not site-specific, the text states that if VOCs are found at a Presidio site, VOC cleanup levels may be re-calculated to be site-specific. Factors that could affect a site-specific calculation include the type of soil, depth to groundwater, presence of buildings, and number and concentrations of VOCs present in soil, among others. Any recalculation of PRGs for VOCs would be conducted in conjunction with discussions with regulatory agencies.

3. *Page 4-2, Section 4.2.2 Potential Human Health Exposure Pathways: The ingestion of groundwater, surface water, and organisms inhabiting surface water bodies will be accounted for by adoption of chemical-specific ARARs as cleanup levels. The ARARs for ingestion by humans of groundwater or surface water will be MCLs. MCLs are not risk-based levels. As stated in Specific Comment one above, MCLGs are based on risk. MCLGs for specific carcinogens are usually set to zero and for non-carcinogens on a Hazard Index of one. Therefore, a discussion should be added to this section explaining the risk consequences of the application of MCLs and explaining the approach that will be used to clean up to an overall target risk level and/or Hazard Index if the ground or surface water contains multiple chemicals of concern.*

The Trust has added text to state the following: "The ARARs being used as cleanup levels include MCLs and aquatic criteria for protection of human health, where applicable. Although MCLs are not explicitly risk-based numbers like MCLGs, they are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. The aquatic criteria for protection of human health are risk-based values that include ingestion of water and consumption of aquatic organisms."

It should be noted that all of the cleanup levels are based on a target risk level applied to each chemical; the cleanup levels do not directly consider cumulative effects. The target risk levels are discussed in Sections 4.2.3 through 4.2.5 of the Cleanup Level Document. This approach is considered to be protective because there are typically only a few chemicals driving the cleanup at a given site.

4. *Page 4-5, Section 4.2.6 Human Health Toxicity Values: Copper is listed as a chemical for which no published toxicity values were found. However, the US EPA Region 9 office lists a copper oral Reference Dose (RfD) from the Health Effects Assessment Summary Tables (HEAST). This RfD should be used to calculate a human-health-based cleanup level for copper in soil and water. The uncertainty of using this RfD may be discussed in the text.*

   The reference dose for copper (0.037 mg/kg-day) included in the U.S. EPA Region IX PRG tables is reportedly based on a value from HEAST. However, the value in the PRG tables appears to be calculated from the drinking water standard of 1.3 mg/L, which is presented in HEAST. HEAST states that the "toxicity data were inadequate for calculation of an R*f*D for copper." Thus, it seems inappropriate to use the value in HEAST to calculate a PRG for copper. The following footnote has been added to Tables 4-3 through 4-5 to clarify the toxicity information available for copper: "According to HEAST, the toxicity data for copper are inadequate for calculation of an RfD."

   At the 12 December 2002 meeting, the DTSC asked the Trust to review the basis of the copper drinking water standard. If the standard was based on impacts to organolipids, then the DTSC recommended calculating a cleanup level using the approach in the Region IX PRG tables. According to the 18 August 1988 Federal Register that discusses the basis for the Lead and Copper Rule, "acute exposure to high copper levels in test animals and humans can cause gastrointestinal disturbances, liver damage, renal damage, hemolytic anemia, and glucose-6-phosphate dehydrogenase (G6PD) inhibition. Chronic toxicity data are limited." The Federal Register further states that people with Wilson's disease, an inborn error in copper metabolism, and individuals with existing G6PD deficiencies are at risk of experiencing toxic effects from copper exposure. Considering the impacts described in the Federal Register, a cleanup level for copper was not derived.

5. *Page 4-6, Section 4.2.9 Human Health PRGs for Potential Chemicals of Concern (PCOCs) Other than Lead in Soil: This section does not mention how these PRGs will be used at the site. The HERD stresses that human health remediation goals for soil applies to soils to a depth of ten feet below ground surface. Soils contaminated below ten feet may still require remediation based on other objectives, such as, protection of groundwater resources.*

   The Trust agrees that cleanup levels should be applied to a depth of 10 feet below ground surface. The text in Section 7.1.1 has been revised.

6. *Page 4-7, Section 4.2.10 Human Health PRGs for Lead in Soil; Appendix A: a) A sentence should be added to this section stating that the lead PRG chosen represents the 99th percentile value and explaining the protective nature of that value. b) The concentration values used in the DTSC Lead Spread Version 7 model are given in this section, and Appendix A contains the lead results from sampling water from the tap in residences on site. The 95 percent upper confidence level of the mean of these results is used in the lead spreadsheets. However, it is not stated in the text or in the appendix whether the water samples represent the first draw of the day or whether water was allowed to run for a certain length of time before samples were collected. A summary of the method used to collect samples should be included in the appendix. For any future sampling of tap water, first draw of the day should be collected and analyzed separately in order to obtain a worst case estimate of the potential impact of plumbing piping and fixtures on lead levels.*

   (a) Text has been added to the first paragraph of Section 4.2.10 stating that the lead PRGs are based on the 99th percentile. Section 4.2.5 presents a discussion of the target risk level for lead (i.e., 10 mg/dl at the 99th percentile). A sentence has been added to Section 4.2.5 explaining that the protective nature of the 99th percentile. (b) The water samples collected by the Trust for lead analysis were from the first draw of the day. A footnote to this effect has been added to Table A-2.

7. *Table 4-1 Exposed Populations and Exposure Pathways Used to Develop PRGs: Ingestion of homegrown produce is not considered in calculating PRGs for this site, because landscaping at the Presidio is maintained by the Presidio Trust (the Trust), and produce grown at the Presidio would be in "community gardens at locations specifically designated by the Trust". Provide information on the criteria that will be used to choose these locations and what precautions will be taken to ensure that produce will not be grown in soil with elevated levels of on-site contaminants.*

   As discussed in the response to Jim Polisini's comment 25, in-ground planting of vegetation by residents and tenants at the Presidio is prohibited through its lease agreements. The Trust and NPS control plantings at the Presidio because of their efforts to restore native plants and maintain historic plantings, as described in the Vegetation Management Plan, (NPS and Trust, May 2001). A copy of the Presidio Trust's planting guidelines for residents is attached. Presidio residents are required to follow these guidelines in accordance with their lease agreements.

   One community garden is located at the Presidio, near Kobbe Terrace. This community garden is not located at a known chemical release site. Currently, the garden has space available in it. If there were a future need for an additional community garden, the Trust would not locate the garden at a known chemical release site. Moreover, due to the Trust and NPS' efforts to restore native plants at the

Presidio, the community garden would likely be planted in raised beds to limit the propagation of non-native plant species.

8. *Figure 4-1 Potential Human Health Exposure Pathways: As depicted in this figure, chemicals in soil may leach to groundwater. However, nowhere in this document is there any summary discussion on any studies or modeling performed to evaluate the leachability of the chemicals found in soil at the Presidio. A discussion should be added to this section on the concentrations of chemicals that can be left in soil and not impact groundwater at levels above their MCLs.*

   A discussion of potential leaching of chemicals in soil to groundwater has been added to Section 4.2.2. In addition, see response to your comment #2. The human health PRGs for VOCs have been modified to consider protection of groundwater resources through leaching (new Table 4-7).

9. *Page 6-1 Section 6.1 Presidio Geology; Figure 6-1 Surface Deposits at the Presidio: The locations and boundaries of the various lithologies or soil types as described in the text and depicted in Figure 6-1 should be verified either before or during remedial activities. This is particularly important, since a different suite of Threshold Levels for inorganic chemicals will be applied to different areas of the site, depending on the lithology.*

   As discussed above, in the response to Jim Polisini's comment 13, the boundaries of the map have not been specifically ground-truthed. However, when environmental samples are collected at a Presidio site, the soil lithology is logged under the oversight of a registered geologist. The soil type at a given site may vary spatially, as a function of depth, or due the presence of fill. Figure 6-1 is intended to be used as a starting point to identify the site lithology. The actual field observations are used to determine site lithology. The text in Section 6.1 has been modified to clarify this point.

10. *Page 6-2, Section 6.1.1 Serpentinite: As stated in this section, chrysotile is a component of serpentinite. However, it should also be stated that chrysotile is a form of asbestos. If areas with exposed serpentinite are subjected to construction or movement of heavy machinery, asbestos fibers and fine particulates containing elevated metal concentrations may be released into the air. Therefore, it should be stated here and in the summary discussion of this document that any health and safety plan will include protective measures preventing potential exposure to these fibers and particulate matter.*

A parenthetical phrase has been added to Section 6.1.1, after "chrysotile", to indicate that chrysotile is a form of asbestos. The Trust agrees that the health and safety plans for workers performing excavations in areas with serpentinite should describe measures to mitigate potential exposures to asbestos and any associated monitoring that would be performed, unless it is shown that asbestos is not present in the serpentinite at the Presidio. However, the Cleanup Level Document will not be modified to discuss health and safety issues because such matters are outside the purview of this document.

11. *Page 6-4 Section 6.1.5 Greenstone; Figure 6-1 Surface Deposits at the Presidio: The text states that greenstone may be present in fill at Area 9 and the Transfer Station sites. Greenstone has naturally elevated levels of some potentially hazardous metals. However, neither greenstone nor these specific locations are identified in Figure 6-1. The figure should be revised to show the probable locations of greenstone-containing fill.*

A sentence has been added to the text stating that greenstone is not specifically mapped on Figure 6-1; reference is also made to new Figure 2-2 which identifies the locations of the known CERCLA sites at the Presidio. Figure 6-1 has not been modified because the primary greenstone observed at the Presidio is part of the surficial fill, rather than the native soil.

12. *Page 6-7, Section 6.2.3 Determining Metals Screening (PCOC) Levels; Table 6-1 Summary of Background Data, Screening Levels, and Threshold Levels- Serpentinite Soil: The possibility of naturally occurring hexavalent chromium being present in Serpentinite should be addressed either in the text or as a footnote to Table 6-1 with a statement that further discussion appears in Section 6.4.*

A footnote has been added to Table 6-1 that indicates the concentrations of hexavalent chromium detected in serpentinite bedrock samples. These concentrations have also been added to Section 6.4.2.2.

13. *Page 6-10, Section 6.4.2.2 Serpentinite Geochemistry; Section 6.4.2.3 Leaching Test Results: In Section 6.4.2.2, the text states that hexavalent chromium was detected in bedrock samples, but there is no summary of the concentrations found or the fraction of total chromium present in the hexavalent form. This information should be included in the text. In Section 6.4.2.3, the text states that hexavalent chromium was measured in leachate from the serpentinite samples, but, again, there is no summary of the concentrations found in the leachate or the amount of chromium in the serpentinite. These sections should be revised to include this information.*

The hexavalent chromium studies were performed by Montgomery Watson, on behalf of the Army. The results of their studies are included as new Appendix D to the Cleanup Level Document. Sections 6.4.2.2 and 6.4.2.3 have been revised to refer to the results included in this new appendix.

14. *Page 6-10, Section 6.4.2 Evidence that Serpentinite is a Natural Source of chromium in Water: This section relies on a study performed by Montgomery, Watson entitled "Hexavalent Chromium in Serpentinite Bedrock and Groundwater in Upland Areas" (July 1999) to support the hypothesis that the presence of hexavalent chromium in water at this site is a natural consequence of contact with serpentinite. It is recognized in this section that further assessment will be required to determine if other metals found in water are also naturally occurring and if hexavalent chromium found in other areas have been transported by groundwater flow from serpentinite areas. A DTSC geologist should consulted on any future assessment to be performed, particularly with regard to sampling locations and data collection approaches.*

The occurrence of hexavalent chromium in non-upland areas will be discussed on a site-by-site basis in the Revised Final Feasibility Study for Main Installation sites. Additional evaluation of the background occurrence of other metals would likely be performed through the groundwater monitoring program established as part of site remedial actions. Such a groundwater monitoring program would be developed in consultation with a DTSC geologist.

15. *Page 7-4 Section 7.3 Presidio Cleanup Levels Applicable to Specific Sites: This section describes the chemical-specific applicable cleanup levels, and the tables in Section 7 lists those levels. However, the section does not summarize the basis for compilation of the complete list of potential chemicals of concern. The text of this section should be revised to include a summary of the criteria used to compile this list.*

The list of chemicals included in the Cleanup Level Document is based on the chemicals detected in soil, sediment, groundwater, and surface water samples collected at the Main Installation and Public Health Service Hospital sites, as included in the database given to the Trust from the Army. This list also includes chemicals that have been detected at the Firing Ranges and at petroleum release sites. Section 2 of the Cleanup Level Document has been modified to state the source of the list of chemicals.

16. Table 7-2 Human Health Cleanup Levels for Non-Petroleum Compounds in Soil at the Presidio of San Francisco: There are landfill areas that may be remediated at this site. As mentioned in a previous memorandum from the HERD, dated June 5, 2000, vinyl chloride is often found associated with landfills, but a cleanup goal has not been calculated for this chemical. Explain why vinyl chloride has not been included as a potential chemical of concern.

Vinyl chloride was not included as a potential chemical of concern in the Cleanup Level Document because it has not been detected in soil or water samples collected at any of the Main Installation sites. Very few chlorinated VOCs have been detected at Main Installation sites, including landfills. Therefore, based on the available data, vinyl chloride is unlikely to be encountered these sites. As stated in Section 7.3.6, if new chemicals are identified at a site, cleanup levels will be calculated for such chemicals.

If you have any questions, please do not hesitate to call.

Very truly yours,

Craig Cooper

Craig Cooper
THE PRESIDIO TRUST

cc: James Polisini, Ph.D., DTSC
A. Kimiko Klein, Ph.D., DTSC
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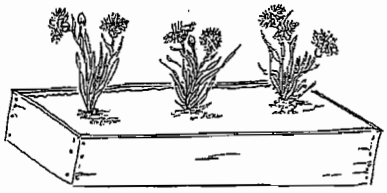

PRESIDIO POTTED PLANT GUIDELINES

(updated Spring 2001)

1. CONTAINERS

- A reasonable number of containers may be placed outside of each unit. The Presidio Trust will, in its sole discretion, determine if inappropriate or an unreasonable number of containers/plants exists. If such a determination is made, the resident will be so notified and asked to remedy the situation.
- Containers must be placed in areas where they will not fall during an earthquake or heavy winds (this includes banisters, railing, etc.) or impede emergency access to buildings.
- Residents are encouraged to grow kitchen herbs and container-sized vegetable plants, since home gardening is an important component of a sustainable community.
- To protect sensitive ecological areas, residents may not discard soil or plant material anywhere on the grounds of the Presidio.
- The use of pesticides or herbicides is prohibited.

2. SUGGESTED PLANTS

Attached is a *partial* list of plants that grow in harmony with the Presidio's native species. Most vegetables and kitchen herbs are also acceptable, since they do not easily cross-pollinate or hybridize with native plants. A more detailed listing of acceptable plants is available at the John Stewart Company leasing offices.

3. PROHIBITED PLANTS

Certain commercial nursery species are difficult to confine to containers since they can spread via seeds or runners. They become aggressive competitors with native species and are difficult to eradicate once established.
Please check the attached list for prohibited plants.

In addition, some commercially available plants labeled "California Native" have the potential to cross-pollinate/hybridize with native plants in natural areas of the Presidio. This is a serious threat to native plants.

PLEASE DO **NOT** BUY PLANTS LABELED "CALIFORNIA NATIVE."

(If you have questions related to plants in the Presidio, please contact the Presidio Trust Natural Resources Program at 415.561.4494 or e-mail us at Nature@presidio.gov.)

SUGGESTED CONTAINER PLANT LIST FOR PRESIDIO RESIDENCES

Scientific name (spp. = species)	**Common Name**
Large Shrubs (>2 m tall)	
Buddleia spp.	butterfly bush
Callistemon citrinus	bottlebrush
Tibouchina semidecandra	princess flower
Small Shrubs (0.5-2 m tall)	
Berberis spp.	Darwin barberry
Fuchsia cultivars	fuchsia
Lavandula spp.	lavender
Nandina domestica	heavenly bamboo
Vines	
Clematis spp., cultivars	clematis
Hardenbergia violacea	hardenbergia
Rosa banksiae	*Lady Banks rose*
Sollya heterophylla	Australian bluebell creeper
Trachelospermum jasminoides	star-jasmine
Wisteria	wisteria
Ferns	
Rumohra adiantiformis	leatherleaf fern
Flowering perennials	
Aquilegia spp.	columbine
Coreopsis spp.	coreopsis
Delphinium spp.	larkspur
Echinacea	echinacea
Lantana spp.	lantana
Penstemon spp., cultivars	beardtongue
Phlox spp.	phlox
Salvia spp., cultivars	sage
Annuals	
Helianthus cultivars	sunflower
Lobelia spp.	lobelia
Salvia spp., cultivars	sage
Viola spp.	violets, pansies
Zinnia	zinnia

Information Advisory
Clean Imported Fill Material

October 2001

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

It is DTSC's mission to restore, protect and enhance the environment, to ensure public health, environmental quality and economic vitality, by regulating hazardous waste, conducting and overseeing cleanups, and developing and promoting pollution prevention.

State of California

California Environmental Protection Agency

Executive Summary

This fact sheet has been prepared to ensure that inappropriate fill material is not introduced onto sensitive land use properties under the oversight of the DTSC or applicable regulatory authorities. Sensitive land use properties include those that contain facilities such as hospitals, homes, day care centers, and schools. This document only focuses on human health concerns and ecological issues are not addressed. It identifies those types of land use activities that may be appropriate when determining whether a site may be used as a fill material source area. It also provides guidelines for the appropriate types of analyses that should be performed relative to the former land use, and for the number of samples that should be collected and analyzed based on the estimated volume of fill material that will need to be used. The information provided in this fact sheet is not regulatory in nature, rather is to be used as a guide, and in most situations the final decision as to the acceptability of fill material for a sensitive land use property is made on a case-by-case basis by the appropriate regulatory agency.

Introduction

The use of imported fill material has recently come under scrutiny because of the instances where contaminated soil has been brought onto an otherwise clean site. However, there are currently no established standards in the statutes or regulations that address environmental requirements for imported fill material. Therefore, the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) has prepared this fact sheet to identify procedures that can be used to minimize the possibility of introducing contaminated soil onto a site that requires imported fill material. Such sites include those that are undergoing site remediation, corrective action, and closure activities overseen by DTSC or the appropriate regulatory agency. These procedures may also apply to construction projects that will result in sensitive land uses. The intent of this fact sheet is to protect people who live on or otherwise use a sensitive land use property. By using this fact sheet as a guide, the reader will minimize the chance of introducing fill material that may result in potential risk to human health or the environment at some future time.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website at www.dtsc.ca.gov.

Overview

Both natural and manmade fill materials are used for a variety of purposes. Fill material properties are commonly controlled to meet the necessary site specific engineering specifications. Because most sites requiring fill material are located in or near urban areas, the fill materials are often obtained from construction projects that generate an excess of soil, and from demolition debris (asphalt, broken concrete, etc.). However, materials from those types of sites may or may not be appropriate, depending on the proposed use of the fill, and the quality of the assessment and/or mitigation measures, if necessary. Therefore, unless material from construction projects can be demonstrated to be free of contamination and/or appropriate for the proposed use, the use of that material as fill should be avoided.

Selecting Fill Material

In general, the fill source area should be located in nonindustrial areas, and not from sites undergoing an environmental cleanup. Nonindustrial sites include those that were previously undeveloped, or used solely for residential or agricultural purposes. If the source is from an agricultural area, care should be taken to insure that the fill does not include former agricultural waste process byproducts such as manure or other decomposed organic material. Undesirable sources of fill material include industrial and/or commercial sites where hazardous ma-

Potential Contaminants Based on the Fill Source Area

Fill Source:	Target Compounds
Land near to an existing freeway	Lead (EPA methods 6010B or 7471A), PAHs (EPA method 8310)
Land near a mining area or rock quarry	Heavy Metals (EPA methods 6010B and 7471A), asbestos (polarized light microscopy), pH
Agricultural land	Pesticides (Organochlorine Pesticides: EPA method 8081A or 8080A; Organophosphorus Pesticides: EPA method 8141A; Chlorinated Herbicides: EPA method 8151A), heavy metals (EPA methods 6010B and 7471A)
Residential/acceptable commercial land	VOCs (EPA method 8021 or 8260B, as appropriate and combined with collection by EPA Method 5035), semi-VOCs (EPA method 8270C), TPH (modified EPA method 8015), PCBs (EPA method 8082 or 8080A), heavy metals including lead (EPA methods 6010B and 7471A), asbestos (OSHA Method ID-191)

**The recommended analyses should be performed in accordance with USEPA SW-846 methods (1996). Other possible analyses include Hexavalent Chromium: EPA method 7199*

Recommended Fill Material Sampling Schedule

Area of Individual Borrow Area	Sampling Requirements
2 acres or less	Minimum of 4 samples
2 to 4 acres	Minimum of 1 sample every 1/2 acre
4 to 10 acres	Minimum of 8 samples
Greater than 10 acres	Minimum of 8 locations with 4 subsamples per location
Volume of Borrow Area Stockpile	**Samples per Volume**
Up to 1,000 cubic yards	1 sample per 250 cubic yards
1,000 to 5,000 cubic yards	4 samples for first 1000 cubic yards +1 sample per each additional 500 cubic yards
Greater than 5,000 cubic yards	12 samples for first 5,000 cubic yards + 1 sample per each additional 1,000 cubic yards

terials were used, handled or stored as part of the business operations, or unpaved parking areas where petroleum hydrocarbons could have been spilled or leaked into the soil. Undesirable commercial sites include former gasoline service stations, retail strip malls that contained dry cleaners or photographic processing facilities, paint stores, auto repair and/or painting facilities. Undesirable industrial facilities include metal processing shops, manufacturing facilities, aerospace facilities, oil refineries, waste treatment plants, etc. Alternatives to using fill from construction sites include the use of fill material obtained from a commercial supplier of fill material or from soil pits in rural or suburban areas. However, care should be taken to ensure that those materials are also uncontaminated.

Documentation and Analysis

In order to minimize the potential of introducing contaminated fill material onto a site, it is necessary to verify through documentation that the fill source is appropriate and/or to have the fill material analyzed for potential contaminants based on the location and history of the source area. Fill documentation should include detailed information on the previous use of the land from where the fill is taken, whether an environmental site assessment was performed and its findings, and the results of any testing performed. It is recommended that any such documentation should be signed by an appropriately licensed (CA-registered) individual. If such documentation is not available or is inadequate, samples of the fill material should be chemically analyzed. Analysis of the fill material should be based on the source of the fill and knowledge of the prior land use.

Detectable amounts of compounds of concern within the fill material should be evaluated for risk in accordance with the DTSC Preliminary Endangerment Assessment (PEA) Guidance Manual. If

metal analyses are performed, only those metals (CAM 17 / Title 22) to which risk levels have been assigned need to be evaluated. At present, the DTSC is working to establish California Screening Levels (CSL) to determine whether some compounds of concern pose a risk. Until such time as these CSL values are established, DTSC recommends that the DTSC PEA Guidance Manual or an equivalent process be referenced. This guidance may include the Regional Water Quality Control Board's (RWQCB) guidelines for reuse of non-hazardous petroleum hydrocarbon contaminated soil as applied to Total Petroleum Hydrocarbons (TPH) only. The RWQCB guidelines should not be used for volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCS). In addition, a standard laboratory data package, including a summary of the QA/QC (Quality Assurance/Quality Control) sample results should also accompany all analytical reports.

When possible, representative samples should be collected at the borrow area while the potential fill material is still in place, and analyzed prior to removal from the borrow area. In addition to performing the appropriate analyses of the fill material, an appropriate number of samples should also be determined based on the approximate volume or area of soil to be used as fill material. The table above can be used as a guide to determine the number of samples needed to adequately characterize the fill material when sampled at the borrow site.

Alternative Sampling

A Phase I or PEA may be conducted prior to sampling to determine whether the borrow area may have been impacted by previous activities on the property. After the property has been evaluated, any sampling that may be required can be determined during a meeting with DTSC or appropriate regulatory agency. However, if it is not possible to analyze the fill material at the borrow area or determine that it is appropriate for use via a Phase I or PEA, it is recommended that one (1) sample per truckload be collected and analyzed for all compounds of concern to ensure that the imported soil is uncontaminated and acceptable. (See chart on Potential Contaminants Based on the Fill Source Area for appropriate analyses). This sampling frequency may be modified upon consultation with the DTSC or appropriate regulatory agency if all of the fill material is derived from a common borrow area. However, fill material that is not characterized at the borrow area will need to be stockpiled either on or off-site until the analyses have been completed. In addition, should contaminants exceeding acceptance criteria be identified in the stockpiled fill material, that material will be deemed unacceptable and new fill material will need to be obtained, sampled and analyzed. Therefore, the DTSC recommends that all sampling and analyses should be completed prior to delivery to the site to ensure the soil is free of contamination, and to eliminate unnecessary transportation charges for unacceptable fill material.

Composite sampling for fill material characterization may or may not be appropriate, depending on quality and homogeneity of source/borrow area, and compounds of concern. Compositing samples for volatile and semivolatile constituents is not acceptable. Composite sampling for heavy metals, pesticides, herbicides or PAH's from unanalyzed stockpiled soil is also unacceptable, unless it is stockpiled at the borrow area and originates from the same source area. In addition, if samples are composited, they should be from the same soil layer, and not from different soil layers.

When very large volumes of fill material are anticipated, or when larger areas are being considered as borrow areas, the DTSC recommends that a Phase I or PEA be conducted on the area to ensure that the borrow area has not been impacted by previous activities on the property. After the property has been evaluated, any sampling that may be required can be determined during a meeting with the DTSC.

For further information, call Richard Coffman, Ph.D., R.G., at (818) 551-2175.

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

ENVIRONMENTAL SOIL INVESTIGATION

Caltrans EA 04-163741
Contract 4

August 2009

Prepared By:

BASELINE Environmental Consulting

ENVIRONMENTAL SOIL INVESTIGATION

Caltrans EA 04-163741

AUGUST 2009

DOYLE DRIVE REPLACEMENT
PROJECT
CONTRACT 4
SAN FRANCISCO, CALIFORNIA

For:

ARUP
San Francisco, California

Y0239-04.A3.01291

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This *Environmental Soil Investigation* report, dated 25 August 2009, has been prepared by BASELINE Environmental Consulting as part of Caltrans contract EA 04-163741

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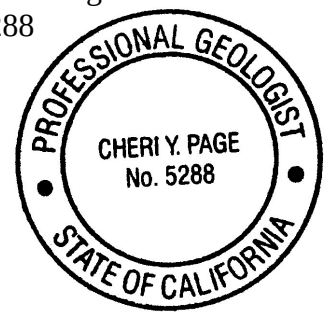

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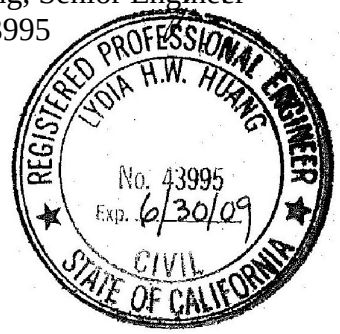

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ENVIRONMENTAL SOIL INVESTIGATION
DOYLE DRIVE REPLACEMENT PROJECT CONTRACT 4
San Francisco, California

1 INTRODUCTION

This report has been prepared by BASELINE Environmental Consulting for ARUP. This report presents the results of environmental soil sampling along Doyle Drive near the Golden Gate Bridge in San Francisco, California.

1.1 Project Description

The Project is the Contract 4 area of the proposed Doyle Drive Replacement Project ("DDRP") in San Francisco, California, and is sponsored by the San Francisco County Transportation Authority and the State of California Department of Transportation ("Caltrans"). The Contract 4 area is located within Presidio Trust Lands. The DDRP will upgrade a portion of Doyle Drive within the Presidio to meet current design and safety standards. The Project is the second phase of the DDRP, and will upgrade some of the central portion of the DDRP between the intersection of Lincoln Boulevard with Crissy Field Avenue and east of the intersection of Lincoln Boulevard and Taylor Road, as shown on Figure 1. Construction is currently scheduled to begin in December 2009. This report includes both the north and south-bound portions of the central DDRP and therefore extends slightly beyond the Contract 4 boundary.

The Project will include excavation of soil ("cut areas") and possible filling in potential fill areas. Figure 2 shows cut areas within the Project; the areas not identified as cut areas could potentially receive fill. Limited excavation also may occur in areas not identified as cut areas prior to potential placement of fill (i.e., while readying the ground surface for placement of fill).

1.2 Investigation Objectives

The objectives of the environmental soil sampling discussed in this report were to: 1) pre-characterize soil for potential disposal off-site at a permitted facility or off-site reuse; 2) pre-characterize soil for potential reuse within the limits of the Project, in accordance with Presidio Trust reuse criteria,[1] 3) obtain chemical quality information of the soil and groundwater[2] for preparation of future worker health and safety plan(s).

2 SOIL SAMPLING WORKPLAN

Soil sampling was conducted in accordance with a Soil and Groundwater Sampling Work Plan ("Workplan") (Caltrans and ARUP PB Joint Venture, 2008). The Workplan was also reviewed and accepted by the Presidio Trust and they issued a License to Enter and Conduct Geotechnical

[1] Evaluation of whether the chemical quality of some or all excavated soil would meet Presidio Trust reuse criteria (EKI, 2002) will be evaluated in a separate report by BASELINE.

[2] Groundwater quality data collected in the Project was presented in Caltrans and ARUP PB Joint Venture, 2009a.

Investigations, Modification No. 2 (Presidio Trust, 2008). The Workplan and License to Enter are attached in Appendices A and B, respectively.

The Workplan was designed to meet the investigation objectives by: 1) collection of representative samples from soil to be excavated during Project construction in general accordance with U.S. Environmental Protection Agency ("EPA") SW-846 (EPA, 1986) guidance; 2) selection of an analytical approach for soil samples that would meet landfill requirements for pre-approval of soil disposal, and that would meet Presidio Trust analytical requirements for potential reuse of soil within the Project limits without additional characterization after excavation; 3) collection and analysis of representative samples to allow Caltrans to prepare project specifications addressing worker health and safety; and 4) to allow the contractor to prepare an appropriate health and safety plan for construction workers.

2.1 Soil Boring Locations and Depths

Soil samples were collected from 26 borings (E059 through E082, E077A, and E078A) drilled within the Project area, as shown on Figure 2. Two shallow hand auger borings (E077A and E078A) were advanced near the primary borings (E077 and E078). These shallow boring locations were the first choice for boring location; however, they were not accessible with the drill rig. Therefore, only shallow soil samples were collected at these two locations, and the deeper boring was located as close as possible to the original borings and in an area accessible with a drill rig.

The boring locations were selected using a systematic, random approach as described in EPA SW-846 guidance (EPA, 1986). An initial, random boring location was selected, and subsequent boring locations were identified approximately every 200 lateral feet along the north- and southbound portions of the Project alignment, as requested by Caltrans.

The majority of the borings (20) were located in proposed cut areas, and the remaining borings (6) were located within potential fill areas (Figure 2). Table 1 lists the borings drilled within the Project area and Table 1 and Figure 2 indicate their location in cut or potential fill areas.

Borings located in potential fill areas were drilled to a depth of 2.5 feet below ground surface ("bgs") to characterize only surficial soil, which may be removed to ready the area for potential surcharge materials (Table 1). With the exception of borings E077A and E078A, discussed above, borings located within proposed cut areas were drilled to a depth of approximately two feet below the proposed depth of cut, or five feet below top of bedrock, if bedrock was encountered. These borings ranged in depth from 7.5 to 40 feet bgs.

2.2 Soil Sampling and Analysis Approach

In general, soil samples were collected at depths of 0.5 to 1.0 and 2.0 to 2.5 feet bgs in every environmental boring and every five feet thereafter to the proposed depth of each boring. Discrete samples from the ground surface to a depth of 2.5 feet bgs were analyzed for lead. Samples collected below a depth of 2.5 feet bgs were composited and analyzed for multiple chemicals identified by Presidio Trust as potential contaminants of concern in the Presidio (EKI, 2002).

Borings within contiguous cut or potential fill areas were identified as a single composite area (Figure 2). Samples collected from borings within a given composite area were composited with samples from other borings within that composite area. The soil analysis approach is described in more detail below in Section 3.4.

3 METHODOLOGY

3.1 Field Preparations

Dig Permits were obtained from the Presidio Trust for all borings (Appendix B). Each boring location was marked in white paint, and locations not covered by asphalt or concrete were also identified using a wooden or metal stake. A private utility locator, Otis Haskin ("OHJ"), cleared all boring locations. Underground Service Alert ("USA") was then contacted for utility clearance, and the Dig Permit was requested from Presidio Trust. Presidio Trust reviewed and checked the borehole locations with their equipment, maps, and site knowledge before issuing the Dig Permit authorizing drilling to commence.

3.2 Drilling Activities

Drilling operations were performed in general accordance with the applicable Standard Operating Procedures ("SOPs") included in the Presidio Trust's Presidio-Wide Quality Assurance Project Plan ("QAPP") (Tetra Tech EM, Inc., 2001). Deviations from the QAPP SOPs are described in the Workplan (Appendix A). BASELINE staff performed fieldwork in accordance with BASELINE's site-specific Health and Site Safety Plan, included in the Workplan.

Drilling and hand augering activities were conducted by Gregg Drilling & Testing, Inc. ("Gregg Drilling") of Martinez, California, a C-57 licensed driller. Borings were drilled using direct-push equipment, a hollow-stem auger drill rig, or a hand auger (Table 1). Drilling augers and rods were cleaned between borings with a steam cleaner. Soil sampling equipment was decontaminated between samples by scrubbing with a laboratory-grade detergent solution and rinsing in two sequential pails of potable water.

A professional BASELINE geologist supervised all drilling activities and logged lithology using the Unified Soil Classification System. Boring logs are included in Appendix C.

Borings completed without encountering groundwater were backfilled with bentonite pellets or chips, hydrated in one-foot lifts, to within about one foot bgs. All borings with standing groundwater at the time of completion were backfilled with a neat cement grout to one foot bgs. The grout was placed using a tremie pipe. Surface completions matched existing conditions (e.g., soil or asphalt). After backfilling, each boring location was marked using a wooden stake, or white paint if the boring was located in concrete or asphalt, in preparation for surveying. A licensed surveyor, Chaudhary & Associates, located the borings after completion in accordance with the Presidio Trust QAPP. Survey coordinates are provided in both Project datum (NAD 83 and NAVD 88) and Presidio Trust datum (NAD27 and Presidio Low Low Water) on Table 1.

3.3 Soil Sampling and Handling Procedures

If asphalt or baserock was present at a boring location, the planned 0.5 to 1.0 foot bgs sample was collected from the first soil interval below the asphalt and baserock. Soil samples within proposed cut areas were also collected every five feet to the proposed depth of the cut. If bedrock was encountered within the planned depth of the boring, a sample was collected near the top of the bedrock and, if possible, five feet below the top of bedrock. Additional bedrock samples were not collected if bedrock was encountered, as it was assumed that the same type of bedrock was present at depth. Bedrock encountered included sandstone and shale. The sampling procedures for Colma Sand were the same as bedrock units because, although Colma Sand is not consolidated, BASELINE understands it will be used as a bearing formation for construction.

Soil samples were collected directly into clean six-inch long brass or stainless steel liners or micro-core tubes. The collected samples were capped with Teflon and plastic end caps, labeled, and immediately stored in ice-cooled chests.

Samples were labeled with the boring number (e.g., E082), soil type, and sample depth in feet bgs. Soil type categories included fill (F), alluvium (A), Colma Sand (C), or Bedrock (BR). Although Bay Mud and serpentinite bedrock were encountered during the previous investigation for the Contract 3 area (Caltrans and ARUP PB Joint Venture, 2009b), they were not encountered during this investigation. Alluvial and marine sediments were included in the "alluvium" category for the purpose of compositing chemically similar soil types. If serpentinite was observed in a sample, an "S" was added to the soil type descriptor (e.g., fill with serpentinite would be labeled "FS"). Sample depth indicated on the sample label was the bottom of the six-inch sample interval.

Composite sample instructions were provided to the laboratory within five days of the sample collection date. Composite samples were identified with "EC" indicating Environmental Composite, followed by the composite area number, the soil type descriptor, and the sample number. A list of composite samples and the discrete samples used to make up each composite sample is presented in Table 2. A total of four composite areas (9 through 12) were designated in the Project area.

The samples were either picked up in the field daily during drilling activities by Curtis & Tompkins, Ltd. of Berkeley, California, a state-certified laboratory, or were delivered by BASELINE directly to the laboratory. In both cases, the samples were handled under chain-of-custody procedures.

3.4 Soil Sample Analyses

All laboratory analyses were conducted by Curtis & Tompkins, Ltd. of Berkeley, California with the exception of asbestos and herbicides analyses, which were performed by Forensic Analytical of Hayward, California and APPL, Inc. of Fresno, California, respectively. These laboratories are state-certified for the analyses conducted. Laboratory analyses performed on each sample are summarized in Table 3. The analytical scheme for the collected samples is described below.

- Fill samples
    - Discrete samples from depths of 1.0 and 2.5 feet bgs were analyzed for total lead.

- Up to five discrete fill samples, collected within five days from the same composite area, were composited and analyzed for **Sampling Suite A.**[3]
- If any metal concentration was greater than 10 times the Soluble Threshold Limit Concentration ("STLC"), the sample was also analyzed for the soluble metal by the Waste Extraction Test ("WET"). If any sample contained greater than 20 times the Toxicity Characteristic Leaching Procedure ("TCLP"), the sample was analyzed for leachable metal contents by TCLP.
- Discrete fill samples observed in the field to contain serpentinite were also analyzed for asbestos using the California Air Resources Board ("CARB") Method.

- Alluvium/Marine and Bay Mud Sediment Samples

  - Up to five native alluvial/colluvial/marine deposit samples, collected within five days from the same composite area, were composited and analyzed for **Sampling Suite B**.[4]
  - Up to five Bay Mud samples collected within five days from the same composite area would have been composited and analyzed for **Sampling Suite B**. Bay Mud was not encountered during this investigation.

- Bedrock Samples

  - Up to five Colma Sand samples, collected within five days from the same composite area, were composited for analysis of **Sampling Suite B**.
  - Up to five bedrock samples, other than Colma Sand, collected within five days from the same composite area, were composited and analyzed for Title 22 metals.

    If any metal concentration was greater than 10 times the STLC, the sample was also analyzed for the soluble metal by WET. If any sample contained greater than 20 times the TCLP threshold, the sample was analyzed for leachable metal by TCLP.
  - Up to five bedrock samples, collected within five days from the same composite area were, composited and analyzed for cyanide, sulfide, and corrosivity ("pH"). The samples were analyzed for reactivity if cyanide was greater than or equal to 250 milligrams per kilogram (mg/kg), and/or sulfide was greater than or equal to 500 mg/kg. Ignitability was determined if total VOCs were greater than one percent.
  - Up to five bedrock samples consisting of serpentinite and collected within five days from the same composite area would have been composited and analyzed for asbestos. Serpentinite bedrock was not encountered during this investigation. However, three geotechnical borings previously drilled by ARUP (BTNB-R2, BTNB-R3, and BTSB-R2) in Composite Area 12 encountered serpentinite bedrock. These boring locations

[3] **Sampling Suite A** consists of Sampling Suite B, listed below, plus organochlorine pesticides by EPA Method 8081A and herbicides by EPA Method 8151A.

[4] **Sampling Suite B** consists of Title 22 metals by EPA Methods 6020/7000 series; volatile organic compounds ("VOCs") by EPA Method 8260B; semi-volatile organic compounds ("SVOCs") by EPA Method 8270C; total petroleum hydrocarbons ("TPH") as gasoline (g), diesel (d), and fuel oil (fo) by EPA Method 8015M/CA LUFT; silica gel cleanup on TPHd and TPHfo by EPA Method 3630; polycyclic aromatic hydrocarbons ("PAHs") by EPA Method 8310; polychlorinated biphenyls ("PCBs") by EPA Method 8082; cyanide by Standard Method 4500-CN-E; sulfide by EPA Method 9034; and corrosivity (pH) by EPA Method 9045D.

are shown on Figure 2. At the request of Caltrans, BASELINE collected six samples of serpentinite bedrock from the cores which had been stored since the borings were drilled in February, May, and July of 2008. These six samples were analyzed for asbestos, nickel, and chromium. Boring logs for these geotechnical borings were included in a previous report (Caltrans and ARUP PB Joint Venture, 2009c) and are also presented in this report in Appendix C.

3.5 Laboratory Quality Assurance

Curtis & Tompkins and APPL, Inc. performed laboratory analyses and quality assurance/quality control procedures in accordance with Presidio Trust's QAPP (Tetra Tech, 2001), with exceptions presented in the Responsibilities and Assumptions Document (BASELINE, 2008) attached as Appendix D. Presidio Trust reviewed the proposed QAPP deviations and did not request changes.

The field sample data were reviewed by Laboratory Data Consultants, Inc. ("LDC") of Sacramento, California for compliance with the Presidio Trust QAPP. Data were reviewed based on the appropriate EPA methods referenced (EPA, 1986), *National Functional Guidelines for Organic Data Review* (EPA, 1999), *National Functional Guidelines for Inorganic Data Review* (EPA, 2004), and the project-specific control limits provided in the QAPP or Presidio-approved variances requested by Curtis & Tompkins. Where specific guidance was not available, the data were evaluated in a conservative manner consistent with industry standards using professional experience.

Data review by LDC concluded that all soil sample analytical results were valid, as analytical methods and reporting were consistent with the Presidio Trust QAPP, National Functional Guidelines, or project-specific control limits. In addition, Level IV data validation packages were provided by Curtis & Tompkins and APPL, Inc., and reviewed by LDC, as required by the Presidio Trust QAPP. LDC's data validation reports are attached as Appendix E. Electronic data are also provided on CD in the Presidio Trust electronic data deliverable ("EDD") format with data qualifiers added by LDC (Appendix E).

3.6 Data Evaluation Methodology

Chemical data from the laboratory were loaded into a database. Soil quality data were screened against federal and state hazardous waste thresholds and California Regional Water Quality Control Board, San Francisco Bay Region ("Water Board") residential and commercial/industrial Environmental Screening Levels ("ESLs") (Water Board, 2008). Statistical analysis of subsets of data was performed, as needed, using guidelines and software developed by the EPA (EPA, 2009) and standard-industry practices. The results of the data evaluation are presented, below, in Section 6.

3.7 Investigation-Derived Waste Disposal

Drill cuttings (typically dry to wet soil or rock) were placed in approved U.S. Department of Transportation ("DOT") 55-gallon drums. Water, used to clean augers and soil sampling equipment, was collected in separate drums and sampled to evaluate disposal options. The drums were sealed, labeled, and stored for no longer than 90 days at the drum storage area along Mason Street. Drums were hauled off-site to an appropriate disposal facility as soon as possible

after laboratory results were available and pick-up by a licensed waste hauler could be scheduled.

Thirty drums of soil and groundwater generated during drilling activities conducted between 12 January 2009 and 18 February 2009 were picked up on 15 April 2009 by Clearwater Environmental of Union City, California. Five drums of liquid and 21 soil drums were disposed of as non-hazardous waste at Alviso Independent Oil of Alviso, California. Four drums of soil were disposed of as non-RCRA hazardous waste within 90 days of generation at Siemens Water Technologies Corporation ("Siemens") in Vernon, California. BASELINE understands that Siemens forwards the waste to Kettleman Hills Hazardous Waste Facility in Kettleman, California after re-packaging. Waste disposal manifests are in Appendix F.

4 SOIL REUSE OR DISPOSAL FRAMEWORK

4.1 Criteria for Federal and California Hazardous and Non-Hazardous Waste

A soil, once excavated, may be classified as a federal hazardous waste, a California hazardous waste, or a non-hazardous waste depending on its characteristics. A soil is considered a federal hazardous waste if it contains leachable concentrations of select chemicals, determined by TCLP, equal to or greater than the thresholds established in Title 40 of the Code of Federal Regulations ("CFR"), Section 261.24. The TCLP method uses a dilution ratio of 20:1 in the extraction process; therefore, a waste with a total concentration equal to or greater than 20 times the TCLP threshold could potentially be a federal hazardous waste, depending on the fraction of the total concentration that is soluble. There are no thresholds for total concentrations of compounds for federal hazardous wastes.

In California, a waste is considered hazardous if the total concentration of a chemical is equal to or greater than the Total Threshold Limit Concentration ("TTLC") and/or if the soluble concentration of a chemical, determined by the WET, is greater than or equal to the STLC. The WET method uses a dilution ratio of 10:1 in the extraction process; therefore, a waste with a total concentration equal to or greater than ten times the STLC value could potentially be a California hazardous waste, depending on the fraction of the total concentration that is soluble. The TTLC and STLC values are established in Title 22 of the California Code of Regulations, Section 66261.24.

A waste that does not exceed the federal and the California hazardous waste criteria is a non-hazardous waste. Federal hazardous wastes are only accepted for disposal at a Class I-permitted landfill. A nonfederal, California hazardous waste may be disposed of at a Class I-permitted landfill or an out-of-state landfill permitted to accept such waste. Non-hazardous wastes are generally accepted at Class II and Class III landfills, depending on the individual landfill's permit.

4.2 ESLs

Soil excavated during Project construction demonstrated to be a non-hazardous waste may be transported offsite and reused for other Caltrans projects and/or become the property of the contractor. The Water Board has developed ESLs (Water Board, 2008) for the protection of

residential and commercial land uses and construction workers for chemical compounds commonly found on contaminated sites. The ESLs are chemical-specific concentrations that, if not exceeded, would not be expected to present a significant threat to human health and/or the environment. The screening values were developed by the Water Board using conservative (worst-case) exposure assumptions. Since it is unknown where soils from the Project may be reused, ESLs for shallow soils for residential and commercial/industrial land uses where groundwater is considered an actual or potential drinking water source were used for screening purposes.

5 INVESTIGATION RESULTS

5.1 Lithologic Units and Potential Waste Streams

Lithologic units encountered during drilling included fill (F), alluvium (A), Colma Sand (C), and Bedrock (BR). These lithologic units were considered potential waste streams for the purpose of compositing chemically similar soil types. Alluvial and marine sediments were included in the "alluvium" category. Lithologic units encountered within each composite area are summarized below. Boring logs are included in Appendix C.

5.1.1 Composite Area 9

Fill was present in two of the three borings in this composite area (E059 and E060) to depths of 7.5 and 10.0 feet bgs, the maximum extent of these borings. Fill was present to a depth of 1.0 feet bgs in the other boring (E061) and was underlain by Colma Sand to a depth of 12.5 feet bgs, the maximum depth of the boring. The fill in boring E060 included serpentinite clasts from approximately 0.5 to 2.5 feet bgs.

5.1.2 Composite Area 10

In this composite area fill was encountered in three of the five borings (E067, E069, and E071) to depths of 5.0 to 11.0 feet bgs, and was underlain by alluvium to depths of 16 to 21 ft bgs. Below the alluvium, Colma Sand was encountered to depths of 22.5 to 27.5 feet bgs, the maximum depth of the borings.

Fill was encountered in the other two borings (E065 and E063) to a depth of 22.5 feet bgs, the maximum depth of the borings. Serpentinite clasts were included in the fill from boring E063 at depths of 20.0 to 22.5 feet bgs.

5.1.3 Composite Area 11

Fill was encountered in all six borings in this composite area to a depth of 2.5 feet bgs, the maximum depth of the borings.

5.1.4 Composite Area 12

Fill was encountered in eight of the twelve borings in this composite area (E074 through E081) to depths of 1.0 to 7.0 feet bgs. Fill was encountered in boring E073 to a depth of 13.0 feet bgs. The fill was underlain by alluvium in most of the borings to depths of 18 to 31 feet bgs. Fill was not present in borings E077A, E078A, or E082, and the alluvium extended to 11.0 feet bgs (E082). Bedrock was encountered below the fill or alluvium at depths from 7.0 feet (E081) to 31 feet bgs (E079). Bedrock consisted of sandstone, shale, or Colma Sand.

Serpentinite bedrock was not encountered in the environmental borings. However, serpentinite bedrock was encountered in one geotechnical boring within the depth of the proposed Battery Tunnel in Composite Area 12 (BTNB-R2) and below the depth of the tunnel in two geotechnical borings just east of the tunnel (BTNB-R3 and BTSB-R2).

5.2 Analytical Results

5.2.1 Chemical Compounds

Analytical results for all the soil samples are summarized in Tables 4 through 12. Only compounds that were identified above laboratory reporting limits in at least one sample are presented on the tables. Semi-volatile organic compounds (analyzed by EPA Method 8270C) and herbicides (analyzed by EPA Method 8151A) were not reported above laboratory reporting limits; therefore, the results are not tabulated.

Hazardous waste thresholds and ESLs are also listed in the tables for compounds with established values. Concentrations that exceed any of the thresholds or ESLs are shaded in the tables.

5.2.2 Asbestos

Asbestos was analyzed for two fill samples in Composite Areas 9 and 10 (E060FS-2.5 and E063FS-22.5, respectively) due to the presence of serpentinite clasts in fill material. Asbestos was not reported in these samples above 0.25 percent (Table 11 and Appendix C). Material containing friable asbestos equal to or greater than one percent is classified as a California hazardous waste. An asbestos dust mitigation plan is required by the California Code of Regulations, Title 17 and the Bay Area Air Quality Management District before grading in areas where asbestos has been reported above 0.25 percent.[5] Based on the results of these two samples, fill material containing serpentinite in Composite Areas 9 and 10 are not hazardous, and a dust mitigation plan is not required before grading. Serpentinite was not encountered in fill materials in Composite Areas 11 and 12.

Asbestos was analyzed for six serpentinite bedrock samples collected from cores of three previously drilled geotechnical borings (BTNB-R2, BTNB-R3, and BTSB-R2) in Composite Area 12 (Table 11 and Figure 2). Asbestos was reported in these samples at concentrations ranging from 0.75 to 2.5%, above the California Code of Regulations, Title 17 limit of 0.25%, indicating a dust mitigation plan is required during excavation of serpentinite bedrock in Composite Area 12 (California Code of Regulations, 2002). The serpentinite bedrock in Composite Area 12 is a California hazardous waste due to asbestos and nickel, as discussed below in Section 6.1.6.

6 WASTE CLASSIFICATION AND SOIL MANAGEMENT

Data evaluation was conducted in two phases. The initial phase was to identify soil types and/or locations where the soil would be classified as a hazardous waste. The second phase was to screen those soils that were determined to be non-hazardous wastes for disposal purposes against

[5] California Code of Regulations, 2002, Title 17, Section 93105, Final Regulation Order, Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining Operations, July 22.

ESLs established by the Water Board for residential and commercial/industrial land uses where the groundwater is considered a current or potential source of drinking water (Table A, Water Board, 2008), and against ESLs for construction/trench worker direct exposure (Table K-3, Water Board, 2008). Screening against ESLs was performed to provide information for Caltrans and/or the contractor use to assess health and safety concerns and possible soil reuse options either within the Project or at other locations.

Evaluation of possible reuse of soils within the Project area in accordance with Presidio Trust reuse criteria may be presented in a separate report to be prepared by BASELINE. BASELINE understands the contractor will be preparing a Soil Management Plan based on recommendations of this report and Presidio Trust's response to our request for soil reuse.

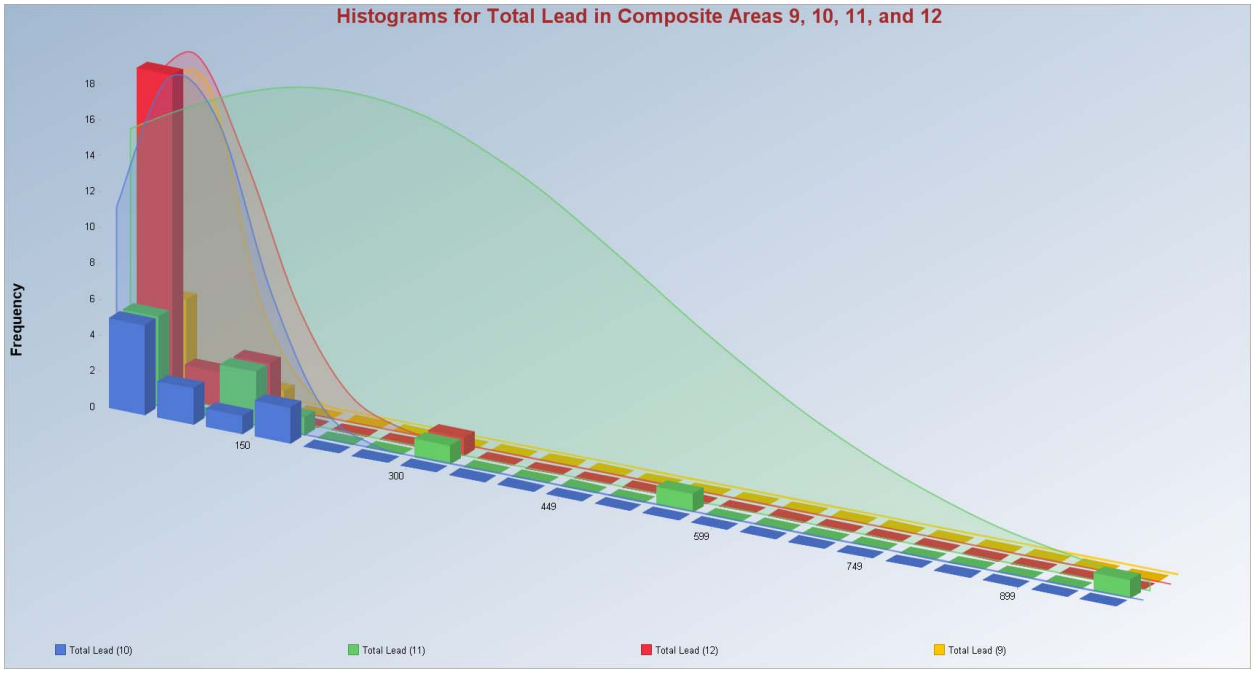
6.1 Evaluation for Waste Classification

The first step in the data evaluation process to determine whether soil may be considered a California or federal hazardous waste was to systematically explore all the soil quality data to identify compounds that may exceed hazardous waste thresholds. The only chemical that had one or more concentrations exceeding hazardous waste thresholds was lead (Table 5). The following discussion regarding hazardous waste thresholds is therefore limited to evaluation of lead.

None of the soil quality data collected during this investigation exceeded any federal TCLP hazardous waste thresholds. All samples with total lead concentrations that exceeded 100 mg/kg (20 times the TCLP threshold) were analyzed for soluble TCLP lead, and all the results were below the federal TCLP hazardous waste threshold of 5 mg/L (Table 5). Therefore, all the soils are not considered federal hazardous wastes.

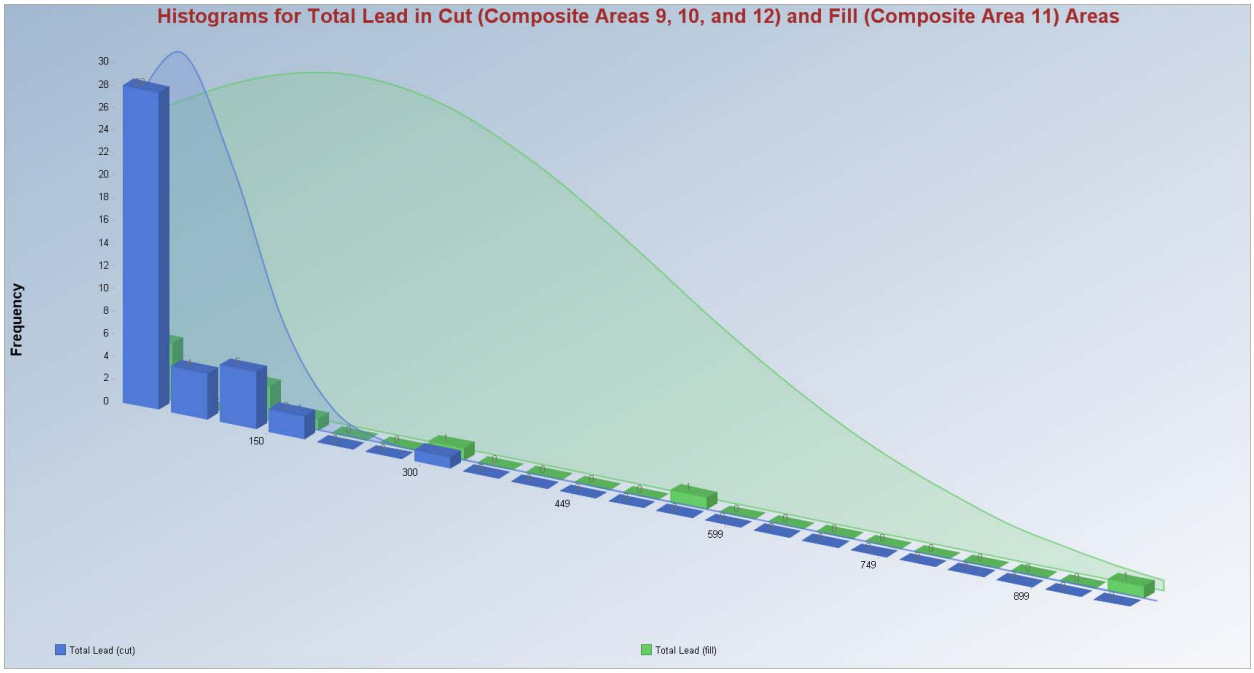
6.1.1 Top 2.5 Feet of Soil in All Composite Areas (9 to 12)

In general, soil samples were collected from 0.5-1.0 and 2.0-2.5 feet bgs and analyzed discretely for total lead. Initial examination of the data revealed that the total lead concentration in Composite Area 11 appeared to be different than in the other Composite Areas, as can be seen in the histograms below.



The histogram for Composite Area 11 (in green) has a much longer tail toward higher concentrations, whereas the histograms for the other Composite Areas appear similar. Therefore, the data for the 40 samples collected from 0-2.5 feet bgs in the proposed cut areas (Composite Areas 9, 10, and 12) were initially considered one subset and data for the 12 samples collected from 0-2.5 feet bgs in the proposed fill area (Composite Area 11) were considered a second subset.

Histograms of the total lead concentrations in the two subsets are shown below. The histograms illustrate that the lead concentrations in the subset of samples from Composite Area 11, which is a potential fill area (charge area), have a significantly longer tail toward higher concentrations, whereas total histogram for Composite Areas 9, 10, and 12, which are proposed excavation areas (cut areas), falls relatively steeply at lower concentrations.



The total lead concentrations in the two subsets were also statistically evaluated using the Wilcoxon-Mann-Whitney test, which is a nonparametric (i.e., no assumption on data distribution) statistical test, to determine whether a difference exists in the two subsets.[6] Using the null hypothesis that the total lead concentrations in the shallow soil from the proposed fill area subset (Composite Area 11) are greater than or equal to those in the proposed cut area subset (Composite Areas 9, 10, and 12) (Form 2), the test found that the null hypothesis should not be rejected at an alpha value of 0.05. Using the null hypothesis that the lead concentrations in soil from the proposed cut area subset are greater than or equal to those in the proposed fill area subset (Form 2), the test found that the null hypothesis should be rejected at an alpha value of 0.05. These results indicate that the lead concentrations in the two subsets were sufficiently different that they should be evaluated separately. The ProUCL outputs for this test are provided in Appendix H.

The majority of the samples collected from the top 2.5 feet of soil in Contract 4 were of fill. Alluvium in shallow soils was encountered sporadically in the western half of Composite Area 12. Separation of shallow fill and alluvium would likely be impractical given that fill and alluvium appeared to be intermixed in this area. Therefore, no attempt was made to classify alluvium separately from fill in the top 2.5 feet of soil.

While all the discrete samples in the two subsets (fill versus cut areas) were analyzed for total lead, only those samples with total lead concentrations greater than 50 mg/kg (ten times the STLC) were analyzed for WET lead. Therefore, to conservatively estimate WET lead

[6] The Wilcoxon-Mann-Whitney test was performed on total lead concentrations, rather than on WET lead concentrations, because only 19 of the 52 discrete samples collected in the top 2.5 feet of soil across all the Composite Areas were actually analyzed for WET lead. The WET lead data set would have been biased because only samples with total lead concentrations above 50 mg/kg would have been analyzed for WET lead.

concentrations for the samples not actually analyzed for WET lead, the WET lead concentrations were assumed to be 10 percent of the total lead concentrations.

The basic statistics for total and WET lead (analyzed and estimated) concentrations in samples collected in the top 2.5 feet from the proposed cut and fill areas are summarized below.

	No. of Samples	Minimum	Maximum	Mean	Median	Variance	Standard Deviation
Total Lead (fill) (mg/kg)	12	8.6	1,000	218	125	86,910	294.8
Total Lead (cut (mg/kg)	40	1.6	320	46	13	4,393	66.28
WET Lead (fill) (mg/L)	12	0.86	23	6.9	4.9	41.85	6.469
WET Lead (cut)) (mg/L)	40	0.16	15	1.9	1.2	7.068	2.659

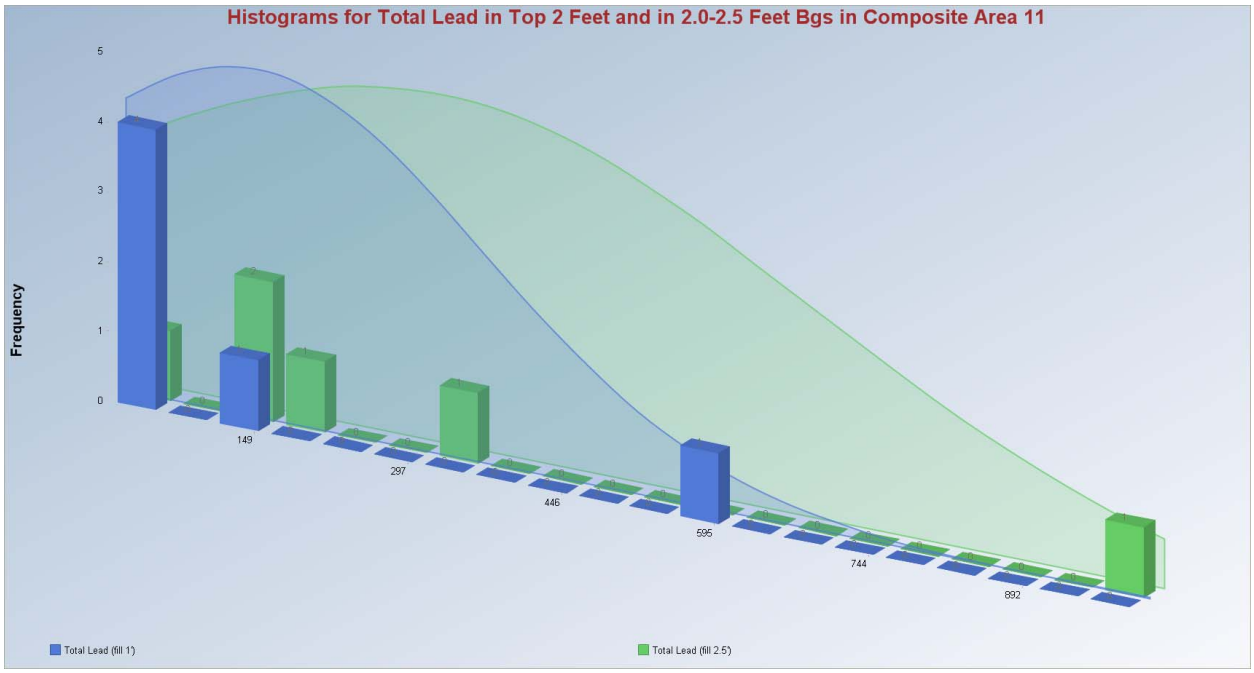
Since the maximum total lead concentration in the proposed fill area subset equaled the TTLC of 1,000 mg/kg, and the maximum WET lead concentrations in both the fill and cut subsets exceeded the STLC of 5 mg/L, these parameters were evaluated further to determine whether representative concentrations exceed California hazardous waste thresholds.

Guidance in the EPA SW-846 specifies that the one-tailed 90 percent upper confidence limit ("UCL") on the mean (which is equivalent to the two-tailed 80 percent UCL) should be calculated and compared to hazardous waste thresholds. If the calculated 90 percent UCL is less than the hazardous waste threshold, then the chemical is not considered to be present in the waste above the threshold, and the waste represented by the data is not considered a hazardous waste due to that chemical (EPA, 1986).

Using ProUCL version 4.00.04 software, estimates of the 90 percent UCL for WET lead concentrations in the less than 2.0 feet bgs subset were calculated (the data and UCL output file is provided in Appendix H). The software tests the data to determine if it is consistent with a normal, lognormal, or gamma distributions, and also calculates UCLs assuming these three distributions as well using nonparametric methods.

6.1.1.1 Total and Soluble WET Lead in Top 2.5 Feet of Soil in Proposed Fill Area (Composite Area 11)

The total and WET lead concentrations in the shallow soil samples collected from Composite Area 11 were higher than from other areas, as discussed in Section 6.1.1, above. Six soil samples were collected from 0.5-1.0 feet bgs and and six samples were collected from 2.0-2.5 feet bgs in Composite Area 11. The total lead concentrations in the two subsets of data were compared using the Wilcoxon-Mann-Whitney test, and test results were inclusive (neither one of the opposite null hypotheses could be rejected). Histograms of the two subsets are shown below.



Therefore, all 12 samples from the top 2.5 feet in Composite Area 11 were considered one group. The basic statistics for total and WET lead concentrations were presented in 6.1.1, above. One of the total lead concentrations equaled the TTLC of 1,000 mg/kg. The seven samples that had total lead concentrations greater than ten times the STLC were analyzed for soluble WET lead, and six of the WET lead concentrations exceeded the STLC of 5 mg/L.

ProUCL was used to estimate the 90 percent UCL for WET lead concentrations in this subset, assuming WET lead concentrations equal to ten percent of the total lead concentration for those samples not actually analyzed for WET lead. The data and UCL output file are provided in Appendix H.

The WET lead concentrations are not normal but are consistent with lognormal and gamma distributions at a five percent significance level. The estimated 90 percent UCLs calculated assuming lognormal and gamma distributions are:

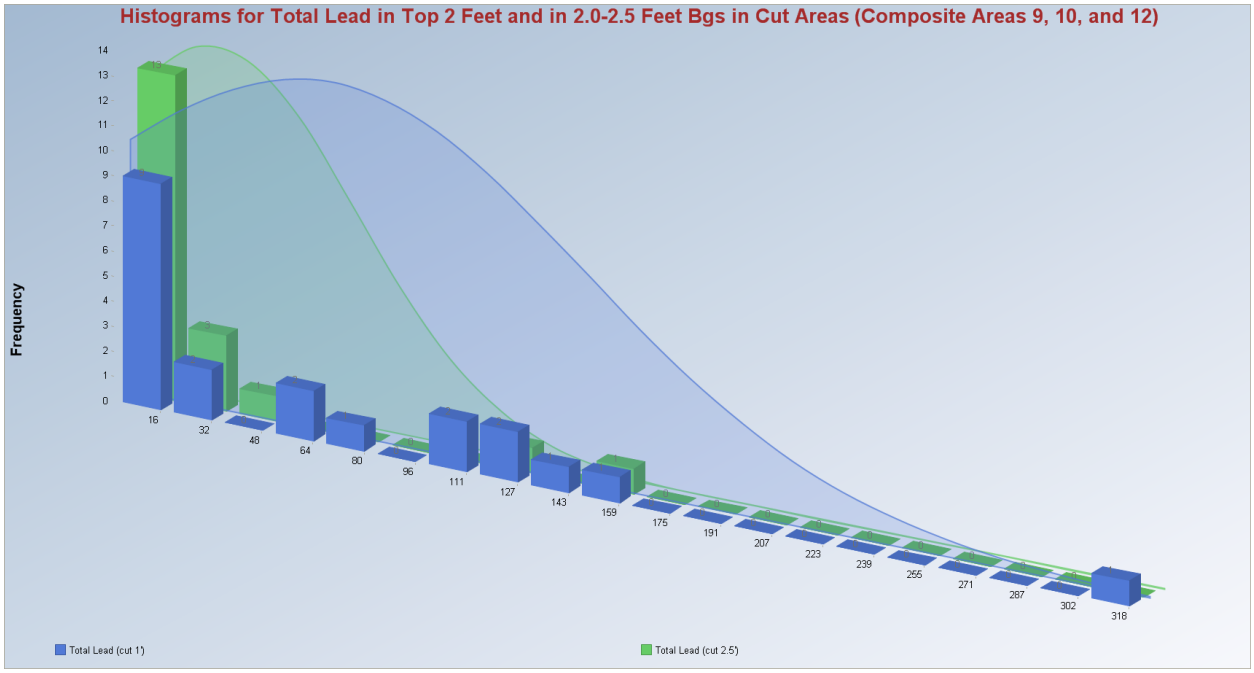
- Gamma Distribution Methods
  - 90% Approximate Gamma UCL =11 mg/L
  - 90% Adjusted Gamma UCL = 11 mg/L
- Lognormal Distribution Methods
  - 90% H-UCL = 15 mg/L
  - 90% Chebyshev (MVUE) UCL = 14 mg/L

The 90% UCL estimates are all greater than the STLC for WET lead of 5 mg/L. Therefore, the representative WET lead concentration in the top 2.5 feet of soil in the proposed fill area (Composite Area 11) would cause the shallow soil above 2.5 feet bgs to be considered a

California hazardous waste. Because this subset is already considered hazardous due to WET lead concentrations, further evaluation of total lead concentrations in this subset is not necessary.

6.1.1.2 Total and Soluble WET Lead in Top 2.5 Feet of Soil in Proposed Cut Areas (Composite Areas 9, 10, and 12)

Twenty-one soil samples were collected from 0.5-2.0 feet bgs and nineteen samples were collected from 2.0-2.5 feet bgs in the proposed cut areas (Composite Areas 9, 10, and 12). Histograms of the total lead concentrations in the two subsets are shown below.



The total lead concentrations in the two subsets of data were compared using the Wilcoxon-Mann-Whitney test, and test results indicate that the two subsets were different at an alpha level of 0.5, and therefore, should be evaluated separately. The outputs from ProUCL are provided in Appendix H.

6.1.1.2.1 Total and Soluble WET Lead in Soil in Top Two Feet Subset in Proposed Cut Areas

The basic statistics on total and WET concentrations in the 21 samples collected from 0.5-2.0 feet bgs are presented below.

	No. of Samples	Minimum	Maximum	Mean	Median	Variance	Standard Deviation
Tot Lead (cut1)	21	2.2	320	65	20	6,075	77.94
WET Lead (cut1)	21	0.22	15	2.6	1.4	11.3	3.362

The maximum total lead concentration was 320 mg/kg, below the TTLC. The maximum WET lead concentration was 15 mg/L, which exceeded the STLC. Using the ten actual soluble WET

lead concentrations and ten estimated WET lead concentrations (assuming ten percent of total lead concentrations) in the less than 2 feet bgs subset, 90 percent UCLs were calculated using ProUCL. The data and ProUCL output are provided in Appendix H. The data do not follow a normal distribution, but are consistent with both a lognormal and gamma distribution at a five percent significance level. The estimated 90 percent UCLs, assuming lognormal and gamma distributions, are:

- Gamma Distribution Methods
  - 90% Approximate Gamma UCL = 3.6 mg/L
  - 90% Adjusted Gamma UCL = 3.6 mg/L
- Lognormal Distribution Methods
  - 90% H-UCL = 4.0 mg/L
  - 90% Chebyshev (MVUE) UCL = 4.4 mg/L

The 90% UCL estimates are all less than the STLC for WET lead of 5 mg/L. Therefore, the representative WET lead concentration in the less than 2 feet bgs subset in the proposed cut areas (Composite Areas 9, 10, and 12) would not cause the shallow soil to be considered a California hazardous waste.

6.1.1.2.2 Total and Soluble WET Lead in Soil in 2.0-2.5 Feet bgs Subset in Proposed Cut Areas (Composite Areas 9, 10, and 12)

The total and soluble WET lead concentrations in the 19 samples collected from 2.0-2.5 feet bgs in the proposed cut areas are presented below.

Sample ID	Sample Depth (feet bgs)	Lead (mg/kg)	WET Lead (mg/L)
E059F-2.5	2.5	120	1.1
E060FS-2.5	2.5	21	Not analyzed
E061C-2.5	2.5	2.5	Not analyzed
E063F-2.5	2.5	160	1.9
E065F-2.5	2.5	23	Not analyzed
E067F-2.5	2.5	13	Not analyzed
E069F-2.5	2.5	4	Not analyzed
E073F-2.5	2.5	3	Not analyzed
E074F-2.5	2.5	4.6	Not analyzed
E075F-2.5	2.5	30	Not analyzed
E076F-2.5	2.5	2.4	Not analyzed
E077A-2.5	2.5	1.8	Not analyzed
E077AA-2.5	2.5	6.9	Not analyzed
E078A-2.5	2.5	1.9	Not analyzed
E078AA-2.5	2.5	2.8	Not analyzed
E079F-2.5	2.5	49	Not analyzed
E080A-2.5	2.5	1.6	Not analyzed
E081F-2.5	2.5	13	Not analyzed
E082A-2.5	2.5	5.1	Not analyzed

The maximum total lead concentration was 160 mg/kg, less than the TTLC. The two samples that had total lead concentrations greater than ten times the STLC were analyzed for soluble WET lead, and none of the WET lead concentrations exceeded the STLC of 5 mg/L. Therefore, neither the total nor soluble WET lead concentrations in the proposed cut areas (Composite Areas 9, 10, and 12) would cause the soil in the 2.0-2.5 feet bgs subset to be considered a California hazardous waste.

6.1.2 Fill Deeper than 2.5 Feet bgs in Proposed Cut Areas (Composite Areas 9, 10, and 12)

During the field investigation, a total of 11 composite samples of fill were analyzed from the proposed cut areas (Composite Areas 9, 10, and 12).[7] All but one of the composite samples were made up of one or more discrete samples collected from shallower than 2.5 feet bgs.[8] Since the shallow soils are known to have higher lead concentrations, the composite sample results were not considered representative of the deeper fill. To obtain representative lead concentrations in the deeper fill, three new composite samples, made up of all the discrete fill samples collected from deeper than 2.5 feet bgs that was not already appropriately composited to characterize deeper fill, were analyzed. One new composite sample was analyzed for each of Composite Areas 9, 10, and 12. Lead concentrations in the three additional and one original composite samples of discrete samples of fill collected from deeper than 2.5 feet bgs are presented below.

Sample ID	Sample Depth (feet bgs)	Lead (mg/kg)	WET Lead (mg/L)
EC09-F005	7.5-12.5	7.3	Not analyzed
EC10-F004	7.5-22.5	21	Not analyzed
EC10-F005	7.5-22.0	18	Not analyzed
EC12-F006	7.5-12.5	3.1	Not analyzed

Total lead concentrations ranged from 3.1 to 21 mg/kg, which are below the TTLC. None of the samples contained total lead above 50 mg/kg so none was analyzed for WET lead. Therefore, fill deeper than 2.5 feet bgs in Composite Areas 9, 10, and 12 would not be considered a California hazardous waste due to lead.

6.1.3 Alluvium Deeper than 2.5 Feet bgs in Composite Areas 10 and 12

Alluvium deeper than 2.5 feet bgs was only encountered in Composite Areas 10 and 12[8] during the investigation. Lead concentrations from nine composite samples of alluvium from Composite Areas 10, and 12 are presented below.[9]

[7] Soil samples were not collected below a depth of 2.5 feet in the proposed fill area (Composite Area 11) since excavation was not planned in that area.

[8] The primary purpose for the composite sample analyses was for the analysis of the Title 22 metals other than lead and organic constituents.

[9] Note that four of the composite samples included discrete samples collected from 2.5 feet bgs and above.

Sample ID	Sample Depth (feet bgs)	Lead (mg/kg)	WET Lead (mg/L)
EC10-A001	7.0-17.5	5.5	Not analyzed
EC10-A002	7.5-17.0	4.1	Not analyzed
EC12-A001	7.5-17.0	5.2	Not analyzed
EC12-A002	1.0-7.5	5.9	Not analyzed
EC12-A003	7.5-27.5	2.7	Not analyzed
EC12-A004	2.5-22.5	2	Not analyzed
EC12-A005	1.0-27.5	4.5	Not analyzed
EC12-F006	1.0-17.5	4.9	Not analyzed
EC12-A007	12.5-22.5	4.4	Not analyzed

Total lead concentrations ranged from 2 to 5.5 mg/kg, which are below the TTLC. None of the samples contained total lead above 50 mg/kg so none was analyzed for WET lead. Therefore, alluvium deeper than 2.5 feet bgs in Composite Areas 10 and 12 would not be considered a California hazardous waste due to lead.

6.1.4 Colma Sand Deeper than 2.5 Feet bgs in Proposed Cut Areas (Composite Areas 9, 10, and 12)

Lead concentrations of five composite samples of Colma Sand collected from deeper than 2.5 feet bgs in the proposed cut areas (Composite Areas 9, 10, and 12) are presented below.[10]

Sample ID	Sample Depth (feet bgs)	Lead (mg/kg)	WET Lead (mg/L)
EC09-C001	2.5-12.5	2.5	Not analyzed
EC10-C001	17.5-27.5	2.7	Not analyzed
EC12-C001	17.5-32.5	3.3	Not analyzed
EC12-C002	12.5-37.5	2.9	Not analyzed
EC12-C003	22.5-32.5	2.9	Not analyzed

Total lead concentrations ranged from 2.5 to 3.3 mg/kg, which are below the TTLC. None of the samples contained total lead above 50 mg/kg so WET lead was not analyzed. Therefore, Colma Sand deeper than 2.5 feet bgs in Composite Areas 9, 10, and 12 would not be considered a California hazardous waste due to lead.

6.1.5 Non-Serpentinite Bedrock in Composite Area 12

Non-serpentinite bedrock was only encountered in Composite Area 12 during the investigation. Lead concentrations from the two composite samples of bedrock collected from Composite Area 12 are presented below.

Sample ID	Sample Depth (feet bgs)	Lead (mg/kg)	WET Lead (mg/L)
EC12-BR001	7.5-22.5	9.2	Not analyzed
EC12-BR002	23.0-38.0	7.3	Not analyzed

[10] Soil samples were not collected below a depth of 2.5 feet in the proposed fill area (Composite Area 11) since excavation was not planned in that area.

Total lead concentrations were 7.3 and 9.2 mg/kg, which are below the TTLC. Neither of the samples contained total lead above 50 mg/kg so they were not analyzed for WET lead. Therefore, the non-serpentinite bedrock encountered in Composite Area 12 would not be considered a California hazardous waste due to lead.

6.1.6 Serpentinite Bedrock in Composite Area 12

Six discrete samples from geotechnical borings BTNB-R3, BTNB-R2, and BTSB-R2 of serpentinite bedrock were analyzed for nickel and chromium. The total chromium concentrations in these samples ranged from 220 to 1,200 mg/kg. The total nickel concentrations in these samples ranged from 1,900 to 3,100 mg/kg and the average was 2,300 mg/kg, which is greater than the TTLC of 2,000 mg/kg (Table 4). Therefore, serpentinite bedrock in Composite Area 12 should be considered a California hazardous waste due to nickel.

Asbestos was analyzed for six serpentinite bedrock samples collected from cores of three previously drilled geotechnical borings (BTNB-R2, BTNB-R3, and BTSB-R2) in Composite Area 12 (Table 11 and Figure 2). Asbestos was reported in these samples at concentrations ranging from 0.75 to 2.5%, indicating a dust mitigation plan is required during excavation of serpentinite bedrock in Composite Area 12. The mean concentration of asbestos in these six samples was 1.78%, above the TTLC of 1%, and the asbestos was identified as chrysotile, a friable form of serpentine. Therefore, the serpentinite bedrock in Composite Area 12 is a California hazardous waste due to asbestos.

6.2 Screening against ESLs

Chemical concentrations quantified above laboratory reporting limits associated with soils that were classified as non-hazardous wastes were screened against ESLs established by the Water Board for residential and commercial/industrial land uses where the groundwater is considered a current or potential source of drinking water (Table A, Water Board, 2008), and against ESLs for construction/trench worker direct exposure (Table K-3, Water Board, 2008). The ESLs are listed in Tables 4 through 10. The compounds that exceeded one or more ESLs in the different soil types that were determined to be non-hazardous wastes are summarized below.

Soil Type	Compound	ESL(s) Exceeded
Alluvium in Composite Areas 9, 10, and 12	Arsenic	Residential and commercial/industrial land uses
	Vanadium	Residential land use
Bedrock (not serpentinite) in Composite Area 12	Arsenic	Residential and commercial/industrial land uses
	Vanadium	Residential land use
Colma Sand in Composite Areas 9, 10, and 12	Arsenic	Residential and commercial/industrial land uses
	Vanadium	Residential land use
Fill in Composite Areas 9, 10, and 12	Arsenic	Residential and commercial/industrial land uses
	Lead	Residential land use
	Vanadium	Residential land use
	Benzo(a)anthracene	Residential and commercial/industrial land uses

Soil Type	Compound	ESL(s) Exceeded
	Benzo(a)pyrene	Residential and commercial/industrial land uses, and construction worker direct contact
	Benzo(b)fluoranthene	Residential and commercial/industrial land uses
	Benzo(k)fluoranthene	Residential land use
	Dibenz(a,h)anthracene	Residential and commercial/industrial land uses
	Indeno(1,2,3-c,d) pyrene	Residential land use
	TPH as diesel	Residential and commercial/industrial land uses
	TPH as motor oil	Residential land use

The information summarized above should be considered a preliminary screening only, and more detailed evaluation may be needed for specific scenarios. The following issues should be considered when reviewing the information:

- Even if only one of numerous samples contained a compound that exceeded an ESL, that compound is listed in the above table. For example, only one out of the 11 samples of fill that were analyzed for PAHs contain benzo(b)fluoranthene above the ESL for residential land use.

- Arsenic ESLs are based on human health risk concerns. Background concentrations for arsenic established by the Lawrence Berkeley National Laboratory ("LBNL") are substantially higher than the ESLs for residential and commercial/industrial land uses. The 95th percentile for arsenic determined by the LBNL is 17 mg/kg (LBNL, 2009), whereas the residential and commercial/industrial ESLs are 0.39 and 1.6 mg/kg, respectively. Background concentrations for arsenic established by Presidio Trust are also higher than the ESLs for residential and commercial/industrial land uses and range from 3.2 to 6.2 mg/kg, depending on lithology (EKI, 2002).

7 CONCLUSIONS

A systematic investigation of the quality of soils that are expected to be excavated within the Project has provided data to support waste classification of the soils for disposal purposes and preliminary screening against ESLs established by the Water Board.

The results of the waste classification are summarized in Table 13. The following soil group or soil types are classified as California hazardous wastes:

- All soil in the top 2.5 feet in Composite Area 11, which consisted of only fill. Excavation was not planned in Composite Area 11, and therefore, no samples were collected from deeper than 2.5 feet bgs during this investigation. Additional characterization of soils below 2.5 feet bgs should be performed if excavation below 2.5 feet were to occur.

- Serpentinite bedrock in Composite Area 12.

The following soil types are classified as non-hazardous wastes:

- Soil in the top 2.5 feet in Composite Areas 9, 10, and 12.
- Fill deeper than 2.5 feet bgs in Composite Areas 9, 10, and 12.
- Alluvium deeper than 2.5 feet bgs in Composite Areas 10 and 12. Alluvium was not encountered in Composite Area 9.
- Colma Sand deeper than 2.5 feet bgs in Composite Areas 9, 10, and 12.
- Bedrock (not serpentinite) in Composite Area 12. Bedrock was not encountered in Composite Areas 9 or 10.

A preliminary screening of chemical constituents against ESLs in shallow soils for residential and commercial/industrial land uses where groundwater is a current or potential drinking water source, and against ESLs for construction/trench workers, indicates that one or more samples of each soil group classified as a non-hazardous waste exceeds one or more ESLs. A more detailed evaluation should be performed to assess specific scenarios of possible soil reuse.

8 LIMITATIONS

BASELINE's objective is to perform our work with care, exercising the customary thoroughness and competence of earth science, environmental, and engineering consulting professionals, in accordance with the standard for professional services for a consulting firm at the time these services were provided. It is important to recognize that even the most comprehensive scope of services may fail to detect environmental conditions and potential liability at a particular site. Therefore, BASELINE cannot act as insurers and cannot "certify or underwrite" that a site is free of environmental contamination, and no expressed or implied representation or warranty is included or intended in this report except that the work was performed within the limits prescribed with the customary thoroughness and competence of our profession.

The passage of time, manifestation of latent conditions, or occurrence of future events may require further exploration at the project site, analysis of the data, and re-evaluation of the findings, observations, conclusions, and recommendations expressed in the report.

The findings, observations, conclusions, and recommendations expressed by BASELINE in this report are limited by the scope of services and should not be considered an opinion concerning the compliance of any past or current owner or operator of the site with any federal, state, or local law or regulation. No warranty or guarantee, whether expressed or implied is made with respect to the data reported or findings, observations, conclusions, and recommendations expressed in this report.

9 REFERENCES

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FIGURES

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	sf	101,1	9.2/9.8, 6.8/7.1		

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

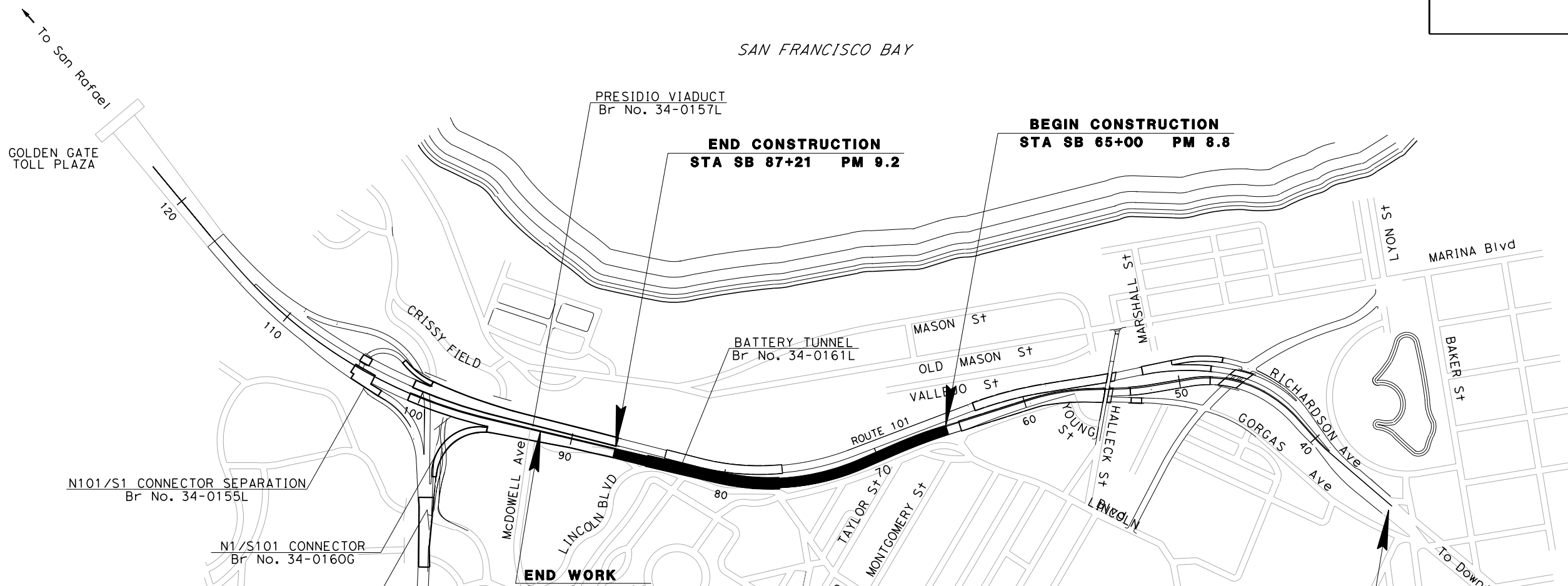
PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN THE CITY AND COUNTY OF SAN FRANCISCO
0.4 MILE SOUTH OF THE
ROUTE 101/1 SEPARATION

TO BE SUPPLEMENTED BY STANDARD PLANS DATED MAY 2006

LOCATION MAP



NOTE:

1. MAPPING AND LIMIT OF WORK INFORMATION FROM CALTRANS.

CONTRACT 4 AREA & REGIONAL PLAN
FIGURE 1 - JULY 24, 2009

0 250 500 1000
FEET

ARUP PB joint venture

Caltrans

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

DATE PLOTTED => $DATE
TIME PLOTTED => $TIME

LAST REVISION 00-00-00

LEGEND:

E062 (10)	ENVIROMENTAL BORING LOCATION COMPOSITE AREA
BNTB-R21 (12)	GEOTECHNICAL BORING LOCATION COMPOSITE AREA (Only Serpertine Bedrock Samples Analyzed at These Locations)
	TEMPORARY CONSTRUCTION EASEMENT (Caltrans 06 April 2009)
	PROPOSED CUT (Caltrans 02 July 2008)
	LOCATION OF POSSIBLE CONTAMINATION AND POTENTIAL LAND USE CONTROL BOUNDARY UNLESS NOTED OTHERWISE
12	COMPOSITE AREA BOUNDARY

Caltrans

ARUP PB joint venture

DOYLE DRIVE REPLACEMENT PROJECT - CONTRACT 4

Environmental Boring Locations and Composite Areas

FIGURE 2 - August 21, 2009 - Rev 02

TABLES

TABLE 1: Soil Boring Survey Data
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Cut or Fill[3]	Drilling Method	Boring Depth	Installatior Date	Project Survey Coordinates[1]			Presidio Trust Survey Coordinates[2]		
						Northing	Easting	Elevation	Northing	Easting	Elevation
9	E059	Cut	HSA	7.5	1/23/2009	2120693.59	5996425.58	12.80	480286.36	1435057.51	13.17
9	E060	Cut	HSA	10.0	1/23/2009	2120739.75	5996360.83	12.56	480332.51	1434992.77	12.93
9	E061	Cut	HSA	12.5	1/22/2009	2120616.78	5996246.58	15.52	480209.54	1434878.52	15.89
11	E062	Fill	DPT	2.5	1/16/2009	2120662.25	5996129.77	12.87	480255.01	1434761.71	13.24
10	E063	Cut	HSA	22.5	1/22/2009	2120538.33	5996051.58	40.10	480131.09	1434683.52	40.47
11	E064	Fill	DPT	2.5	1/16/2009	2120599.62	5995929.49	12.28	480192.38	1434561.42	12.65
10	E065	Cut	HSA	22.5	1/22/2009	2120481.62	5995875.60	44.70	480074.37	1434507.53	45.07
11	E066	Fill	DPT	2.5	1/16/2009	2120535.26	5995742.86	12.15	480128.02	1434374.79	12.52
10	E067	Cut	HSA	22.5	1/21/2009	2120369.57	5995667.73	54.48	479962.32	1434299.67	54.85
11	E068	Fill	DPT	2.5	1/16/2009	2120472.18	5995546.01	11.89	480064.93	1434177.94	12.26
10	E069	Cut	HSA	22.5	1/21/2009	2120296.79	5995517.29	63.84	479889.53	1434149.22	64.21
11	E070	Fill	DPT	2.5	1/16/2009	2120408.33	5995346.36	12.60	480001.08	1433978.29	12.97
10	E071	Cut	HSA	27.5	1/21/2009	2120266.36	5995354.58	70.97	479859.11	1433986.51	71.34
11	E072	Fill	DPT	2.5	1/16/2009	2120370.68	5995187.76	17.65	479963.42	1433819.69	18.02
12	E073	Cut	HSA	33.0	1/15/2009	2120198.80	5995091.71	85.14	479791.54	1433723.64	85.51
12	E074	Cut	HSA	40.0	1/12/2009	2120363.70	5994997.01	70.22	479956.44	1433628.94	70.59
12	E075	Cut	HSA	28.0	1/15/2009	2120249.73	5994867.92	91.49	479842.47	1433499.85	91.86
12	E076	Cut	HSA	33.5	1/12/2009	2120379.69	5994828.09	78.03	479972.43	1433460.01	78.40
12	E077	Cut	HSA	28.0	1/15/2009	2120247.25	5994588.54	96.81	479839.98	1433220.46	97.18
12	E077A	Cut	HA	2.5	1/14/2009	2120282.34	5994595.25	90.26	479875.08	1433227.17	90.63
12	E078	Cut	HSA	27.5	1/14/2009	2120286.41	5994479.35	98.96	479879.14	1433111.27	99.33
12	E078A	Cut	HA	2.5	1/14/2009	2120314.56	5994495.61	91.68	479907.29	1433127.52	92.05
12	E079	Cut	HSA	38.0	1/16/2009	2120337.14	5994394.43	100.25	479929.87	1433026.34	100.62
12	E080	Cut	HSA	18.0	1/14/2009	2120326.29	5994301.86	103.84	479919.02	1432933.77	104.21
12	E081	Cut	HSA	8.5	1/13/2009	2120394.42	5994256.59	105.56	479987.15	1432888.51	105.93
12	E082	Cut	HSA	23.0	1/13/2009	2120380.24	5994109.87	108.44	479972.97	1432741.78	108.81
12	BTNB-R2[4]	Cut	MR	71.5	6/1/2008	2120407.63	5994505.43	89.42	480000.36	1433137.35	89.79
12	BTNB-R3[4]	Fill	MR	100	7/26/2008	2120351.99	5994725.98	86.29	479944.72	1433357.90	86.66
12	BTSB-R2[4]	Fill	MR	115	2/29/2008	2120218.26	5994858.34	92.12	479811.00	1433490.27	92.49

Notes:

bgs = below ground surface.
Drilling Methods:
HA=Hand Auger
HSA= Hollow Stem Auger
DPT= Direct Push Technology
MR = Mud Rotary

[1] Project survey coordinates and vertical datum in NAD83 (State Plane System, California Zone III) and NAVD 88, respectively. Borings surveyed at ground elevation by Chaudhary & Associates.

[2] Presidio Trust survey coordinates and vertical datum are in NAD27 and Presidio Low Low Water (PLLW), respectively. Survey data calculated by Chaudhary & Associates from NAD 83 and NAVD 88.

[3] Proposed cut and potential fill areas are shown on Figure 2. Borings BTNB-R2, E067, E069, E073, E076, and E077 are located immediately outside the proposed cut area due to drill rig access limitations. These borings are intended to represent soil that will be encountered during excavation activities.

[4] The Battery Tunnel Northbound (BTNB) and Battery Tunnel Southbound (BTSB) borings were drilled by ARUP in 2008 for geotechnical purposes on behalf of ARUP/PB Joint Venture.

TABLE 2: Soil Composite and Discrete Sample Correlations
Contract 4 of Doyle Drive Replacement Project

Composite Area	Composite Sample ID	Discrete Sample ID	Lithology
9	EC09-C001	E061C-12.5	C
		E061C-2.5	
		E061C-7.5	
9	EC09-F001	E057F-1.0	F
		E059F-1.0	
		E059F-2.5	
		E059F-7.5	
		E061F-1.0	
9	EC09-F003	E055F-12.5	F/FS
		E055F-7.5	
		E060F-1.0	
		E060FS-2.5	
9	EC09-F004	E058F-1.0	F
		E058F-2.5	
		E058F-7.5	
		E060F-7.5	
9	EC09-F005	E055F-7.5	F
		E055F-12.5	
		E058F-7.5	
		E059F-7.5	
		E060F-7.5	
10	EC10-A001	E069A-12.5	A
		E069A-7.0	
		E071A-12.5	
		E071A-17.5	
10	EC10-A002	E067A-12.5	A
		E067A-7.5	
		E069A-17.5	
10	EC10-C001	E067C-17.5	C
		E067C-22.5	
		E069C-22.5	
		E071C-22.5	
		E071C-27.5	
10	EC10-F001	E069F-1.0	F
		E069F-2.5	
		E071F-1.0	
		E071F-2.0	
		E071F-7.5	
10	EC10-F002	E065F-1.0	F
		E065F-2.5	
		E065F-7.5	
		E067F-1.0	
		E067F-2.5	
10	EC10-F003	E063F-1.0	F
		E063F-2.5	
		E065F-12.5	
		E065F-17.5	
		E065F-22.0	
10	EC10-F004	E063F-11.5[1]	F/FS
		E063F-17.5	
		E063F-7.5	
		E063FS-22.5	

TABLE 2: Soil Composite and Discrete Sample Correlations
Contract 4 of Doyle Drive Replacement Project

Composite Area	Composite Sample ID	Discrete Sample ID	Lithology
10	EC10-F005	E065F-7.5	F
		E065F-12.5	
		E065F-17.5	
		E065F-22.0	
		E071F-7.5	
11	EC11-F001	E070F-1.0	F
		E070F-2.5	
		E072F-1.0	
		E072F-2.5[2]	
11	EC11-F002	E066F-1.0	F
		E066F-2.5	
		E068F-1.0	
		E068F-2.5	
11	EC11-F003	E062F-1.0	F
		E062F-2.5	
		E064F-1.0	
		E064F-2.5	
12	EC12-A001	E074A-12.5	A
		E074A-7.5	
		E076A-12.5	
		E076A-17.5	
		E076A-7.5	
12	EC12-A002	E080A-2.5	A
		E080A-7.5	
		E082A-1.0	
		E082A-2.5	
		E082A-7.5	
12	EC12-A003	E079A-12.5	A
		E079A-17.5	
		E079A-22.5	
		E079A-27.5	
		E079A-7.5	
12	EC12-A004	E078A-12.5	A
		E078A-17.5	
		E078A-2.5	
		E078A-22.5	
		E078A-7.5	
12	EC12-A005	E077A-2.5	A
		E077A-7.5	
		E078A-27.5	
		E078AA-1.0	
		E078AA-2.5	
12	EC12-A006	E075A-7.5	A
		E077A-12.5	
		E077A-17.5	
		E077AA-1.0	
		E077AA-2.0	
12	EC12-A007	E073A-17.5	A
		E073A-22.5	
		E075A-12.5	
		E075A-17.5	
12	EC12-BR001	E080BR-12.5	BR

TABLE 2: Soil Composite and Discrete Sample Correlations
Contract 4 of Doyle Drive Replacement Project

Composite Area	Composite Sample ID	Discrete Sample ID	Lithology
		E080BR-17.5	
		E081BR-7.5	
		E082BR-17.5	
		E082BR-22.5	
12	EC12-BR002	E077BR-23.0	BR
		E077BR-28.0	
		E079BR-33.0	
		E079BR-38.0	
12	EC12-C001	E074C-17.5	C
		E074C-22.5	
		E076C-22.5	
		E076C-27.5	
		E076C-32.5	
12	EC12-C002	E074C-27.5	C
		E074C-32.5	
		E074C-37.5	
		E082C-12.5	
12	EC12-C003	E073C-27.5	C
		E073C-32.5	
		E075C-22.5	
		E075C-27.5	
12	EC12-F002	E078F-1.0	F
		E079F-1.0	
		E079F-2.5	
		E081F-1.0	
		E081F-2.5	
12	EC12-F003	E073F-1.0	F
		E075F-1.0	
		E075F-2.5	
		E077F-1.0	
12	EC12-F004	E073F-12.5	F
		E073F-2.5	
		E073F-7.5	
12	EC12-F005	E074F-1.0	F
		E074F-2.5	
		E076F-1.0	
		E076F-2.5	
		E080F-1.0	
12	EC12-F006	E073F-7.5	F
		E073F-12.5	

Notes:
Boring locations are shown on Figure 2.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
bgs = below ground surface.

[1] The laboratory sample identification was E063F-12.5. BASELINE changed the sample identification to E063F-11.5 based on review of the boring log.
[2] The laboratory sample identification was E072F-2.0. BASELINE changed the sample identification to E072F-2.5 based on review of the boring log.

TABLE 3: Summary of Soil Sample Analyses
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Lithology	Title 22 Metals	Total Lead (Only)	Soluble Chromium	Soluble Lead	Total Petroleum Hydrocarbons	Volatile Organic Compounds	Semi-Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons	Pesticides	Herbicides	Polychlorinated Biphenyls	Asbestos	Cyanide	Sulfide	Ignitability	pH	Moisture
					Table Location:	**4,5**	**5**	**5**	**5**	**6**	**7**	**NT**	**8**	**9**	**NT**	**10**	**11**	**12**	**12**	**12**	**12**	**12**
9	E059	E059F-1.0	1.0	1/23/2009	F		X															
9	E059	E059F-2.5	2.5	1/23/2009	F		X		X													
9	E060	E060F-1.0	1.0	1/23/2009	F		X															
9	E060	E060FS-2.5	2.5	1/23/2009	FS		X										X					
9	E061	E061C-2.5	2.5	1/22/2009	C		X															
9	E061	E061F-1.0	1.0	1/22/2009	F		X															
11	E062	E062F-1.0	1.0	1/16/2009	F		X															X
11	E062	E062F-2.5	2.5	1/16/2009	F		X															X
10	E063	E063F-1.0	1.0	1/22/2009	F		X		X													
10	E063	E063F-2.5	2.5	1/22/2009	F		X		X													
10	E063	E063FS-22.5	22.5	1/22/2009	FS												X					
11	E064	E064F-1.0	1.0	1/16/2009	F		X		X													X
11	E064	E064F-2.5	2.5	1/16/2009	F		X		X													X
10	E065	E065F-1.0	1.0	1/22/2009	F		X		X													
10	E065	E065F-2.5	2.5	1/22/2009	F		X															
11	E066	E066F-1.0	1.0	1/16/2009	F		X		X													X
11	E066	E066F-2.5	2.5	1/16/2009	F		X		X													X
10	E067	E067F-1.0	1.0	1/21/2009	F		X		X													
10	E067	E067F-2.5	2.5	1/21/2009	F		X															
11	E068	E068F-1.0	1.0	1/16/2009	F		X															X
11	E068	E068F-2.5	2.5	1/16/2009	F		X		X													X
10	E069	E069F-1.0	1.0	1/21/2009	F		X															
10	E069	E069F-2.5	2.5	1/21/2009	F		X															
11	E070	E070F-1.0	1.0	1/16/2009	F		X															X
11	E070	E070F-2.5	2.5	1/16/2009	F		X		X													X

TABLE 3: Summary of Soil Sample Analyses
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Lithology	Title 22 Metals	Total Lead (Only)	Soluble Chromium	Soluble Lead	Total Petroleum Hydrocarbons	Volatile Organic Compounds	Semi-Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons	Pesticides	Herbicides	Polychlorinated Biphenyls	Asbestos	Cyanide	Sulfide	Ignitability	pH	Moisture
					Table Location:	**4,5**	**5**	**5**	**5**	**6**	**7**	**NT**	**8**	**9**	**NT**	**10**	**11**	**12**	**12**	**12**	**12**	**12**
10	E071	E071F-1.0	1.0	1/21/2009	F		X		X													
10	E071	E071F-2.0	2.0	1/21/2009	F		X															
11	E072	E072F-1.0	1.0	1/16/2009	F		X															X
11	E072	E072F-2.5 [1]	2.5	1/16/2009	F		X		X													X
12	E073	E073F-1.0	1.0	1/15/2009	F		X		X													
12	E073	E073F-2.5	2.5	1/15/2009	F		X															
12	E074	E074F-1.0	1.0	1/12/2009	F		X		X													
12	E074	E074F-2.5	2.5	1/12/2009	F		X															
12	E075	E075F-1.0	1.0	1/15/2009	F		X		X													X
12	E075	E075F-2.5	2.5	1/15/2009	F		X															X
12	E076	E076F-1.0	1.0	1/12/2009	F		X		X													
12	E076	E076F-2.5	2.5	1/12/2009	F		X															
12	E077	E077A-2.5	2.5	1/15/2009	A		X															X
12	E077A	E077AA-1.0	1.0	1/14/2009	A		X															
12	E077A	E077AA-2.5	2.5	1/14/2009	A		X															
12	E077	E077F-1.0	1.0	1/15/2009	F		X															X
12	E078	E078A-2.5	2.5	1/14/2009	A		X															
12	E078A	E078AA-1.0	1.0	1/14/2009	A		X															
12	E078A	E078AA-2.5	2.5	1/14/2009	A		X															
12	E078	E078F-1.0	1.0	1/14/2009	F		X															
12	E079	E079F-1.0	1.0	1/16/2009	F		X		X													X
12	E079	E079F-2.5	2.5	1/16/2009	F		X															X
12	E080	E080A-2.5	2.5	1/14/2009	A		X															
12	E080	E080F-1.0	1.0	1/14/2009	F		X		X													
12	E081	E081F-1.0	1.0	1/13/2009	F		X															X

TABLE 3: Summary of Soil Sample Analyses
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Lithology	Title 22 Metals	Total Lead (Only)	Soluble Chromium	Soluble Lead	Total Petroleum Hydrocarbons	Volatile Organic Compounds	Semi-Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons	Pesticides	Herbicides	Polychlorinated Biphenyls	Asbestos	Cyanide	Sulfide	Ignitability	pH	Moisture
					Table Location:	**4,5**	**5**	**5**	**5**	**6**	**7**	**NT**	**8**	**9**	**NT**	**10**	**11**	**12**	**12**	**12**	**12**	**12**
12	E081	E081F-2.5	2.5	1/13/2009	F		X															X
12	E082	E082A-1.0	1.0	1/13/2009	A		X															X
12	E082	E082A-2.5	2.5	1/13/2009	A		X															X
12	BTNB-R2	BTNB-R2-27.0-27.5 [2]	27.0-27.5	8/14/2009	BRS	X											X					
12	BTNB-R2	BTNB-R2-29.5-30.0 [2]	29.5-30.0	8/14/2009	BRS	X											X					
12	BTSB-R2	BTSB-R2-51.0-51.5 [2]	51.0-51.5	8/14/2009	BRS	X											X					
12	BTSB-R2	BTSB-R2-53.5-54.0 [2]	53.5-54.0	8/14/2009	BRS	X											X					
12	BTNB-R3	BTNB-R3-48.5-49.0 [2]	48.5-49.0	8/14/2009	BRS	X											X					
12	BTNB-R3	BTNB-R3-51.0-51.5 [2]	51.0-51.5	8/14/2009	BRS	X											X					
9	--	EC09-C001	2.5-12.5	1/22/2009	C	X		X		X	X	X	X			X		X	X		X	X
9	--	EC09-F001	1.0-7.5	1/22/2009	F	X		X		X	X	X	X	X	X	X		X	X		X	X
9	--	EC09-F003	1.0-12.5	1/23/2009	F	X		X		X	X	X	X	X	X	X		X	X		X	X
9	--	EC09-F004	1.0-7.5	1/23/2009	F	X			X	X	X	X	X	X	X	X		X	X		X	X
9	--	EC09-F005	7.5-12.5	1/23/2009	F		X															X
10	--	EC10-A001	7.0-17.5	1/21/2009	A	X		X		X	X	X	X			X		X	X		X	X
10	--	EC10-A002	7.5-17.5	1/21/2009	A	X		X		X	X	X	X			X		X	X		X	X
10	--	EC10-C001	17.5-27.5	1/21/2009	C	X		X		X	X	X	X			X		X	X		X	X
10	--	EC10-F001	1.0-7.5	1/21/2009	F	X		X		X	X	X	X	X	X	X		X	X		X	X
10	--	EC10-F002	1.0-7.5	1/21/2009	F	X		X	X	X	X	X	X	X	X	X		X	X		X	X
10	--	EC10-F003	1.0-22.0	1/22/2009	F	X		X	X	X	X	X	X	X	X	X		X	X		X	X
10	--	EC10-F004	7.5-22.5	1/22/2009	F	X		X		X	X	X	X	X	X	X		X	X		X	X
10	--	EC10-F005	7.5-22.0	1/22/2009	F		X															X
11	--	EC11-F001	1.0-2.5	1/16/2009	F	X				X	X	X	X	X		X		X	X		X	X
11	--	EC11-F002	1.0-2.5	1/16/2009	F	X			X	X	X	X	X	X		X		X	X		X	X

TABLE 3: Summary of Soil Sample Analyses
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Lithology	Title 22 Metals	Total Lead (Only)	Soluble Chromium	Soluble Lead	Total Petroleum Hydrocarbons	Volatile Organic Compounds	Semi-Volatile Organic Compounds	Polycyclic Aromatic Hydrocarbons	Pesticides	Herbicides	Polychlorinated Biphenyls	Asbestos	Cyanide	Sulfide	Ignitability	pH	Moisture
					Table Location:	**4,5**	**5**	**5**	**5**	**6**	**7**	**NT**	**8**	**9**	**NT**	**10**	**11**	**12**	**12**	**12**	**12**	**12**
11	--	EC11-F003	1.0-2.5	1/16/2009	F	X			X	X	X	X	X	X		X		X	X		X	X
12	--	EC12-A001	7.5-17.5	1/12/2009	A	X		X		X	X	X	X			X		X	X		X	X
12	--	EC12-A002	1.0-7.5	1/13/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-A003	7.5-27.5	1/16/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-A004	2.5-22.5	1/14/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-A005	1.0-27.5	1/14/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-A006	1.0-17.5	1/14/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-A007	12.5-22.5	1/15/2009	A	X				X	X	X	X			X		X	X		X	X
12	--	EC12-BR001	7.5-22.5	1/13/2009	BR	X												X	X	X	X	X
12	--	EC12-BR002	23.0-38.0	1/15/2009	BR	X		X										X	X	X	X	X
12	--	EC12-C001	17.5-32.5	1/12/2009	C	X		X		X	X	X	X			X		X	X		X	X
12	--	EC12-C001-RE	17.5-32.5	1/12/2009	C								X									
12	--	EC12-C002	12.5-37.5	1/12/2009	C	X		X		X	X	X	X			X		X	X		X	X
12	--	EC12-C002-RE	12.5-37.5	1/12/2009	C								X									
12	--	EC12-C003	22.5-32.5	1/15/2009	C	X		X		X	X	X	X			X		X	X		X	X
12	--	EC12-F002	1.0-2.5	1/13/2009	F	X				X	X	X	X	X		X		X	X		X	X
12	--	EC12-F003	1.0-2.5	1/15/2009	F	X			X	X	X	X	X	X		X		X	X		X	X
12	--	EC12-F004	2.5-12.5	1/15/2009	F	X				X	X	X	X	X		X		X	X		X	X
12	--	EC12-F005	1.0-2.5	1/12/2009	F	X		X	X	X	X	X	X	X		X		X	X		X	X
12	--	EC12-F006	7.5-12.5	1/15/2009	F		X															X

TABLE 3: Summary of Soil Sample Analyses
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
"RE" at the end of a Sample ID indicates the sample was re-extracted for quality assurance reasons and was analyzed outside the method sample hold time. Both original and re-extraction results are included in this table.
Title 22 Metals analyzed by Environmental Protection Agency ("EPA") Methods 6020, 6010B, and 7471A (Mercury).
Total chromium and lead analyzed by EPA Methods 6010B and 6020.
Soluble chromium and lead by Waste Extraction Test ("WET") and Toxicity Characteristic Leaching Procedure ("TCLP") methods.
Total Petroleum Hydrocarbons analyzed by EPA Method 8015B.
Volatile Organic Compounds analyzed by EPA Method 8260B.
Semi-Volatile Organic Compounds analyzed by EPA Method 8270C.
Polycyclic Aromatic Hydrocarbons analyzed by EPA Method 8310.
Pesticides analyzed by EPA Method 8081A.
Herbicides analyzed by EPA Method 8151A.
Polychlorinated Biphenyls analyzed by EPA Method 8082.
Asbestos analyzed by California Air Resource Board Method 435 with reporting limit of 0.25 percent.
Cyanide analyzed by Standard Method 4500-CN-E.
Sulfide analyzed by EPA Method 9034.
Ignitability analyzed by EPA Method 1030.
pH analyzed by EPA Method 9045D.
Moisture analyzed by ASTM Method D2216/CLP.
bgs = below ground surface.
NT = No table (constituents were not detected above laboratory reporting limits).

[1] The laboratory sample identification was E072F-2.0. BASELINE changed the sample identification to E072F-2.5 based on review of the boring log.

[2] Samples were collected from cores of geotechnical borings previously drilled by ARUP in 2008. Metals analyses were limited to total nickel and chromium.

TABLE 4: Total Metal Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Sample Depth (feet bgs)	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
9	EC09-C001	2.5-12.5	1/22/2009	<0.29	**1.6**	**30**	**0.19**	<0.29	**80**	**8.4**	**8**	**2.5**	<0.024	<0.29	**50**	<0.29	<0.29	<0.29	**44**	**27**
9	EC09-F001	1.0-7.5	1/22/2009	**0.08**	**2**	**53**	**0.18**	**0.063**	**72**	**9.1**	**18**	**12**	**0.072**	**0.16**	**51**	**0.19**	**0.082**	<0.28	**46**	**38**
9	EC09-F003	1.0-12.5	1/23/2009	**0.2**	**3.1**	**90**	**0.3**	**0.087**	**79**	**8.1**	**33**	**6.5**	<0.024	**0.16**	**44**	**0.11**	<0.29	<0.29	**42**	**33**
9	EC09-F004	1.0-7.5	1/23/2009	**0.22**	**2.9**	**80**	**0.22**	**0.35**	**45**	**6.5**	**21**	**140**	**0.043**	**0.28**	**31**	<0.29	<0.29	<0.29	**38**	**76**
10	EC10-A001	7.0-17.5	1/21/2009	**0.19**	**5.3**	**83**	**0.54**	<0.29	**77**	**14**	**21**	**5.5**	**0.023**	**0.55**	**55**	**0.11**	<0.29	**0.076**	**68**	**49**
10	EC10-A002	7.5-17.5	1/21/2009	**0.11**	**4.9**	**45**	**0.34**	**0.092**	**110**	**14**	**16**	**4.1**	<0.024	**0.32**	**73**	<0.28	<0.28	**0.036**	**67**	**39**
10	EC10-C001	17.5-27.5	1/21/2009	**0.056**	**3.7**	**39**	**0.23**	<0.28	**82**	**12**	**13**	**2.7**	<0.023	**0.17**	**71**	<0.28	<0.28	<0.28	**61**	**32**
10	EC10-F001	1.0-7.5	1/21/2009	**0.18**	**3.4**	**58**	**0.29**	**0.072**	**62**	**6.5**	**15**	**24**	<0.022	**0.31**	**35**	**0.19**	<0.27	**0.034**	**46**	**41**
10	EC10-F002	1.0-7.5	1/21/2009	**0.35**	**4.4**	**110**	**0.41**	**0.14**	**63**	**12**	**28**	**96**	**0.17**	**0.34**	**72**	**0.16**	**0.078**	**0.037**	**45**	**94**
10	EC10-F003	1.0-22.0	1/22/2009	**0.24**	**3.6**	**140**	**0.26**	**0.2**	**69**	**12**	**23**	**90**	**0.13**	**0.33**	**65**	**0.11**	**0.12**	<0.27	**49**	**150**
10	EC10-F004	7.5-22.5	1/22/2009	**0.16**	**4.5**	**180**	**0.4**	<0.3	**78**	**13**	**20**	**21**	**0.059**	**0.47**	**53**	**0.19**	<0.3	**0.06**	**57**	**45**
11	EC11-F001	1.0-2.5	1/16/2009	**0.02**	**0.33**	**7.3**	**0.019**	**0.028**	**3.7**	**0.7**	**1.7**	**9.1**	**0.21**	**0.014**	**3.6**	**0.0096**	**0.012**	<0.27	**3**	**7.5**
11	EC11-F002	1.0-2.5	1/16/2009	**0.37**	**3.7**	**97**	**0.25**	**0.2**	**47**	**10**	**31**	**110**	**0.14**	**0.3**	**54**	**0.12**	<0.28	<0.28	**36**	**81**
11	EC11-F003	1.0-2.5	1/16/2009	**0.22**	**3.4**	**140**	**0.26**	**0.28**	**37**	**7.2**	**31**	**150**	**0.21**	**0.23**	**40**	**0.11**	**0.11**	<0.28	**33**	**130**
12	EC12-A001	7.5-17.5	1/12/2009	**0.13**	**4.5**	**110**	**0.38**	<0.29	**68**	**15**	**25**	**5.2**	**0.055**	**0.4**	**50**	**0.15**	<0.29	<0.29	**58**	**73**
12	EC12-A002	1.0-7.5	1/13/2009	**0.092**	**4**	**84**	**0.3**	<0.27	**48**	**13**	**12**	**5.9**	<0.023	**0.27**	**35**	**0.2**	<0.27	<0.27	**43**	**38**
12	EC12-A003	7.5-27.5	1/16/2009	<0.27	**3.4**	**58**	**0.22**	<0.27	**43**	**9.1**	**15**	**2.7**	**0.038**	**0.17**	**30**	**0.1**	<0.27	<0.27	**35**	**36**
12	EC12-A004	2.5-22.5	1/14/2009	<0.26	**2.6**	**30**	**0.12**	<0.26	**42**	**6.2**	**9.3**	**2**	<0.022	**0.066**	**25**	<0.26	<0.26	<0.26	**33**	**23**
12	EC12-A005	1.0-27.5	1/14/2009	<0.26	**2.9**	**29**	**0.1**	<0.26	**35**	**5.3**	**9**	**4.5**	<0.021	**0.075**	**29**	<0.26	<0.26	<0.26	**29**	**22**
12	EC12-A006	1.0-17.5	1/14/2009	<0.27	**2.9**	**37**	**0.12**	<0.27	**44**	**7.1**	**34**	**4.9**	<0.022	**0.072**	**37**	<0.27	<0.27	<0.27	**33**	**43**
12	EC12-A007	12.5-22.5	1/15/2009	**0.073**	**3.5**	**120**	**0.31**	<0.29	**69**	**8.9**	**19**	**4.4**	**0.1**	**0.26**	**39**	**0.13**	<0.29	<0.29	**48**	**45**
12	EC12-BR001	7.5-22.5	1/13/2009	**0.27**	**6.7**	**140**	**0.53**	<0.3	**36**	**12**	**45**	**9.2**	**0.056**	**0.52**	**68**	**0.095**	<0.3	<0.3	**38**	**77**
12	EC12-BR002	23.0-38.0	1/15/2009	**0.27**	**7**	**130**	**0.53**	<0.29	**64**	**12**	**36**	**7.3**	**0.088**	**0.29**	**71**	**0.2**	<0.29	<0.29	**64**	**65**
12	EC12-C001	17.5-32.5	1/12/2009	<0.29	**5.7**	**75**	**0.21**	<0.29	**70**	**22**	**9.6**	**3.3**	<0.026	**0.11**	**86**	<0.29	<0.29	<0.29	**53**	**45**
12	EC12-C002	12.5-37.5	1/12/2009	<0.3	**3.5**	**52**	**0.2**	<0.3	**55**	**13**	**27**	**2.9**	<0.025	**0.092**	**71**	<0.3	<0.3	<0.3	**42**	**50**
12	EC12-C003	22.5-32.5	1/15/2009	<0.29	**4.3**	**50**	**0.22**	<0.29	**75**	**12**	**12**	**2.9**	<0.024	**0.13**	**62**	<0.29	<0.29	<0.29	**56**	**36**
12	EC12-F002	1.0-2.5	1/13/2009	**0.14**	**3.1**	**180**	**0.23**	**0.097**	**43**	**9.2**	**39**	**34**	**0.2**	**0.58**	**38**	**0.15**	<0.27	<0.27	**37**	**61**
12	EC12-F003	1.0-2.5	1/15/2009	**0.22**	**2.6**	**120**	**0.22**	**0.24**	**39**	**8.9**	**34**	**120**	**0.092**	**0.28**	**41**	**0.12**	<0.28	<0.28	**30**	**94**
12	EC12-F004	2.5-12.5	1/15/2009	<0.27	**3**	**87**	**0.22**	<0.27	**45**	**7.4**	**14**	**3.6**	<0.021	**0.23**	**27**	**0.19**	<0.27	<0.27	**39**	**31**
12	EC12-F005	1.0-2.5	1/12/2009	**0.41**	**3.6**	**170**	**0.36**	**0.22**	**60**	**11**	**28**	**50**	**0.18**	**0.59**	**35**	**0.23**	**0.14**	**0.13**	**46**	**65**
12	BTNB-R2-27.0-27.5 [1]	27.0-27.5	8/14/2009	--	--	--	--	--	**420**	--	--	--	--	--	**2,400**	--	--	--	--	--
12	BTNB-R2-29.5-30.0 [1]	29.5-30.0	8/14/2009	--	--	--	--	--	**220**	--	--	--	--	--	**3,100**	--	--	--	--	--
12	BTSB-R2-51.0-51.5 [1]	51.0-51.5	8/14/2009	--	--	--	--	--	**860**	--	--	--	--	--	**2,300**	--	--	--	--	--
12	BTSB-R2-53.5-54.0 [1]	53.5-54.0	8/14/2009	--	--	--	--	--	**1,200**	--	--	--	--	--	**1,900**	--	--	--	--	--
12	BTNB-R3-48.5-49.0 [1]	48.5-49.0	8/14/2009	--	--	--	--	--	**610**	--	--	--	--	--	**1,900**	--	--	--	--	--
12	BTNB-R3-51.0-51.5 [1]	51.0-51.5	8/14/2009	--	--	--	--	--	**880**	--	--	--	--	--	**2,200**	--	--	--	--	--
California Hazardous Waste Criteria - TTLC (mg/kg) [2]				500	500	10,000	75	100	2,500	8,000	2,500	1,000	20	3,500	2,000	100	500	700	2,400	5,000
California Hazardous Waste Criteria - STLC (mg/L) [2]				15	5	100	0.75	1	560	80	25	5	0.2	350	20	1	5	7	24	250
RCRA Hazardous Waste Criteria - TCLP (mg/L) [3]				NV	5	100	NV	1	5	NV	NV	5	0.2	NV	NV	1	5	NV	NV	NV
ESL for Residential Land Use (mg/kg) [4]				6.3	0.39	750	4	1.7	750	40	230	200	1.3	40	150	10	20	1.3	16	600
ESL for Commercial/Industrial Land Use (mg/kg) [5]				40	1.6	1500	8	7.4	750	80	230	750	10	40	150	10	40	16	200	600
ESL for Construction/Trench Worker Exposure (mg/kg) [6]				310	15	2,600	98	39	1,200,000	94	310,000	750	58	3,900	260	3,900	3,900	62	770	230,000

TABLE 4: Total Metal Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Shaded cells indicate concentrations were greater than or equal to hazardous waste criteria or Environmental Screening Levels ("ESLs").
Additional samples that were analyzed for lead only are included in Table 5.
Title 22 Metals analyzed by Environmental Protection Agency ("EPA") Methods 6020, 6010B, and 7471A (Mercury).
bgs = below ground surface.
mg/kg = milligram per kilogram.
mg/L = milligram per liter.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
-- = Not analyzed or not applicable.
NV = No Value.

[1] Samples were collected from cores of geotechnical borings previously drilled by ARUP in 2008.

[2] California Code of Regulations, Title 22, Division 4.5, Chapter 11.

[3] Code of Federal Regulations, Title 40, Chapter 1, Section 261.24.

[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.

[5] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.

[6] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 5: Total and Soluble Chromium and Lead Concentrations in Soil
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chromium	Chromium, TCLP	Chromium, WET	Lead	Lead, TCLP	Lead, WET
				Units	mg/kg	mg/L	mg/L	mg/kg	mg/L	mg/L
9	E059	E059F-1.0	1.0	1/23/2009	--	--	--	**2.2**	--	--
9	E059	E059F-2.5	2.5	1/23/2009	--	--	--	**120**	<0.03	**1.1**
9	E060	E060F-1.0	1.0	1/23/2009	--	--	--	**9.9**	--	--
9	E060	E060FS-2.5	2.5	1/23/2009	--	--	--	**21**	--	--
9	E061	E061C-2.5	2.5	1/22/2009	--	--	--	**2.5**	--	--
9	E061	E061F-1.0	1.0	1/22/2009	--	--	--	**8.2**	--	--
11	E062	E062F-1.0	1.0	1/16/2009	--	--	--	**34**	--	--
11	E062	E062F-2.5	2.5	1/16/2009	--	--	--	**27**	--	--
10	E063	E063F-1.0	1.0	1/22/2009	--	--	--	**110**	**0.071**	**7.8**
10	E063	E063F-2.5	2.5	1/22/2009	--	--	--	**160**	<0.03	**1.9**
11	E064	E064F-1.0	1.0	1/16/2009	--	--	--	**570**	**0.038**	**5.1**
11	E064	E064F-2.5	2.5	1/16/2009	--	--	--	**1,000**	**0.031**	**7.5**
10	E065	E065F-1.0	1.0	1/22/2009	--	--	--	**100**	**0.23**	**15**
10	E065	E065F-2.5	2.5	1/22/2009	--	--	--	**23**	--	--
11	E066	E066F-1.0	1.0	1/16/2009	--	--	--	**140**	<0.03	**7.9**
11	E066	E066F-2.5	2.5	1/16/2009	--	--	--	**130**	**1.3**	**13**
10	E067	E067F-1.0	1.0	1/21/2009	--	--	--	**160**	<0.03	**2.9**
10	E067	E067F-2.5	2.5	1/21/2009	--	--	--	**13**	--	--
11	E068	E068F-1.0	1.0	1/16/2009	--	--	--	**47**	--	--
11	E068	E068F-2.5	2.5	1/16/2009	--	--	--	**120**	**0.57**	**23**
10	E069	E069F-1.0	1.0	1/21/2009	--	--	--	**20**	--	--
10	E069	E069F-2.5	2.5	1/21/2009	--	--	--	**4**	--	--
11	E070	E070F-1.0	1.0	1/16/2009	--	--	--	**8.6**	--	--
11	E070	E070F-2.5	2.5	1/16/2009	--	--	--	**190**	<0.03	**0.98**
10	E071	E071F-1.0	1.0	1/21/2009	--	--	--	**79**	--	**1.9**
10	E071	E071F-2.0	2.0	1/21/2009	--	--	--	**12**	--	--
11	E072	E072F-1.0	1.0	1/16/2009	--	--	--	**17**	--	--
11	E072	E072F-2.5[1]	2.5	1/16/2009	--	--	--	**330**	**0.7**	**12**
12	E073	E073F-1.0	1.0	1/15/2009	--	--	--	**120**	**0.056**	**4.9**
12	E073	E073F-2.5	2.5	1/15/2009	--	--	--	**3**	--	--
12	E074	E074F-1.0	1.0	1/12/2009	--	--	--	**59**	--	**1.2**
12	E074	E074F-2.5	2.5	1/12/2009	--	--	--	**4.6**	--	--
12	E075	E075F-1.0	1.0	1/15/2009	--	--	--	**320**	**0.063**	**2.7**
12	E075	E075F-2.5	2.5	1/15/2009	--	--	--	**30**	--	--
12	E076	E076F-1.0	1.0	1/12/2009	--	--	--	**130**	<0.03	**2**
12	E076	E076F-2.5	2.5	1/12/2009	--	--	--	**2.4**	--	--
12	E077	E077A-2.5	2.5	1/15/2009	--	--	--	**1.8**	--	--
12	E077A	E077AA-1.0	1.0	1/14/2009	--	--	--	**20**	--	--
12	E077A	E077AA-2.5	2.5	1/14/2009	--	--	--	**6.9**	--	--
12	E077	E077F-1.0	1.0	1/15/2009	--	--	--	**14**	--	--
12	E078	E078A-2.5	2.5	1/14/2009	--	--	--	**1.9**	--	--
12	E078A	E078AA-1.0	1.0	1/14/2009	--	--	--	**7.4**	--	--
12	E078A	E078AA-2.5	2.5	1/14/2009	--	--	--	**2.8**	--	--
12	E078	E078F-1.0	1.0	1/14/2009	--	--	--	**8.2**	--	--
12	E079	E079F-1.0	1.0	1/16/2009	--	--	--	**120**	**0.033**	**4.3**
12	E079	E079F-2.5	2.5	1/16/2009	--	--	--	**49**	--	--
12	E080	E080A-2.5	2.5	1/14/2009	--	--	--	**1.6**	--	--
12	E080	E080F-1.0	1.0	1/14/2009	--	--	--	**60**	--	**1.1**

TABLE 5: Total and Soluble Chromium and Lead Concentrations in Soil
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chromium	Chromium, TCLP	Chromium, WET	Lead	Lead, TCLP	Lead, WET
				Units	mg/kg	mg/L	mg/L	mg/kg	mg/L	mg/L
12	E081	E081F-1.0	1.0	1/13/2009	--	--	--	**3.7**	--	--
12	E081	E081F-2.5	2.5	1/13/2009	--	--	--	**13**	--	--
12	E082	E082A-1.0	1.0	1/13/2009	--	--	--	**4.1**	--	--
12	E082	E082A-2.5	2.5	1/13/2009	--	--	--	**5.1**	--	--
9	--	EC09-C001	2.5-12.5	1/22/2009	**80**	--	<0.25	**2.5**	--	--
9	--	EC09-F001	1.0-7.5	1/22/2009	**72**	--	<0.25	**12**	--	--
9	--	EC09-F003	1.0-12.5	1/23/2009	**79**	--	<0.25	**6.5**	--	--
9	--	EC09-F004	1.0-7.5	1/23/2009	**45**	--	--	**140**	**0.32**	**3.7**
9	--	EC09-F005	7.5-12.5	1/23/2009	--	--	--	**7.3**	--	--
10	--	EC10-A001	7.0-17.5	1/21/2009	**77**	--	<0.25	**5.5**	--	--
10	--	EC10-A002	7.5-17.5	1/21/2009	**110**	<0.05	<0.25	**4.1**	--	--
10	--	EC10-C001	17.5-27.5	1/21/2009	**82**	--	<0.25	**2.7**	--	--
10	--	EC10-F001	1.0-7.5	1/21/2009	**62**	--	<0.25	**24**	--	--
10	--	EC10-F002	1.0-7.5	1/21/2009	**63**	--	<0.25	**96**	--	**6.7**
10	--	EC10-F003	1.0-22.0	1/22/2009	**69**	--	<0.25	**90**	--	**1.1**
10	--	EC10-F004	7.5-22.5	1/22/2009	**78**	--	**0.45**	**21**	--	--
10	--	EC10-F005	7.5-22.0	1/22/2009	--	--	--	**18**	--	--
11	--	EC11-F001	1.0-2.5	1/16/2009	**3.7**	--	--	**9.1**	--	--
11	--	EC11-F002	1.0-2.5	1/16/2009	**47**	--	--	**110**	**0.28**	**9**
11	--	EC11-F003	1.0-2.5	1/16/2009	**37**	--	--	**150**	**0.031**	**4.4**
12	--	EC12-A001	7.5-17.5	1/12/2009	**68**	--	<0.25	**5.2**	--	--
12	--	EC12-A002	1.0-7.5	1/13/2009	**48**	--	--	**5.9**	--	--
12	--	EC12-A003	7.5-27.5	1/16/2009	**43**	--	--	**2.7**	--	--
12	--	EC12-A004	2.5-22.5	1/14/2009	**42**	--	--	**2**	--	--
12	--	EC12-A005	1.0-27.5	1/14/2009	**35**	--	--	**4.5**	--	--
12	--	EC12-A006	1.0-17.5	1/14/2009	**44**	--	--	**4.9**	--	--
12	--	EC12-A007	12.5-22.5	1/15/2009	**69**	--	--	**4.4**	--	--
12	--	EC12-BR001	7.5-22.5	1/13/2009	**36**	--	--	**9.2**	--	--
12	--	EC12-BR002	23.0-38.0	1/15/2009	**64**	--	<0.25	**7.3**	--	--
12	--	EC12-C001	17.5-32.5	1/12/2009	**70**	--	<0.25	**3.3**	--	--
12	--	EC12-C002	12.5-37.5	1/12/2009	**55**	--	<0.25	**2.9**	--	--
12	--	EC12-C003	22.5-32.5	1/15/2009	**75**	--	<0.25	**2.9**	--	--
12	--	EC12-F002	1.0-2.5	1/13/2009	**43**	--	--	**34**	--	--
12	--	EC12-F003	1.0-2.5	1/15/2009	**39**	--	--	**120**	**0.14**	**1.2**
12	--	EC12-F004	2.5-12.5	1/15/2009	**45**	--	--	**3.6**	--	--
12	--	EC12-F005	1.0-2.5	1/12/2009	**60**	--	**0.28**	**50**	--	**0.67**
12	--	EC12-F006	7.5-12.5	1/15/2009	--	--	--	**3.1**	--	--
12	BTNB-R2	BTNB-R2-27.0-27.5 [1]	27.0-27.5	8/14/2009	**420**	--	--	--	--	--
12	BTNB-R2	BTNB-R2-29.5-30.0 [1]	29.5-30.0	8/14/2009	**220**	--	--	--	--	--
12	BTSB-R2	BTSB-R2-51.0-51.5 [1]	51.0-51.5	8/14/2009	**860**	--	--	--	--	--
12	BTSB-R2	BTSB-R2-53.5-54.0 [1]	53.5-54.0	8/14/2009	**1200**	--	--	--	--	--
12	BTNB-R3	BTNB-R3-48.5-49.0 [1]	48.5-49.0	8/14/2009	**610**	--	--	--	--	--
12	BTNB-R3	BTNB-R3-51.0-51.5 [1]	51.0-51.5	8/14/2009	**880**	--	--	--	--	--
				California Hazardous Waste Criteria - TTLC (mg/kg) [2]	2,500	NV	NV	1,000	NV	NV
				California Hazardous Waste Criteria - STLC (mg/L) [2]	NV	NV	560	NV	NV	5
				RCRA Hazardous Waste Criteria - TCLP (mg/L) [3]	NV	5	NV	NV	5	NV
				ESL for Residential Land Use (mg/kg) [4]	750	NV	NV	200	NV	NV
				ESL for Commerical/Industrial Land Use (mg/kg) [5]	750	NV	NV	750	NV	NV
				ESL for Construction/Trench Worker Exposure (mg/kg) [6]	1.2E+06	NV	NV	750	NV	NV

TABLE 5: Total and Soluble Chromium and Lead Concentrations in Soil
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Shaded cells indicate concentrations were greater than or equal to hazardous waste criteria or Environmental Screening Levels ("ESLs").
Title 22 Metals analyzed by Environmental Protection Agency ("EPA") Methods 6020, 6010B, and 7471A (Mercury).
Total chromium and lead analyzed by EPA Methods 6010B and 6020.
Soluble chromium and lead by Waste Extraction Test ("WET") and Toxicity Characteristic Leaching Procedure ("TCLP") methods.
Total chromium and lead reported in milligrams per kilogram ("mg/kg").
Soluble chromium and lead report in milligrams per liter ("mg/L").
bgs = below ground surface.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
-- = Not analyzed or not applicable.
NV = No Value.

[1] The laboratory sample identification was E072F-2.0. BASELINE changed the sample identification to E072F-2.5 based on review of the boring log.
[2] California Code of Regulations, Title 22, Division 4.5, Chapter 11.
[3] Code of Federal Regulations, Title 40, Chapter 1, Section 261.24.
[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.
[5] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.
[6] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 6: Total Petroleum Hydrocarbon Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Sample Depth (feet bgs)	Sample Date	TPH as Gasoline C7-C12	TPH as Diesel C12-C24	TPH as Motor Oil C24-C36
9	EC09-C001	2.5-12.5	1/22/2009	<1.1	<1.2	<5.9
9	EC09-F001	1.0-7.5	1/22/2009	<1.2	**22**	**94**
9	EC09-F003	1.0-12.5	1/23/2009	<1.1	**24**	**240**
9	EC09-F004	1.0-7.5	1/23/2009	<1.1	**29**	**260**
10	EC10-A001	7.0-17.5	1/21/2009	<1.1	<1.1	<5.7
10	EC10-A002	7.5-17.5	1/21/2009	<1.2	<1.1	<5.7
10	EC10-C001	17.5-27.5	1/21/2009	<1.2	<1.1	<5.7
10	EC10-F001	1.0-7.5	1/21/2009	<1.1	**5.4**	**32**
10	EC10-F002	1.0-7.5	1/21/2009	<1	**11**	**49**
10	EC10-F003	1.0-22.0	1/22/2009	<1.1	**19**	**74**
10	EC10-F004	7.5-22.5	1/22/2009	<1.2	**20**	**66**
11	EC11-F001	1.0-2.5	1/16/2009	<1.1	**19**	**120**
11	EC11-F002	1.0-2.5	1/16/2009	<1.1	**25**	**99**
11	EC11-F003	1.0-2.5	1/16/2009	<1.1	**100**	**580**
12	EC12-A001	7.5-17.5	1/12/2009	<1.2	<1.2	<5.8
12	EC12-A002	1.0-7.5	1/13/2009	<1.2	**3.8**	<5.5
12	EC12-A003	7.5-27.5	1/16/2009	<1	**1.4**	<5.4
12	EC12-A004	2.5-22.5	1/14/2009	<0.97	<1	<5.2
12	EC12-A005	1.0-27.5	1/14/2009	<0.96	<1	<5.2
12	EC12-A006	1.0-17.5	1/14/2009	<1.2	<1.1	<5.4
12	EC12-A007	12.5-22.5	1/15/2009	<1.2	<1.2	<5.9
12	EC12-C001	17.5-32.5	1/12/2009	<1.2	<1.2	<5.9
12	EC12-C002	12.5-37.5	1/12/2009	<1.3	<1.2	<5.9
12	EC12-C003	22.5-32.5	1/15/2009	<1.2	<1.2	<5.8
12	EC12-F002	1.0-2.5	1/13/2009	<1.1	**7.7**	**19**
12	EC12-F003	1.0-2.5	1/15/2009	<1.1	**8.1**	**49**
12	EC12-F004	2.5-12.5	1/15/2009	<1.1	**7.8**	<5.3
12	EC12-F005	1.0-2.5	1/12/2009	<1.1	**10**	**49**
California Hazardous Waste Criteria (mg/kg) [1]				NV	NV	NV
ESL for Residential Land Use (mg/kg) [2]				83	83	370
ESL for Commerical/Industrial Land Use (mg/kg) [3]				83	83	2500
ESL for Construction/Trench Worker Exposure (mg/kg) [4]				4200	4200	12000

TABLE 6: Total Petroleum Hydrocarbon Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Shaded cells indicate concentrations were greater than or equal to hazardous waste criteria or Environmental Screening Levels ("ESLs").
Total Petroleum Hydrocarbons analyzed by EPA Method 8015B.
bgs = below ground surface.
mg/kg = milligram per kilogram.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
NV = No Value.

[1] California Code of Regulations, Title 22, Division 4.5, Chapter 11.
[2] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.
[3] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.
[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 7: Volatile Organic Compound Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Sample Depth (feet bgs)	Sample Date	Acetone	Methylene Chloride
9	EC09-C001	2.5-12.5	1/22/2009	<0.022	<0.022
9	EC09-F001	1.0-7.5	1/22/2009	**0.031**	<0.021
9	EC09-F003	1.0-12.5	1/23/2009	<0.022	**0.0047**
9	EC09-F004	1.0-7.5	1/23/2009	<0.021	<0.021
10	EC10-A001	7.0-17.5	1/21/2009	<0.023	<0.023
10	EC10-A002	7.5-17.5	1/21/2009	<0.022	<0.022
10	EC10-C001	17.5-27.5	1/21/2009	<0.022	<0.022
10	EC10-F001	1.0-7.5	1/21/2009	<0.021	<0.021
10	EC10-F002	1.0-7.5	1/21/2009	<0.021	<0.021
10	EC10-F003	1.0-22.0	1/22/2009	<0.022	**0.0028**
10	EC10-F004	7.5-22.5	1/22/2009	**0.029**	**0.0032**
11	EC11-F001	1.0-2.5	1/16/2009	**0.019**	**0.0024**
11	EC11-F002	1.0-2.5	1/16/2009	<0.021	<0.021
11	EC11-F003	1.0-2.5	1/16/2009	<0.021	**0.0025**
12	EC12-A001	7.5-17.5	1/12/2009	<0.019	<0.019
12	EC12-A002	1.0-7.5	1/13/2009	<0.022	<0.022
12	EC12-A003	7.5-27.5	1/16/2009	**0.011**	<0.021
12	EC12-A004	2.5-22.5	1/14/2009	**0.0022**	<0.019
12	EC12-A005	1.0-27.5	1/14/2009	<0.021	<0.021
12	EC12-A006	1.0-17.5	1/14/2009	<0.021	<0.021
12	EC12-A007	12.5-22.5	1/15/2009	**0.0031**	<0.023
12	EC12-C001	17.5-32.5	1/12/2009	<0.023	<0.023
12	EC12-C002	12.5-37.5	1/12/2009	<0.024	<0.024
12	EC12-C003	22.5-32.5	1/15/2009	**0.0042**	<0.022
12	EC12-F002	1.0-2.5	1/13/2009	<0.02	<0.02
12	EC12-F003	1.0-2.5	1/15/2009	<0.021	<0.021
12	EC12-F004	2.5-12.5	1/15/2009	**0.0085**	<0.021
12	EC12-F005	1.0-2.5	1/12/2009	<0.023	<0.023
California Hazardous Waste Criteria (mg/kg) [1]				NV	NV
ESL for Residential Land Use (mg/kg) [2]				0.5	0.077
ESL for Commerical/Industrial Land Use (mg/kg) [3]				0.5	0.077
ESL for Construction/Trench Worker Exposure (mg/kg) [4]				100,000	630

TABLE 7: Volatile Organic Compound Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Only compounds that were identified above laboratory reporting limits in at least one sample are presented.
Volatile Organic Compounds analyzed by EPA Method 8260B.
bgs = below ground surface.
mg/kg = milligram per kilogram.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
NV = No Value.

[1] California Code of Regulations, Title 22, Division 4.5, Chapter 11.
[2] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.
[3] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.
[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 8: Polycyclic Aromatic Hydrocarbon Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Analysis Method	Sample Depth (feet bgs)	Sample Date	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
9	EC09-C001	EPA 8310	2.5-12.5	1/22/2009	<0.078	<0.0039	<0.0039	<0.0039	<0.0078	<0.0078	<0.0039	<0.0039	<0.0078	<0.0078	<0.0078	<0.0039	<0.0039	<0.0039
9	EC09-F001	EPA 8310	1.0-7.5	1/22/2009	<0.074	**0.0015**	**0.0058**	**0.011**	**0.012**	**0.012**	**0.0046**	**0.017**	**0.0065**	**0.075**	<0.0074	**0.0045**	**0.016**	**0.016**
9	EC09-F003	EPA 8310	1.0-12.5	1/23/2009	<0.076	**0.0065**	**0.028**	**0.0027**	**0.024**	**0.049**	**0.0039**	**0.057**	<0.0076	**0.032**	<0.0076	<0.0038	**0.0095**	**0.013**
9	EC09-F004	EPA 8310	1.0-7.5	1/23/2009	<0.076	**0.0054**	**0.009**	**0.016**	**0.024**	**0.033**	**0.01**	**0.039**	**0.0052**	**0.076**	<0.0076	**0.011**	**0.052**	**0.037**
10	EC10-A001	EPA 8310	7.0-17.5	1/21/2009	<0.076	<0.0038	<0.0038	<0.0038	<0.0076	<0.0076	<0.0038	<0.0038	<0.0076	<0.0076	<0.0076	<0.0038	<0.0038	<0.0038
10	EC10-A002	EPA 8310	7.5-17.5	1/21/2009	<0.075	<0.0038	<0.0038	<0.0038	<0.0075	<0.0075	<0.0038	<0.0038	<0.0075	<0.0075	<0.0075	<0.0038	<0.0038	<0.0038
10	EC10-C001	EPA 8310	17.5-27.5	1/21/2009	<0.076	<0.0038	<0.0038	<0.0038	<0.0076	<0.0076	<0.0038	<0.0038	<0.0076	<0.0076	<0.0076	<0.0038	<0.0038	<0.0038
10	EC10-F001	EPA 8310	1.0-7.5	1/21/2009	<0.072	**0.00099**	**0.0048**	**0.0062**	**0.0049**	<0.0072	<0.0036	**0.0082**	**0.0046**	**0.011**	<0.0072	**0.0019**	**0.0079**	**0.009**
10	EC10-F002	EPA 8310	1.0-7.5	1/21/2009	<0.071	**0.0012**	**0.0063**	**0.011**	**0.0092**	**0.02**	**0.0039**	**0.013**	**0.0074**	**0.027**	<0.0071	**0.0021**	**0.016**	**0.014**
10	EC10-F003	EPA 8310	1.0-22.0	1/22/2009	**0.12**	**0.0084**	**0.049**	**0.063**	**0.049**	**0.066**	**0.023**	**0.068**	**0.058**	**0.14**	<0.0073	**0.026**	**0.093**	**0.14**
10	EC10-F004	EPA 8310	7.5-22.5	1/22/2009	<0.079	**0.0011**	**0.0057**	**0.011**	**0.0061**	**0.01**	**0.017**	**0.0082**	**0.0091**	**0.017**	**0.0095**	**0.0033**	**0.0076**	**0.011**
11	EC11-F001	EPA 8310	1.0-2.5	1/16/2009	<0.074	**0.0012**	**0.027**	**0.062**	**0.031**	**0.13**	**0.014**	**0.073**	**0.025**	**0.12**	**0.011**	**0.011**	**0.042**	**0.029**
11	EC11-F002	EPA 8310	1.0-2.5	1/16/2009	<0.075	**0.0027**	**0.01**	**0.027**	**0.023**	<0.0075	**0.0095**	**0.045**	<0.0075	**0.064**	<0.0075	**0.0051**	**0.03**	**0.039**
11	EC11-F003	EPA 8310	1.0-2.5	1/16/2009	<0.076	**0.013**	**0.027**	**0.047**	**0.056**	**0.048**	**0.023**	**0.14**	**0.025**	**0.1**	<0.0076	**0.0056**	**0.069**	**0.075**
12	EC12-A001	EPA 8310	7.5-17.5	1/12/2009	<0.076	<0.0038	<0.0038	<0.0038	<0.0076	<0.0076	<0.0038	<0.0038	<0.0076	<0.0076	<0.0076	<0.0038	<0.0038	<0.0038
12	EC12-A002	EPA 8310	1.0-7.5	1/13/2009	<0.073	<0.0037	**0.0016**	**0.0016**	**0.0017**	**0.0042**	<0.0037	**0.0032**	<0.0073	**0.0053**	<0.0073	**0.00053**	**0.0023**	**0.0012**
12	EC12-A003	EPA 8310	7.5-27.5	1/16/2009	<0.071	<0.0036	<0.0036	<0.0036	<0.0071	<0.0071	<0.0036	<0.0036	<0.0071	<0.0071	<0.0071	<0.0036	<0.0036	<0.0036
12	EC12-A004	EPA 8310	2.5-22.5	1/14/2009	<0.07	<0.0035	<0.0035	<0.0035	<0.007	<0.007	<0.0035	<0.0035	<0.007	<0.007	<0.007	<0.0035	<0.0035	<0.0035
12	EC12-A005	EPA 8310	1.0-27.5	1/14/2009	<0.07	**0.0011**	**0.0032**	**0.0029**	**0.0023**	<0.007	**0.0013**	**0.0035**	**0.0023**	**0.0086**	<0.007	**0.0011**	**0.0093**	**0.0076**
12	EC12-A006	EPA 8310	1.0-17.5	1/14/2009	<0.072	**0.008**	**0.013**	**0.012**	**0.0092**	**0.019**	**0.0054**	**0.015**	**0.0087**	**0.049**	<0.0072	**0.0061**	**0.026**	**0.041**
12	EC12-A007	EPA 8310	12.5-22.5	1/15/2009	<0.078	<0.0039	<0.0039	<0.0039	<0.0078	<0.0078	<0.0039	<0.0039	<0.0078	<0.0078	<0.0078	<0.0039	<0.0039	<0.0039
12	EC12-C001	EPA 8310	17.5-32.5	1/12/2009	<0.079	<0.0039	<0.0039	<0.0039	<0.0079	<0.0079	<0.0039	<0.0039	<0.0079	<0.0079	<0.0079	<0.0039	<0.0039	<0.0039
12	EC12-C001-RE	EPA 8310	17.5-32.5	1/12/2009	<0.079	<0.0039	<0.0039	<0.0039	<0.0079	<0.0079	<0.0039	<0.0039	<0.0079	<0.0079	<0.0079	<0.0039	<0.0039	<0.0039
12	EC12-C002	EPA 8310	12.5-37.5	1/12/2009	<0.079	<0.004	<0.004	<0.004	<0.0079	<0.0079	<0.004	<0.004	<0.0079	<0.0079	<0.0079	<0.004	<0.004	<0.004
12	EC12-C002-RE	EPA 8310	12.5-37.5	1/12/2009	<0.079	<0.0039	<0.0039	<0.0039	<0.0079	<0.0079	<0.0039	<0.0039	<0.0079	<0.0079	<0.0079	<0.0039	<0.0039	<0.0039
12	EC12-C003	EPA 8310	22.5-32.5	1/15/2009	<0.078	<0.0039	<0.0039	<0.0039	<0.0078	<0.0078	<0.0039	<0.0039	<0.0078	<0.0078	<0.0078	<0.0039	<0.0039	<0.0039
12	EC12-F002	EPA 8310	1.0-2.5	1/13/2009	<0.071	**0.02**	**0.084**	**0.089**	**0.066**	**0.14**	**0.04**	**0.11**	**0.058**	**0.26**	<0.0071	**0.043**	**0.078**	**0.23**
12	EC12-F002	EPA 8270C[1]	1.0-2.5	1/13/2009	**0.53**	**1.7**	**2.9**	**2.3**	**2.3**	**1.2**	**0.98**	**3.1**	**0.3**	**5.8**	**0.52**	**1.1**	**4.5**	**5.8**
12	EC12-F003	EPA 8310	1.0-2.5	1/15/2009	<0.074	**0.0015**	**0.0085**	**0.013**	**0.015**	**0.031**	**0.0056**	**0.027**	**0.01**	**0.043**	<0.0074	**0.0072**	**0.018**	**0.022**
12	EC12-F004	EPA 8310	2.5-12.5	1/15/2009	<0.071	<0.0036	<0.0036	<0.0036	<0.0071	<0.0071	<0.0036	<0.0036	<0.0071	<0.0071	<0.0071	<0.0036	<0.0036	<0.0036
12	EC12-F005	EPA 8310	1.0-2.5	1/12/2009	<0.077	**0.0017**	**0.017**	**0.023**	**0.019**	**0.046**	**0.0065**	**0.049**	**0.0066**	**0.15**	<0.0077	**0.0041**	<0.0039	**0.015**
California Hazardous Waste Criteria (mg/kg) [2]					NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
ESL for Residential Land Use (mg/kg) [3]					13	2.8	0.38	0.038	0.38	27	0.38	23	0.062	40	8.9	0.62	11	85
ESL for Commerical/Industrial Land Use (mg/kg) [4]					13	2.8	1.3	0.13	1.3	27	1.3	23	0.21	40	8.9	2.1	11	85
ESL for Construction/Trench Worker Exposure (mg/kg) [5]					11000	100000	15	1.5	15	11000	15	2400	2.4	14000	12000	24	11000	21000

TABLE 8: Polycyclic Aromatic Hydrocarbon Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
"RE" at the end of a Sample ID indicates the sample was re-extracted for quality assurance reasons and was analyzed outside the method sample hold time. Both original and re-extraction results are included in this table.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Shaded cells indicate concentrations were greater than or equal to hazardous waste criteria or Environmental Screening Levels ("ESLs").
Only compounds that were identified above laboratory reporting limits in at least one sample are presented.
bgs = below ground surface.
mg/kg = milligram per kilogram.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
NV = No Value.
EPA = Environmental Protection Agency

[1] Analytical results for this composite sample by EPA Methods 8310 and 8270C were significantly different, and are likely due to lab composite sample non-homogeneity. Results for all quality assurance samples for both methods were acceptable. The five subsamples for this composite sample were composited by the laboratory, and unique aliquots were collected for each analysis. One of the five subsamples was collected immediately below an asphalt road. Asphalt particles, which contain polycyclic aromatic hydrocarbons, may have been present in the EPA Method 8270C sample aliquot.

[2] California Code of Regulations, Title 22, Division 4.5, Chapter 11.

[3] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.

[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.

[5] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 9: Pesticide Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Sample Depth (feet bgs)	Sample Date	4,4'-DDD	4,4'-DDT	alpha-Chlordane	gamma-Chlordane
9	EC09-F001	1.0-7.5	1/22/2009	<0.0037	<0.0037	<0.0019	<0.0019
9	EC09-F003	1.0-12.5	1/23/2009	<0.019	<0.019	<0.0099	<0.0099
9	EC09-F004	1.0-7.5	1/23/2009	**0.027**	**0.026**	**0.14**	**0.12**
10	EC10-F001	1.0-7.5	1/21/2009	<0.0036	<0.0036	<0.0018	<0.0018
10	EC10-F002	1.0-7.5	1/21/2009	<0.0036	<0.0036	<0.0018	<0.0018
10	EC10-F003	1.0-22.0	1/22/2009	<0.036	<0.036	<0.019	<0.019
10	EC10-F004	7.5-22.5	1/22/2009	<0.0039	<0.0039	<0.002	<0.002
11	EC11-F001	1.0-2.5	1/16/2009	<0.0036	<0.0036	<0.0019	<0.0019
11	EC11-F002	1.0-2.5	1/16/2009	<0.0037	<0.0037	**0.014**	**0.011**
11	EC11-F003	1.0-2.5	1/16/2009	<0.038	<0.038	<0.019	<0.019
12	EC12-F002	1.0-2.5	1/13/2009	<0.0036	<0.0036	<0.0018	<0.0018
12	EC12-F003	1.0-2.5	1/15/2009	<0.0037	**0.0091**	<0.0019	<0.0019
12	EC12-F004	2.5-12.5	1/15/2009	<0.0035	<0.0035	<0.0018	<0.0018
12	EC12-F005	1.0-2.5	1/12/2009	<0.0038	<0.0038	<0.002	<0.002
California Hazardous Waste Criteria (mg/kg) [1]				1	1	2.5	2.5
ESL for Residential Land Use (mg/kg) [2]				2.4	1.7	0.44	0.44
ESL for Commerical/Industrial Land Use (mg/kg) [3]				10	4	1.7	1.7
ESL for Construction/Trench Worker Exposure (mg/kg) [4]				120	87	21	21

Notes:

Boring locations are shown on Figure 2.

Laboratory reports are included in Appendix G.

Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.

Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).

Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.

Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).

Values shown in bold indicate compound was quantified above the laboratory reporting limit.

Only compounds that were identified above laboratory reporting limits in at least one sample are presented.

Pesticides analyzed by EPA Method 8081A.

bgs = below ground surface.

mg/kg = milligram per kilogram.

<x.x = Compound was not identified above laboratory reporting limit of x.x.

-- = Not analyzed or not applicable.

NV = No Value.

[1] California Code of Regulations, Title 22, Division 4.5, Chapter 11.

[2] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.

[3] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.

[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 10: Polychlorinated Biphenyl Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Sample ID	Sample Depth (feet bgs)	Sample Date	Aroclor-1254	Aroclor-1260
12	EC12-F005	1.0-2.5	1/12/2009	<0.014	<0.014
12	EC12-F004	2.5-12.5	1/15/2009	<0.013	<0.013
12	EC12-F003	1.0-2.5	1/15/2009	**0.046**	**0.018**
12	EC12-F002	1.0-2.5	1/13/2009	<0.013	<0.013
12	EC12-C003	22.5-32.5	1/15/2009	<0.014	<0.014
12	EC12-C002	12.5-37.5	1/12/2009	<0.014	<0.014
12	EC12-C001	17.5-32.5	1/12/2009	<0.014	<0.014
12	EC12-A007	12.5-22.5	1/15/2009	<0.014	<0.014
12	EC12-A006	1.0-17.5	1/14/2009	<0.013	<0.013
12	EC12-A005	1.0-27.5	1/14/2009	<0.013	<0.013
12	EC12-A004	2.5-22.5	1/14/2009	<0.013	<0.013
12	EC12-A003	7.5-27.5	1/16/2009	<0.013	<0.013
12	EC12-A002	1.0-7.5	1/13/2009	<0.013	<0.013
12	EC12-A001	7.5-17.5	1/12/2009	<0.014	<0.014
11	EC11-F003	1.0-2.5	1/16/2009	<0.014	**0.042**
11	EC11-F002	1.0-2.5	1/16/2009	<0.013	**0.028**
11	EC11-F001	1.0-2.5	1/16/2009	**0.025**	**0.034**
10	EC10-F004	7.5-22.5	1/22/2009	<0.014	<0.014
10	EC10-F003	1.0-22.0	1/22/2009	<0.013	<0.013
10	EC10-F002	1.0-7.5	1/21/2009	<0.013	<0.013
10	EC10-F001	1.0-7.5	1/21/2009	<0.013	<0.013
10	EC10-C001	17.5-27.5	1/21/2009	<0.014	<0.014
10	EC10-A002	7.5-17.5	1/21/2009	<0.014	<0.014
10	EC10-A001	7.0-17.5	1/21/2009	<0.014	<0.014
9	EC09-F004	1.0-7.5	1/23/2009	<0.014	**0.04**
9	EC09-F003	1.0-12.5	1/23/2009	<0.014	<0.014
9	EC09-F001	1.0-7.5	1/22/2009	<0.013	<0.013
9	EC09-C001	2.5-12.5	1/22/2009	<0.014	<0.014
California Hazardous Waste Criteria (mg/kg) [1]				50	50
ESL for Residential Land Use (mg/kg) [2]				0.22	0.22
ESL for Commerical/Industrial Land Use (mg/kg) [3]				0.74	0.74
ESL for Construction/Trench Worker Exposure (mg/kg) [4]				6.7	6.7

TABLE 10: Polychlorinated Biphenyl Concentrations in Soil (mg/kg, dry weight basis)
Contract 4 of Doyle Drive Replacement Project

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Only compounds that were identified above laboratory reporting limits in at least one sample are presented.
Polychlorinated Biphenyls analyzed by EPA Method 8082.
bgs = below ground surface.
mg/kg = milligram per kilogram.
<x.x = Compound was not identified above laboratory reporting limit of x.x.
NV = No Value.

[1] California Code of Regulations, Title 22, Division 4.5, Chapter 11.
[2] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Residential Land Use.
[3] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table A, Environmental Screening Levels, Shallow Soils (≤ 3 meters bgs), Groundwater is a Current or Potential Source of Drinking Water, Commercial/Industrial Land Use.
[4] California Regional Water Quality Control Board, San Francisco Bay Region, 2008, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final, May, Table K-3, Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario.

TABLE 11: Asbestos in Soil (percent)
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Percent Asbestos	Asbestos Type
9	E060	E060FS-2.5	2.5	1/23/2009	<0.25	
10	E063	E063FS-22.5	22.5	1/22/2009	<0.25	
12	BTNB-R2	BTNB-R2-27.0-27.5 [1]	27.0-27.5	8/14/2009	**1.8**	Chrysotile
12	BTNB-R2	BTNB-R2-29.5-30.0 [1]	29.5-30.0	8/14/2009	**2.5**	Chrysotile
12	BTSB-R2	BTSB-R2-51.0-51.5 [1]	51.0-51.5	8/14/2009	**0.75**	Chrysotile
12	BTSB-R2	BTSB-R2-53.5-54.0 [1]	53.5-54.0	8/14/2009	**2.3**	Chrysotile
12	BTNB-R3	BTNB-R3-48.5-49.0 [1]	48.5-49.0	8/14/2009	**1.3**	Chrysotile
12	BTNB-R3	BTNB-R3-51.0-51.5 [1]	51.0-51.5	8/14/2009	**2.0**	Chrysotile
California Hazardous Waste Criteria (TTLC) [2]					1%	
CARB Asbestos Dust Mitigation Plan Action Level [3]					0.25%	

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Values shown in bold indicate compound was quantified above the laboratory reporting limit.
Shaded cells indicate concentrations were greater than or equal to the California hazardous waste criteria.
Asbestos analyzed by California Air Resource Board Method 435 with reporting limit of 0.25 percent.
bgs = below ground surface.
<x.x = Compound was not identified above laboratory reporting limit of x.x.

[1] Samples were collected from cores of geotechnical borings previously drilled by ARUP in 2008.

[2] California Code of Regulations, Title 22, Division 4.5, Chapter 11.

[3] California Air Resources Board (CARB) Asbestos Toxic Control Measure, California Code of Regulations, Title 17, Section 93105.

TABLE 12: Miscellaneous Parameters in Soil
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Cyanide	Sulfide	Ignitability	pH	Moisture
				Units	mg/kg	mg/kg	°F	SU	%
11	E062	E062F-1.0	1.0	1/16/2009	--	--	--	--	5
11	E062	E062F-2.5	2.5	1/16/2009	--	--	--	--	11
11	E064	E064F-1.0	1.0	1/16/2009	--	--	--	--	10
11	E064	E064F-2.5	2.5	1/16/2009	--	--	--	--	21
11	E066	E066F-1.0	1.0	1/16/2009	--	--	--	--	7
11	E066	E066F-2.5	2.5	1/16/2009	--	--	--	--	16
11	E068	E068F-1.0	1.0	1/16/2009	--	--	--	--	10
11	E068	E068F-2.5	2.5	1/16/2009	--	--	--	--	11
11	E070	E070F-1.0	1.0	1/16/2009	--	--	--	--	5
11	E070	E070F-2.5	2.5	1/16/2009	--	--	--	--	20
11	E072	E072F-1.0	1.0	1/16/2009	--	--	--	--	10
11	E072	E072F-2.5[1]	2.5	1/16/2009	--	--	--	--	17
12	E075	E075F-1.0	1.0	1/15/2009	--	--	--	--	13
12	E075	E075F-2.5	2.5	1/15/2009	--	--	--	--	6
12	E077	E077A-2.5	2.5	1/15/2009	--	--	--	--	2
12	E077	E077F-1.0	1.0	1/15/2009	--	--	--	--	7
12	E079	E079F-1.0	1.0	1/16/2009	--	--	--	--	8
12	E079	E079F-2.5	2.5	1/16/2009	--	--	--	--	9
12	E081	E081F-1.0	1.0	1/13/2009	--	--	--	--	6
12	E081	E081F-2.5	2.5	1/13/2009	--	--	--	--	8
12	E082	E082A-1.0	1.0	1/13/2009	--	--	--	--	10
12	E082	E082A-2.5	2.5	1/13/2009	--	--	--	--	10
9	--	EC09-C001	2.5-12.5	1/22/2009	<1.2	<12	--	7.5	15
9	--	EC09-F001	1.0-7.5	1/22/2009	<1.1	<11	--	7.6	11
9	--	EC09-F003	1.0-12.5	1/23/2009	<1.1	<11	--	7.9	13
9	--	EC09-F004	1.0-7.5	1/23/2009	<1.1	<11	--	7.3	13
9	--	EC09-F005	7.5-12.5	1/23/2009	--	--	--	--	18
10	--	EC10-A001	7.0-17.5	1/21/2009	<1.1	<11	--	7.1	13
10	--	EC10-A002	7.5-17.5	1/21/2009	<1.1	<11	--	6.2	12
10	--	EC10-C001	17.5-27.5	1/21/2009	<1.1	<11	--	6.9	12
10	--	EC10-F001	1.0-7.5	1/21/2009	<1.1	<11	--	6.9	8
10	--	EC10-F002	1.0-7.5	1/21/2009	<1.1	<11	--	7	8
10	--	EC10-F003	1.0-22.0	1/22/2009	<1.1	<11	--	7.8	9
10	--	EC10-F004	7.5-22.5	1/22/2009	<1.2	<12	--	7.3	16
10	--	EC10-F005	7.5-22.0	1/22/2009	--	--	--	--	7
11	--	EC11-F001	1.0-2.5	1/16/2009	<1.1	<11	--	7.2	9
11	--	EC11-F002	1.0-2.5	1/16/2009	<1.1	<11	--	7.9	11
11	--	EC11-F003	1.0-2.5	1/16/2009	<1.1	<11	--	8.1	12
12	--	EC12-A001	7.5-17.5	1/12/2009	<1.1	<11	--	7.2	13
12	--	EC12-A002	1.0-7.5	1/13/2009	<1.1	<11	--	5.6	9
12	--	EC12-A003	7.5-27.5	1/16/2009	<1.1	<11	--	6.8	7
12	--	EC12-A004	2.5-22.5	1/14/2009	<1	<10	--	5.9	4
12	--	EC12-A005	1.0-27.5	1/14/2009	<1	<10	--	6	4
12	--	EC12-A006	1.0-17.5	1/14/2009	<1.1	<11	--	6.2	7
12	--	EC12-A007	12.5-22.5	1/15/2009	<1.2	<12	--	6.5	15

TABLE 12: Miscellaneous Parameters in Soil
Contract 4 of Doyle Drive Replacement Project

Composite Area	Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Cyanide	Sulfide	Ignitability	pH	Moisture
				Units	mg/kg	mg/kg	°F	SU	%
12	--	EC12-BR001	7.5-22.5	1/13/2009	<1.2	<12	>1000	6.5	16
12	--	EC12-BR002	23.0-38.0	1/15/2009	<1.2	<12	>1000	7	14
12	--	EC12-C001	17.5-32.5	1/12/2009	<1.2	<12	--	6.8	15
12	--	EC12-C002	12.5-37.5	1/12/2009	<1.2	<12	--	7.6	16
12	--	EC12-C003	22.5-32.5	1/15/2009	<1.2	<12	--	6.8	14
12	--	EC12-F002	1.0-2.5	1/13/2009	<1.1	<11	--	5.8	7
12	--	EC12-F003	1.0-2.5	1/15/2009	<1.1	<11	--	6	10
12	--	EC12-F004	2.5-12.5	1/15/2009	<1.1	<11	--	6	6
12	--	EC12-F005	1.0-2.5	1/12/2009	<1.2	<12	--	6.4	14
12	--	EC12-F006	7.5-12.5	1/15/2009	--	--	--	--	5

Notes:
Boring locations are shown on Figure 2.
Laboratory reports are included in Appendix G.
Key to Discrete Sample IDs: E061C-2.5 indicates sample collected from environmental boring number E061, lithology of sample is Colma sand (C=Colma sand), and sample depth is 2.0 to 2.5 feet bgs.
Key to Composite Sample IDs: EC09-C001 indicates an environmental composite sample made up of discrete samples collected from Composite Area 9, and lithology of sample is Colma sand (C=Colma sand).
Key to Lithologies: F = Fill; FS = Fill with serpentinite; A = Alluvium; C = Colma Sand; BR = Bedrock.
Soil results for cyanide and sulfide are reported on a dry-weight basis in accordance with the Presidio Trust Quality Assurance Project Plan (QAPP).
Cyanide analyzed by Standard Method 4500-CN-E.
Sulfide analyzed by EPA Method 9034.
Ignitability analyzed by EPA Method 1030.
pH analyzed by EPA Method 9045D.
Moisture analyzed by ASTM Method D2216/CLP.
bgs = below ground surface.
mg/kg = milligram per kilogram.
°F = degrees fahrenheit
SU = standard units
% = percent
<x.x = Compound was not identified above laboratory reporting limit of x.x.
-- = Not analyzed or not applicable.

[1] The laboratory sample identification was E072F-2.0. BASELINE changed the sample identification to E072F-2.5 based on review of the boring log.

TABLE 13: Summary of Waste Classification Results by Composite Area
Contract 4 of Doyle Drive Replacement Project

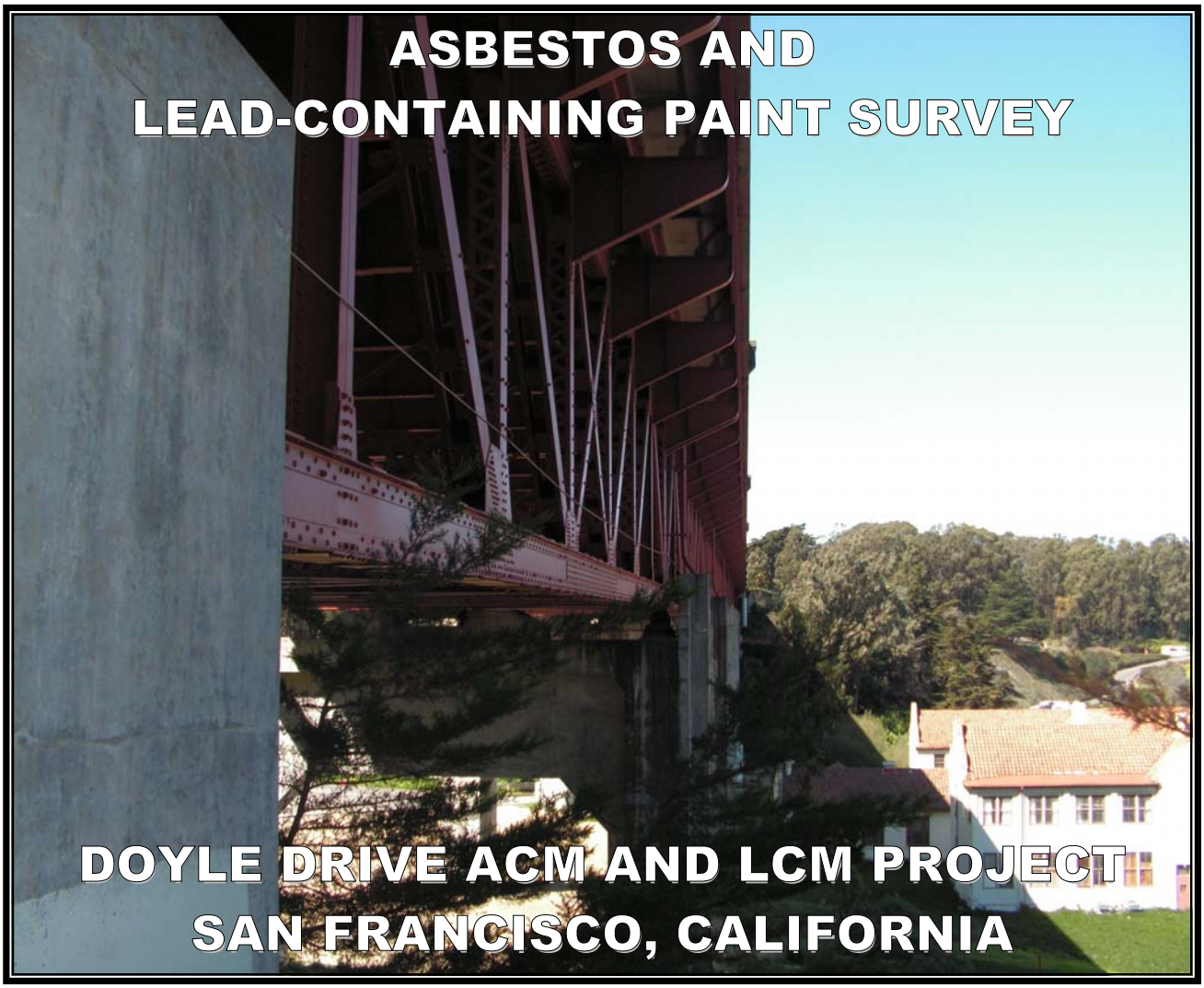
	COMPOSITE AREA			
	9	**10**	**11**	**12**
Top 2.5 Feet of Soil	Non-hw	Non-hw	**CA hw**	Non-hw
Fill Deeper than 2.5 Feet bgs	Non-hw	Non-hw	NE	Non-hw
Alluvium Deeper than 2.5 Feet bgs	NE	Non-hw	NE	Non-hw
Colma Sand Deeper than 2.5 Feet bgs	Non-hw	Non-hw	NE	Non-hw
Non-Serpentinite Bedrock	NE	NE	NE	Non-hw
Serpentinite Bedrock	NE	NE	NE	**CA hw**

Notes:
CA hw = California hazardous waste.
Non-hw = Nonhazardous waste.
NE = Not encountered during investigation.
See Figure 2 for location of composite areas.

APPENDICES

(IN PDF ON CD ROM)

ASBESTOS AND LEAD-CONTAINING PAINT SURVEY



DOYLE DRIVE ACM AND LCM PROJECT SAN FRANCISCO, CALIFORNIA

PREPARED FOR:
CALIFORNIA DEPARTMENT OF TRANSPORTATION
DISTRICT 4
OFFICE OF ENVIRONMENTAL ENGINEERING
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CALTRANS EA 04-163741
EA 04-163751
EA 04-163761
EA 04-163771

Caltrans

GEOCON

AUGUST 2009

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ASBESTOS AND LEAD-CONTAINING PAINT SURVEY REPORT

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REPORT LIMITATIONS

This asbestos and lead-containing paint (LCP) survey was conducted in conformance with generally accepted standards of practice for identifying and evaluating asbestos and LCP in structures. Due to the nature of structure surveys, asbestos and LCP use, and laboratory analytical limitations, some asbestos or LCP in the structures may not have been identified. Structure spaces such as cavities, crawlspaces, and pipe chases may have been concealed to our investigator. Previous structure renovation work may have concealed or covered spaces or materials, or may have partially demolished materials and left debris in inaccessible areas. Additionally, renovation activities may have partially replaced asbestos with indistinguishable non-asbestos materials. Asbestos or LCP may exist in areas of the structures not accessible or sampled in conjunction with this Task Order.

During renovation or demolition operations, suspect materials may be uncovered which are different from those accessible for sampling during this assessment. Personnel in charge of renovation/demolition should be alerted to note materials uncovered during such activities that differ substantially from those included in this or previous assessment reports. If suspect materials are found, additional sampling and analysis should be performed to determine if the materials contain asbestos or lead.

This report has been prepared exclusively for the State of California Department of Transportation (Caltrans) District 4. The information contained herein is only valid as of the date of the report, and will require an update to reflect additional information obtained.

This report is not a comprehensive site characterization and should not be construed as such. The findings as presented in this report are predicated on the results of the limited sampling and laboratory testing performed. In addition, the information obtained is not intended to address potential impacts related to sources other than those specified herein. Therefore, the report should be deemed conclusive with respect to only the information obtained. We make no warranty, express or implied, with respect to the content of this report or any subsequent reports, correspondence or consultation. Geocon strived to perform the services summarized herein in accordance with the local standard of care in the geographic region at the time the services were rendered.

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

GEOCON CONSULTANTS, INC

Chris Giuntoli, CAC
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CALIFORNIA DEPARTMENT OF TRANSPORTATION – DISTRICT 4
OFFICE OF ENVIRONMENTAL ENGINEERING

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EXECUTIVE SUMMARY

This asbestos and lead-containing paint (LCP) survey report for the Doyle Drive Project was prepared by Geocon Consultants, Inc., under California Department of Transportation (Caltrans) Contract No. 04A2912 and Task Order 28 (TO-28), under the following four EAs: 1) EA 04-163741, 2) EA 04-163751, 3) EA 04-163761, and 4) EA 04-163771. This work was conducted at Highway 101 (Doyle Drive) from Post Mile (PM) 8.0 to PM 9.8, associated exit and entrance connectors, and Highway 1 from PM 6.8 to PM 7.1 in San Francisco, California. We performed an asbestos and LCP survey on the following Doyle Drive and Highway 1 roadway segments and bridges:

- Marina Viaduct - Bridge No. 34-0014;
- Presidio Viaduct - Bridge No. 34-0019;
- Lincoln Boulevard Undercrossing (UC) - Bridge No. 34-0062;
- N101-S1 Connector UC - Bridge No. 34-0020;
- N1-N101 Connector Pedestrian Undercrossing (PUC) - Bridge No. 34-0023G;
- N101-S1 Connector PUC - Bridge No. 34-0025G;
- N1-S101 Connector Overcrossing (OC) - Bridge No. 34-0040G;
- Ruckman Avenue UC - Bridge No. 34-0018; and
- Richardson Avenue connectors to the northbound and southbound Marina Viaduct.

The project location is depicted on the Vicinity Map, Figure 1, and Site Plans, Figures 2a through 2f. Caltrans has requested an investigation at the project location to provide data regarding the presence of asbestos and LCP prior to demolition activities.

This report documents the investigation sampling methods and laboratory analytical data. The primary objective of our survey was to determine and quantify asbestos and deteriorated LCP at the project location prior to demolition activities. The information obtained from this investigation will be used by Caltrans to coordinate proposed demolition activities, determine appropriate abatement/disposal costs, and identify health and safety concerns during improvements.

The field investigation was performed on April 7, 9, and 15, 2009. The following field activities were performed during asbestos and LCP sampling efforts:

- Collected 50 bulk suspect asbestos samples at the project location;
- Collected 14 suspect LCP sample at the project location; and
- Transported samples to Caltrans-approved, California-certified environmental laboratories.

Samples were collected from locations as shown in the Site Plans (Figures 2a through 2f). Suspect asbestos and LCP sample identification numbers are presented in Tables 1 and 2, respectively. Materials represented by the samples collected are presented in the Site Photographs.

Bulk suspect asbestos samples were collected after first wetting friable material with a light mist of water. The samples were then cut from the substrate and transferred to labeled containers and sealed.

Twenty-four suspect materials were identified during the survey (see Table 1). When multiple samples of a material were collected, the sampling locations were distributed throughout the homogeneous areas (spaces where the material was observed).

We relinquished bulk samples for asbestos analysis using standard chain-of-custody documentation. Asbestos content was determined using EPA Test Method 600/R-93/116 for polarized light microscopy (PLM). We requested laboratory analyses to be within a 24-hour turn-around-time.

Bulk paint samples were collected using techniques presented in U.S. Department of Housing and Urban Development (HUD) guidelines. Fourteen paint systems were identified during the survey (see Table 2).

> *It was not Geocon's intent during this inspection to conduct an evaluation of lead-based paint hazards in accordance with HUD guidelines. HUD protocol generally requires a very extensive sampling strategy that includes sampling of paint on each surface type.*

We relinquished the bulk paint samples for lead analysis using standard chain-of-custody documentation. Total lead content was determined using EPA Test Method 6010B. Soluble (Waste Extraction Test [WET]) lead content was determined following EPA Test Method 7420. Soluble (Toxicity Characteristic Leaching Procedure [TCLP]) lead content was determined following EPA Test Method 1311. We requested laboratory analyses to be within a 24-hour turn-around-time.

The laboratory analyses for asbestos indicated the following:

- Chrysotile asbestos at a concentration of 2% was detected in samples representing nonfriable black abutment joint material (surface coat) on the Marina Viaduct (Bridge No. 34-0014) in the northbound direction. We were unable to quantify the material due to safety constraints (i.e., traffic).
- Chrysotile asbestos at a concentration of less than (<) 0.1% was detected in a sample representing approximately 1,000 square feet of nonfriable silver paint applied to the pedestrian stairway at the Richardson Avenue merge with the Marina Viaduct (Bridge No. 34-0014). The material was analyzed using PLM point count analysis (1,000 points).
- Chrysotile asbestos at a concentration of 2% was detected in samples representing nonfriable black deck joint material at the Richardson Avenue merge with the Marina Viaduct (Bridge No. 34-0014). We were unable to quantify the material due to safety constraints (i.e., traffic).

- Chrysotile asbestos at a concentration of 3% was detected in samples representing nonfriable black bent joint fill material at the Marina Viaduct (Bridge No. 34-0014) southbound exit to Richardson Avenue. We were unable to quantify the material due to safety constraints (i.e., traffic).

No asbestos was detected in samples of the remaining suspect materials collected during our survey. Laboratory results for the asbestos samples are summarized on Table 1. Reproductions of the laboratory report and chain-of-custody documentation are presented in Appendix A.

The laboratory analyses for lead paint indicated the following:

- A bulk sample representing intact red paint used on the Marina Viaduct (Bridge No. 34-0014) bent footings at Halleck Street exhibited a total lead concentration of 19,000 milligrams per kilogram (mg/kg) and a soluble (TCLP) lead concentration of 100 milligrams per liter (mg/l).
- A bulk sample representing intact silver paint used on the pedestrian stairway at the Richardson Avenue merge with the northbound Marina Viaduct (Bridge No. 34-0014) exhibited a total lead concentration of 76 mg/kg and a soluble (WET) lead concentration of 7.2 mg/l.
- A bulk sample representing intact beige paint used on the Marina Viaduct (Bridge No. 34-0014) bents (seismic retrofit collars) exhibited a total lead concentration of 64 mg/kg and a soluble (WET) lead concentration of 0.86 mg/l.
- A bulk sample representing intact red paint used on the Presidio Viaduct (Bridge No. 34-0019) girder and truss systems exhibited a total lead concentration of 76 mg/kg and a soluble (WET) lead concentration of 5.2 mg/l.
- A bulk sample representing intact red paint used on the Presidio Viaduct (Bridge No. 34-0019) girder system exhibited a total lead concentration of 480 mg/kg, a soluble (WET) lead concentration of 3.4 mg/l, and a soluble (TCLP) lead concentration of 0.28 mg/l.
- A bulk sample representing intact white paint used on the Lincoln Boulevard UC (Bridge No. 34-0062) seismic retrofit collars exhibited a total lead concentration of <2.0 mg/kg.
- A bulk sample representing intact white graffiti abatement paint used on the Lincoln Boulevard UC (Bridge No. 34-0062) bent wall exhibited a total lead concentration of 23 mg/kg.
- A bulk sample representing deteriorated red paint used on the Marina Viaduct (Bridge No. 34-0014) light posts exhibited a total lead concentration of 32,000 mg/kg and a soluble (TCLP) lead concentration of 67 mg/l. We were unable to quantify the deteriorated paint due to safety constraints (i.e., traffic).
- A bulk sample representing intact white roadway striping used on the Marina Viaduct (Bridge No. 34-0014) exhibited a total lead concentration of 28 mg/kg.
- A bulk sample representing approximately 500 square feet of deteriorated green paint used on the pedestrian railing of the Lincoln Boulevard UC (Bridge No. 34-0062) exhibited a total lead concentration of 130,000 mg/kg and a soluble (TCLP) lead concentration of 9.5 mg/l.
- A bulk sample representing intact multi-layered graffiti abatement paint used in the N101-S1 Connector PUC (Bridge No. 34-0025G) exhibited a total lead concentration of 13 mg/kg.
- A bulk sample representing deteriorated red paint used on light posts on Doyle Drive exhibited a total lead concentration of 52,000 mg/kg and a soluble (TCLP) lead concentration of 54 mg/l. We were unable to quantify the deteriorated paint due to safety constraints (i.e., traffic).

- A bulk sample of deteriorated green paint used on the pedestrian sidewalk fence adjacent to westbound Doyle Drive approaching the Golden Gate Bridge toll plaza exhibited a total lead concentration of 220,000 mg/kg and a soluble (TCLP) lead concentration of 3.7 mg/l.
- A bulk sample representing intact white paint used on the Ruckman Avenue UC (Bridge No. 34-0018) bent exhibited a total lead concentration of 100 mg/kg and a soluble (WET) lead concentration of 1.9 mg/l.

Geocon paint sample laboratory results are summarized on Table 2. Reproductions of the lead laboratory report and chain-of-custody documentation are presented in Appendix A.

We provide the following conclusions and recommendations based on the results of our investigation.

NESHAP regulations do not require that asbestos-containing joint material (a Category I nonfriable/nonhazardous material) or asbestos-containing paint identified during this survey be removed prior to demolition or be treated as hazardous waste. However, the disturbance of the materials is still covered by the Cal/OSHA asbestos standard (Title 8, CCR Section 1529). We recommend that demolition activities be performed by a licensed contractor registered with Cal/OSHA for asbestos-related work (or by a certified asbestos abatement contractor) following Cal/OSHA asbestos work requirements if the asbestos-containing materials are left in place during demolition. Contractors are responsible for informing the landfill of the contractor's intent to dispose of asbestos waste. Some landfills may require additional waste characterization. Contractors are responsible for segregating and characterizing waste streams prior to disposal.

Geocon also recommends the notification of contractors (that will be conducting demolition, renovation, or related activities) of the presence of asbestos in their work areas (i.e., provide the contractor[s] with a copy of this report and a list of asbestos removed by asbestos abatement contractor[s] during subsequent abatement activities). Contractors (not involved in asbestos abatement) should be instructed not to disturb asbestos during their work.

In accordance with Bay Area Air Quality Management District (BAAQMD) Regulation 11, Rule 2, written notification is required ten working days prior to commencement of *any* demolition activity (whether asbestos is present or not). In accordance with Title 8, CCR 341.9, written notification to the nearest Cal/OSHA district office is required at least 24 hours prior to certain asbestos-related work.

Based on the analytical test results, we recommend that deteriorated LCP on the light posts, pedestrian railing, and fencing (a California and Federal [RCRA] hazardous waste) be removed and disposed of prior to renovation, demolition, or other activities that would disturb the paint. We recommend that the contractor be required to use personnel who have lead-related construction certification as supervisors or workers, as appropriate, from the California Department of Public Health for LCP removal work. Loose and peeling/flaking LCP require removal prior to demolition for waste segregation purposes: to separate potentially hazardous waste (Category III concentrated lead such as loose paint, paint sludge, vacuum debris, and vacuum filters) from non-hazardous demolition debris (Category II intact lead-painted architectural components such as doors, windows, framework, cladding, and trim). Category I waste is low lead waste (typically non-hazardous) such as construction materials, filtered wash water, and plastic sheeting. Contractors are responsible for informing the landfill of the contractor's intent to dispose of RCRA waste, California hazardous waste, and/or architectural components containing intact LCP. Some landfills may require additional waste characterization. Contractors are responsible for segregating and characterizing waste streams prior to disposal.

We recommend that all paints at the project location be treated as lead-containing for purposes of determining the applicability of the Cal/OSHA lead standard during any future maintenance, renovation, and demolition activities. This recommendation is based on LCP sample results and the fact that lead was a common ingredient of paints manufactured before 1978 and is still an ingredient of some industrial paints. In accordance with Title 8, CCR, Section 1532.1(p), written notification to the nearest Cal/OSHA district office is required at least 24 hours prior to certain lead-related work.

ASBESTOS AND LEAD-CONTAINING PAINT SURVEY REPORT

1.0 INTRODUCTION

This asbestos and lead-containing paint (LCP) survey report for the Doyle Drive Project was prepared by Geocon Consultants, Inc., under California Department of Transportation (Caltrans) Contract No. 04A2912 and Task Order 28 (TO-28), under the following four EAs: 1) EA 04-163741, 2) EA 04-163751, 3) EA 04-163761, and 4) EA 04-163771. This work was conducted at Highway 101 (Doyle Drive) from Post Mile (PM) 8.0 to PM 9.8, associated exit and entrance connectors, and Highway 1 from PM 6.8 to PM 7.1 in San Francisco, California. This report documents the investigation sampling methods and laboratory analytical data.

1.1 Site Description and Proposed Improvements

We performed an asbestos and LCP survey on the following Doyle Drive and Highway 1 roadway segments and bridges:

- Marina Viaduct - Bridge No. 34-0014;
- Presidio Viaduct - Bridge No. 34-0019;
- Lincoln Boulevard Undercrossing (UC) - Bridge No. 34-0062;
- N101-S1 Connector UC - Bridge No. 34-0020;
- N1-N101 Connector Pedestrian Undercrossing (PUC) - Bridge No. 34-0023G;
- N101-S1 Connector PUC - Bridge No. 34-0025G;
- N1-S101 Connector Overcrossing (OC) - Bridge No. 34-0040G;
- Ruckman Avenue UC - Bridge No. 34-0018; and
- Richardson Avenue connectors to the northbound and southbound Marina Viaduct.

The project location is depicted on the Vicinity Map, Figure 1, and Site Plans, Figures 2a through 2f. Caltrans has requested an investigation at the project location to provide data regarding the presence of asbestos and LCP prior to demolition activities.

1.2 Purpose

This report documents the investigation sampling methods and laboratory analytical data. The primary objective of our survey was to determine and quantify asbestos and deteriorated LCP at the project location prior to demolition activities. The information obtained from this investigation will be used by Caltrans to coordinate proposed demolition activities, determine appropriate abatement/disposal costs, and identify health and safety concerns during improvements.

2.0 BACKGROUND

The *Code of Federal Regulations (CFR),* 40 CFR 61, Subpart M, National Emissions Standards for Hazardous Air Pollutants (NESHAP) and Federal Occupational Safety and Health Administration (FED OSHA) classify asbestos-containing material (ACM) as any material or product that contains *greater than* 1% asbestos. Nonfriable ACM is classified by NESHAP as either Category I or Category II material defined as follows:

- **Category I** – asbestos-containing packings, gaskets, resilient floor coverings, and asphalt roofing products.
- **Category II** – all remaining types of nonfriable asbestos-containing material not included in Category I that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Regulated asbestos-containing material (RACM), a hazardous waste when friable, is classified as any manufactured material that contains *greater than* 1% asbestos by dry weight *and* is:

- Friable; or
- Category I material that has become friable; or
- Category I material that has been subjected to sanding, grinding, cutting, or abrading; or
- Category II nonfriable material that has a high probability of becoming crumbled, pulverized, or reduced to a powder during demolition or renovation activities.

Activities that disturb materials containing *any* amount of asbestos are subject to certain requirements of the Cal/OSHA asbestos standard contained in Title 8, CCR Section 1529. Typically, removal or disturbance of more than 100 square feet of material containing more than 0.1% asbestos must be performed by a registered asbestos abatement contractor, but associated waste labeling is not required if the material contains 1% or less asbestos. When the asbestos content of a material exceeds 1%, virtually all requirements of the standard become effective.

Materials containing more than 1% asbestos are also subject to NESHAP regulations (40 CFR Part 61, Subpart M). RACM (friable ACM and nonfriable ACM that will become friable during demolition operations) must be removed from structures prior to demolition. Certain nonfriable ACM and materials containing 1% or less asbestos may remain in structures during demolition; however, there are waste handling/disposal issues and Cal/OSHA work requirements that must be followed. Contractors are responsible for segregating and characterizing waste streams prior to disposal.

With respect to potential worker exposure, notification, and registration requirements, Cal/OSHA defines asbestos-containing construction material (ACCM) as construction material that contains more than 0.1% asbestos (Title 8, CCR 341.6).

2.2 Lead Paint

Construction activities (including demolition) that disturb materials or paints containing *any* amount of lead are subject to certain requirements of the Cal/OSHA lead standard contained in Title 8, CCR, Section 1532.1. Deteriorated paint is defined by Title 17, CCR, Division 1, Chapter 8, §35022 as a surface coating that is cracking, chalking, flaking, chipping, peeling, non-intact, failed, or otherwise separating from a component. Demolition of a deteriorated LCP component would require waste characterization and appropriate disposal. Most landfill facilities and recyclers currently accept intact LCP on a component; however, contractors are responsible for segregating and characterizing waste streams prior to disposal.

For a solid waste containing lead, the waste is classified as California hazardous when: 1) the total lead content equals or exceeds the respective Total Threshold Limit Concentration (TTLC) of 1,000 milligrams per kilogram (mg/kg); or 2) the soluble lead content equals or exceeds the respective Soluble Threshold Limit Concentration (STLC) of 5 milligrams per liter (mg/l) based on the standard Waste Extraction Test (WET). A waste has the potential for exceeding the lead STLC when the waste's total lead content is greater than or equal to ten times the respective STLC value since the WET uses a 1:10 dilution ratio. Hence, when total lead is detected at a concentration greater than or equal to 50 mg/kg, and assuming that 100 percent of the total lead is soluble, soluble lead analysis is required. Lead-containing waste is classified as "Resource, Conservation, and Recovery Act" (RCRA) hazardous, or Federal hazardous, when the soluble lead content equals or exceeds the Federal regulatory level of 5 mg/l based on the Toxicity Characteristic Leaching Procedure (TCLP).

The above regulatory criteria are based on chemical concentrations. Wastes may also be classified as hazardous based on other criteria such as ignitability; however, for the purposes of this investigation, toxicity (i.e., lead concentrations) is the primary factor considered for waste classification since waste generated during the construction activities would not likely warrant testing for ignitability or other criteria. Waste that is classified as either California hazardous or RCRA hazardous requires management as a hazardous waste.

Potential hazards exist to workers who remove or cut through LCP coatings during demolition. Dust containing hazardous concentrations of lead may be generated during scraping or cutting materials coated with LCP. Torching of these materials may produce lead oxide fumes. Therefore, air monitoring and/or respiratory protection may be required during the demolition of materials coated with LCP. Guidelines regarding regulatory provisions for construction work where workers may be exposed to lead are presented in the Title 8, CCR, Section 1532.1.

2.3 Architectural Drawings and Previous Survey Activities

Architectural drawings and previous survey reports for the project were not available for our review.

3.0 SCOPE OF SERVICES

The following scope of services was performed:

3.1 Pre-Field Activities

- Prepared a Health and Safety Plan, dated April 2009, to provide guidelines on personal safety during the field activities.
- Prepared a Workplan, dated April 8, 2009, to summarize the scope of services to be performed by Geocon.
- Retained the services of EMSL, Inc. (EMSL), a Caltrans-approved laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP), to perform the asbestos analyses.
- Retained the services of Advance Technology Laboratories, Inc. (ATL), a Caltrans-approved laboratory, to perform the lead paint analyses.

3.2 Field Activities

Mr. Chris Giuntoli, a California-certified Asbestos Consultant (CAC), Certification No. 02-3163 (expiration June 18, 2010), and Certified Lead Paint Inspector with the California Department of Public Health (DPH), Certification No. I-5502 (expiration June 14, 2010) performed the asbestos and LCP survey on April 7, 9, and 15, 2009. Fifty bulk samples of suspect ACM were collected. Fourteen bulk samples of suspect LCP were collected.

4.0 INVESTIGATIVE METHODS

4.1 Asbestos

Bulk suspect asbestos samples were collected after first wetting friable material with a light mist of water. The samples were then cut from the substrate and transferred to labeled containers and sealed. We observed 24 suspect materials during the survey (see Table 1). When multiple samples of a material were collected, the sampling locations were distributed throughout the homogeneous areas (spaces where the material was observed).

We relinquished bulk samples for asbestos analysis using standard chain-of-custody documentation. Asbestos content was determined using EPA Test Method 600/R-93/116 for polarized light microscopy (PLM). We requested laboratory analyses to be within a 24-hour turn-around-time.

4.2 Lead Paint

Bulk paint samples were collected using techniques presented in U.S. Department of Housing and Urban Development (HUD) guidelines. Fourteen paint systems were identified during the survey (see Table 2).

> *It was not Geocon's intent during this inspection to conduct an evaluation of lead-based paint hazards in accordance with HUD guidelines. HUD protocol generally requires a very extensive sampling strategy that includes sampling of paint on each surface type.*

We relinquished the bulk paint sample for lead analysis using standard chain-of-custody documentation. Total lead content was determined using EPA Test Method 6010B. Soluble (WET and TCLP) lead content was determined following EPA Test Methods 7420 and 1311, respectively. We requested laboratory analyses to be within a 24-hour turn-around-time.

5.0 INVESTIGATIVE RESULTS

5.1 Asbestos

The laboratory analyses for asbestos indicated the following:

- Chrysotile asbestos at a concentration of 2% was detected in samples representing nonfriable black abutment joint material (surface coat) on the Marina Viaduct (Bridge No. 34-0014) in the northbound direction. We were unable to quantify the material due to safety constraints (i.e., traffic).
- Chrysotile asbestos at a concentration of less than (<) 0.1% was detected in a sample representing approximately 1,000 square feet of nonfriable silver paint applied to the pedestrian stairway at the Richardson Avenue merge with the Marina Viaduct (Bridge No. 34-0014). The material was analyzed using PLM point count analysis (1,000 points).
- Chrysotile asbestos at a concentration of 2% was detected in samples representing nonfriable black deck joint material at the Richardson Avenue merge with the Marina Viaduct (Bridge No. 34-0014). We were unable to quantify the material due to safety constraints (i.e., traffic).
- Chrysotile asbestos at a concentration of 3% was detected in samples representing nonfriable black bent joint fill material at the Marina Viaduct (Bridge No. 34-0014) southbound exit to Richardson Avenue. We were unable to quantify the material due to safety constraints (i.e., traffic).

No asbestos was detected in samples of the remaining suspect materials collected during our survey. Laboratory results for the asbestos samples are summarized on Table 1. Reproductions of the laboratory report and chain-of-custody documentation are presented in Appendix A.

5.2 Lead Paint

The laboratory analyses for lead paint indicated the following:

- A bulk sample representing intact red paint used on the Marina Viaduct (Bridge No. 34-0014) bent footings at Halleck Street exhibited a total lead concentration of 19,000 mg/kg and a soluble (TCLP) lead concentration of 100 mg/l.
- A bulk sample representing intact silver paint used on the pedestrian stairway at the Richardson Avenue merge with the northbound Marina Viaduct (Bridge No. 34-0014) exhibited a total lead concentration of 76 mg/kg and a soluble (WET) lead concentration of 7.2 mg/l.
- A bulk sample representing intact beige paint used on the Marina Viaduct (Bridge No. 34-0014) bents (seismic retrofit collars) exhibited a total lead concentration of 64 mg/kg and a soluble (WET) lead concentration of 0.86 mg/l.
- A bulk sample representing intact red paint used on the Presidio Viaduct (Bridge No. 34-0019) girder and truss systems exhibited a total lead concentration of 76 mg/kg and a soluble (WET) lead concentration of 5.2 mg/l.
- A bulk sample representing intact red paint used on the Presidio Viaduct (Bridge No. 34-0019) girder system exhibited a total lead concentration of 480 mg/kg, a soluble (WET) lead concentration of 3.4 mg/l, and a soluble (TCLP) lead concentration of 0.28 mg/l.
- A bulk sample representing intact white paint used on the Lincoln Boulevard UC (Bridge No. 34-0062) seismic retrofit collars exhibited a total lead concentration of <2.0 mg/kg.
- A bulk sample representing intact white graffiti abatement paint used on the Lincoln Boulevard UC (Bridge No. 34-0062) bent wall exhibited a total lead concentration of 23 mg/kg.
- A bulk sample representing deteriorated red paint used on the Marina Viaduct (Bridge No. 34-0014) light posts exhibited a total lead concentration of 32,000 mg/kg and a soluble (TCLP) lead concentration of 67 mg/l. We were unable to quantify the deteriorated paint due to safety constraints (i.e., traffic).
- A bulk sample representing intact white roadway striping used on the Marina Viaduct (Bridge No. 34-0014) exhibited a total lead concentration of 28 mg/kg.
- A bulk sample representing approximately 500 square feet of deteriorated green paint used on the pedestrian railing of the Lincoln Boulevard UC (Bridge No. 34-0062) exhibited a total lead concentration of 130,000 mg/kg and a soluble (TCLP) lead concentration of 9.5 mg/l.
- A bulk sample representing intact multi-layered graffiti abatement paint used in the N101-S1 Connector PUC (Bridge No. 34-0025G) exhibited a total lead concentration of 13 mg/kg.
- A bulk sample representing deteriorated red paint used on light posts on Doyle Drive exhibited a total lead concentration of 52,000 mg/kg and a soluble (TCLP) lead concentration of 54 mg/l. We were unable to quantify the deteriorated paint due to safety constraints (i.e., traffic).
- A bulk sample of deteriorated green paint used on the pedestrian sidewalk fence adjacent to westbound Doyle Drive approaching the Golden Gate Bridge toll plaza exhibited a total lead concentration of 220,000 mg/kg and a soluble (TCLP) lead concentration of 3.7 mg/l.
- A bulk sample representing intact white paint used on the Ruckman Avenue UC (Bridge No. 34-0018) bent exhibited a total lead concentration of 100 mg/kg and a soluble (WET) lead concentration of 1.9 mg/l.

Geocon paint sample laboratory results are summarized on Table 2. Reproductions of the lead laboratory report and chain-of-custody documentation are presented in Appendix A.

6.0 CONCLUSIONS

6.1 Asbestos

NESHAP regulations do not require that asbestos-containing joint material (a Category I nonfriable/nonhazardous material) or asbestos-containing paint identified during this survey be removed prior to demolition or be treated as hazardous waste. However, the disturbance of the materials is still covered by the Cal/OSHA asbestos standard (Title 8, CCR Section 1529). We recommend that demolition activities be performed by a licensed contractor registered with Cal/OSHA for asbestos-related work (or by a certified asbestos abatement contractor) following Cal/OSHA asbestos work requirements if the asbestos-containing materials are left in place during demolition. Contractors are responsible for informing the landfill of the contractor's intent to dispose of asbestos waste. Some landfills may require additional waste characterization. Contractors are responsible for segregating and characterizing waste streams prior to disposal.

Geocon also recommends the notification of contractors (that will be conducting demolition, renovation, or related activities) of the presence of asbestos in their work areas (i.e., provide the contractor[s] with a copy of this report and a list of asbestos removed by asbestos abatement contractor[s] during subsequent abatement activities). Contractors (not involved in asbestos abatement) should be instructed not to disturb asbestos during their work.

In accordance with Bay Area Air Quality Management District (BAAQMD) Regulation 11, Rule 2, written notification is required ten working days prior to commencement of *any* demolition activity (whether asbestos is present or not). In accordance with Title 8, CCR 341.9, written notification to the nearest Cal/OSHA district office is required at least 24 hours prior to certain asbestos-related work.

6.2 Lead Paint

Based on the analytical test results, we recommend that deteriorated LCP applied to the light posts, pedestrian railing, and fencing along Doyle Drive (California and Federal [RCRA] hazardous waste) be removed and disposed of prior to renovation, demolition, or other activities that would disturb the paint. We recommend that the contractor be required to use personnel who have lead-related construction certification as supervisors or workers, as appropriate, from the California DPH for LCP removal work. Loose and peeling/flaking LCP require removal prior to demolition for waste segregation purposes: to separate potentially hazardous waste (Category III concentrated lead such as loose paint, paint sludge, vacuum debris, and vacuum filters) from non-hazardous demolition debris (Category II intact lead-painted architectural components such as doors, windows, framework, cladding, and trim). Category I waste is low lead waste (typically non-hazardous) such as construction materials, filtered wash water, and plastic sheeting. Contractors are responsible for informing the landfill of the contractor's intent to dispose of RCRA waste, California hazardous waste, and/or architectural components containing intact LCP. Some landfills may require additional waste

characterization. Contractors are responsible for segregating and characterizing waste streams prior to disposal.

We recommend that all paints at the project location be treated as lead-containing for purposes of determining the applicability of the Cal/OSHA lead standard during any future maintenance, renovation, and demolition activities. This recommendation is based on LCP sample results and the fact that lead was a common ingredient of paints manufactured before 1978 and is still an ingredient of some industrial paints. In accordance with Title 8, CCR, Section 1532.1(p), written notification to the nearest Cal/OSHA district office is required at least 24 hours prior to certain lead-related work.

TABLE 1
SUMMARY OF ANALYTICAL LABORATORY TEST RESULTS - ASBESTOS
DOYLE DRIVE ACM AND LCM PROJECT
SAN FRANCISCO, CALIFORNIA

Polarized Light Microscopy (PLM) - EPA Test Method 600/R-93/116

Sample Group ID[1]	Description of Suspect Material	Location	Approximate Quantity	Friable	Site Photo	Asbestos Content
DD-1	Bent joint fill material (styrene)	Marina Viaduct (Bridge No. 34-0014) exit to Richardson Avenue	NA	NA	11	ND
DD-2	Brown fiber board	Marina Viaduct (Bridge No. 34-0014) exit to Richardson Avenue	NA	NA	12	ND
DD-3	Brown fiber board (seismic anchor covers)	Marina Viaduct (Bridge No. 34-0014) exit to Richardson Avenue	NA	NA	13	ND
DD-4	Bent joint fill material (styrene)	Marina Viaduct (Bridge No. 34-0014)	NA	NA	14	ND
DD-5	Elastomeric deck joint material	Marina Viaduct (Bridge No. 34-0014)	NA	NA	14	ND
DD-6	**Black abutment joint fill material**	**Marina Viaduct (Bridge No. 34-0014)**	**Unable to safely quantify**	**No**	**15**	**2% - Surface coat** ND - Felt
DD-7	Brown fiber board (seismic anchor covers)	Marina Viaduct (Bridge No. 34-0014)	NA	NA	13	ND
DD-8	**Silver paint**	**Pedestrian stairway at Richardson Avenue merge with Marina Viaduct (Bridge No. 34-0014)**	**1,000 square feet**	**No**	**16**	**<0.1%***
DD-9	Elastomeric deck joint material	Marina Viaduct (Bridge No. 34-0014)	NA	NA	17	ND
DD-10	Elastomeric deck joint material	Marina Viaduct (Bridge No. 34-0014)	NA	NA	18	ND

TABLE 1
SUMMARY OF ANALYTICAL LABORATORY TEST RESULTS - ASBESTOS
DOYLE DRIVE ACM AND LCM PROJECT
SAN FRANCISCO, CALIFORNIA

Polarized Light Microscopy (PLM) - EPA Test Method 600/R-93/116

Sample Group ID[1]	Description of Suspect Material	Location	Approximate Quantity	Friable	Site Photo	Asbestos Content
DD-11	Elastomeric deck joint material	Richardson Avenue merge with Marina Viaduct (Bridge No. 34-0014)	NA	NA	19	ND
DD-12	**Black deck joint fill material**	**Richardson Avenue merge with Marina Viaduct (Bridge No. 34-0014)**	**Unable to safely quantify**	**No**	**20**	**2%**
DD-13	Sidewalk joint fill material	Presidio Viaduct (Bridge No. 34-0019)	NA	NA	21	ND
DD-14	Retaining wall joint fill material	N101-S1 Connector Pedestrian Undercrossing (Bridge No. 34-0025G)	NA	NA	22	ND
DD-15	Retaining wall joint fill material	N1-N101 Connector Pedestrian Undercrossing (Bridge No. 34-0023G)	NA	NA	23	ND
DD-16	Retaining wall joint fill material	N101-S1 Connector Undercrossing (Bridge No. 34-0020)	NA	NA	24	ND
DD-17	Bent joint fill material (styrene)	Marina Viaduct (Bridge No. 34-0014)	NA	NA	25	ND
DD-18	Elastomeric bent joint material	Marina Viaduct (Bridge No. 34-0014)	NA	NA	26	ND
DD-19	Bent joint fill material (styrene)	Richardson Avenue	NA	NA	27	ND
DD-20	Brown fiber board	Richardson Avenue	NA	NA	27	ND

TABLE 1
SUMMARY OF ANALYTICAL LABORATORY TEST RESULTS - ASBESTOS
DOYLE DRIVE ACM AND LCM PROJECT
SAN FRANCISCO, CALIFORNIA

Polarized Light Microscopy (PLM) - EPA Test Method 600/R-93/116

Sample Group ID[1]	Description of Suspect Material	Location	Approximate Quantity	Friable	Site Photo	Asbestos Content
DD-21	Drain pipe packing (foam sheeting)	Richardson Avenue	NA	NA	28	ND
DD-22	Bent joint fill material (styrene)	Marina Viaduct exit to Richardson Avenue	NA	NA	29	ND
DD-23	**Black bent joint fill material**	**Marina Viaduct exit to Richardson Avenue**	**Unable to safety quantify**	**No**	**30**	**3%**
DD-24	Black joint fill material	Ruckman Aveune Undercrossing (Bridge No. 34-0018)	NA	NA	31	ND

Notes:

[1] Each sample group represents one or more samples of similar material. When multiple samples of a material were collected, the sampling locations were distributed throughout the homogeneous area (spaces where the material was observed).

NA = Not applicable

ND = No Asbestos fibers detected

* = Material analyzed using PLM Point Count (1,000 points)

Identified asbestos is of the chrysotile variety unless otherwise indicated

TABLE 2
SUMMARY OF ANALYTICAL LABORATORY TEST RESULTS - PAINT
DOYLE DRIVE ACM AND LCM PROJECT
SAN FRANCISCO, CALIFORNIA

Total and Soluble Lead

Sample No.	Paint Description	Approximate Quantity Peeling/Flaking	Site Photo	Total Lead (mg/kg)	WET Lead (mg/l)	TCLP Lead (mg/l)
DD-P1A	Red paint - Marina Viaduct (Bridge No. 34-0014) bent at Halleck Street	Intact	32	19,000	---	100
DD-P2A	Silver paint - Pedestrian stairway at Richardson Avenue merge with Marina Viaduct (Bridge No. 34-0014)	Intact	16	76	7.2	---
DD-P3A	Beige paint - Marina Viaduct (Bridge No. 34-0014) seismic retrofit collars on bents	Intact	33	64	0.86	---
DD-P4A	Red paint - Presidio Viaduct (Bridge No. 34-0019) girders and trusses	Intact	34	76	5.2	---
DD-P5A	Red paint - Presidio Viaduct (Bridge No. 34-0019) girders	Intact	35	480	3.4	0.28
DD-P6A	White paint - Lincoln Boulevard Undercrossing (Bridge No. 34-0062) seismic retrofit collars on bents	Intact	36	<2.0	---	---
DD-P7A	White graffiti abatement paint - Lincoln Boulevard Undercrossing (Bridge No. 34-0062) bent wall	Intact	37	23	---	---
DD-P8A	Red paint - Marina Viaduct (Bridge No. 34-0014) light post	Unable to safely quantify	38	32,000	---	67

TABLE 2
SUMMARY OF ANALYTICAL LABORATORY TEST RESULTS - PAINT
DOYLE DRIVE ACM AND LCM PROJECT
SAN FRANCISCO, CALIFORNIA

Total and Soluble Lead

Sample No.	Paint Description	Approximate Quantity Peeling/Flaking	Site Photo	Total Lead (mg/kg)	WET Lead (mg/l)	TCLP Lead (mg/l)
DD-P9A	White paint - Marina Viaduct (Bridge No. 34-0014) roadway striping	Intact	39	28	---	---
DD-P10A	Green paint - Lincoln Boulevard Undercrossing (Bridge No. 34-0062) sidewalk railing	500 square feet	40	130,000	---	9.5
DD-P11A	Multi-layer graffiti abatement paint - N101-S1 Connector Pedestrian Undercrossing (Bridge No. 34-0025G)	Intact	41	13	---	---
DD-P12A	Red paint - Doyle Drive light post	Unable to safely quantify	42	52,000	---	54
DD-P13A	Green paint - pedestrian sidewalk fence adjacent to westbound Doyle Drive (approaching the Golden Gate Bridge toll plaza)	Unable to safely quantify	43	220,000	---	3.7
DD-P14A	White paint - Ruckman Avenue Undercrossing (Bridge No. 34-0018)	Intact	44	100	1.9	---

Notes:
mg/kg = milligrams per kilogram (EPA Test Method 6010)
mg/l = milligrams per liter
WET = Waste Extraction Test (EPA Test Method 7420)
TCLP = Toxicity Characteristic Leaching Procedure (EPA Test Method 1311)
--- = Not Analyzed

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Doyle Drive ACM and LCM Project

San Francisco, California

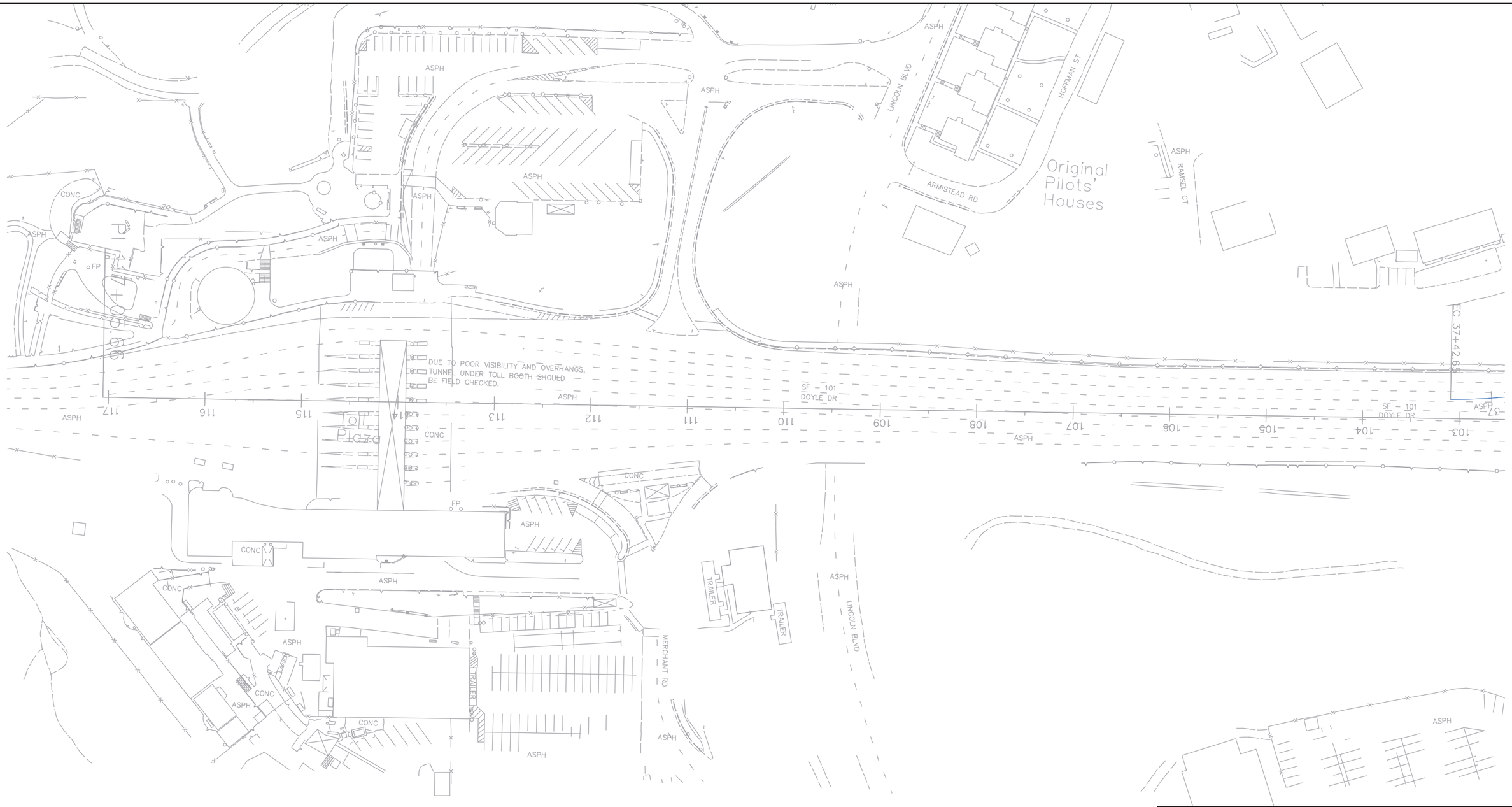
VICINITY MAP

GEOCON Proj. No. E8435-06-24

Task Order No. 24

August 2009

Figure 1



LEGEND:

- ● Approximate Asbestos Sample Location
- ▲ Approximate Paint Sample Location

0 100

Scale in Feet

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Doyle Drive ACM and LCM Project

San Francisco, California

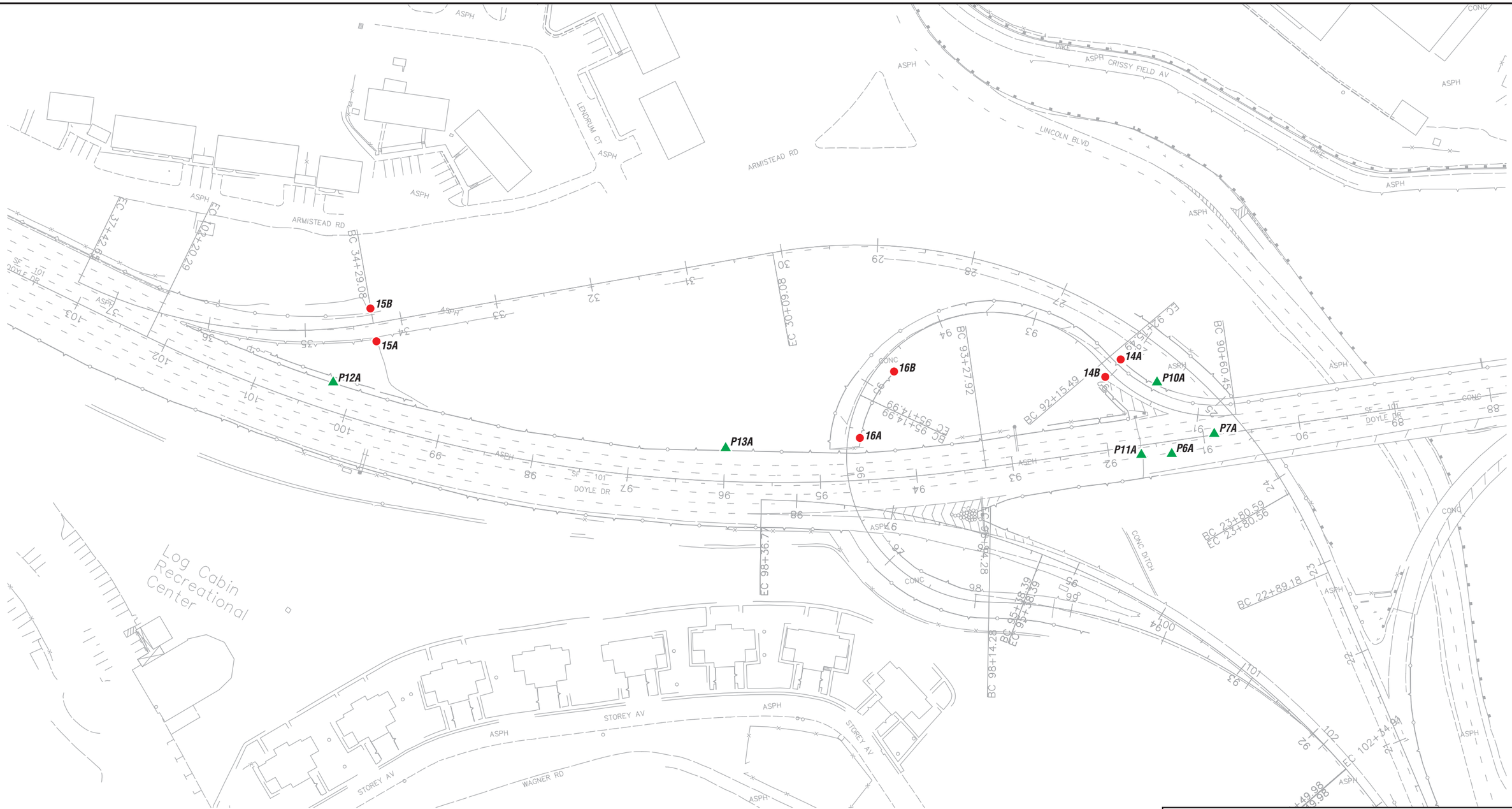
SITE PLAN

GEOCON Proj. No. E8435-06-24

Task Order No. 24

August 2009

Figure 2a



LEGEND:

- ● Approximate Asbestos Sample Location
- ▲ Approximate Paint Sample Location

0 100

Scale in Feet

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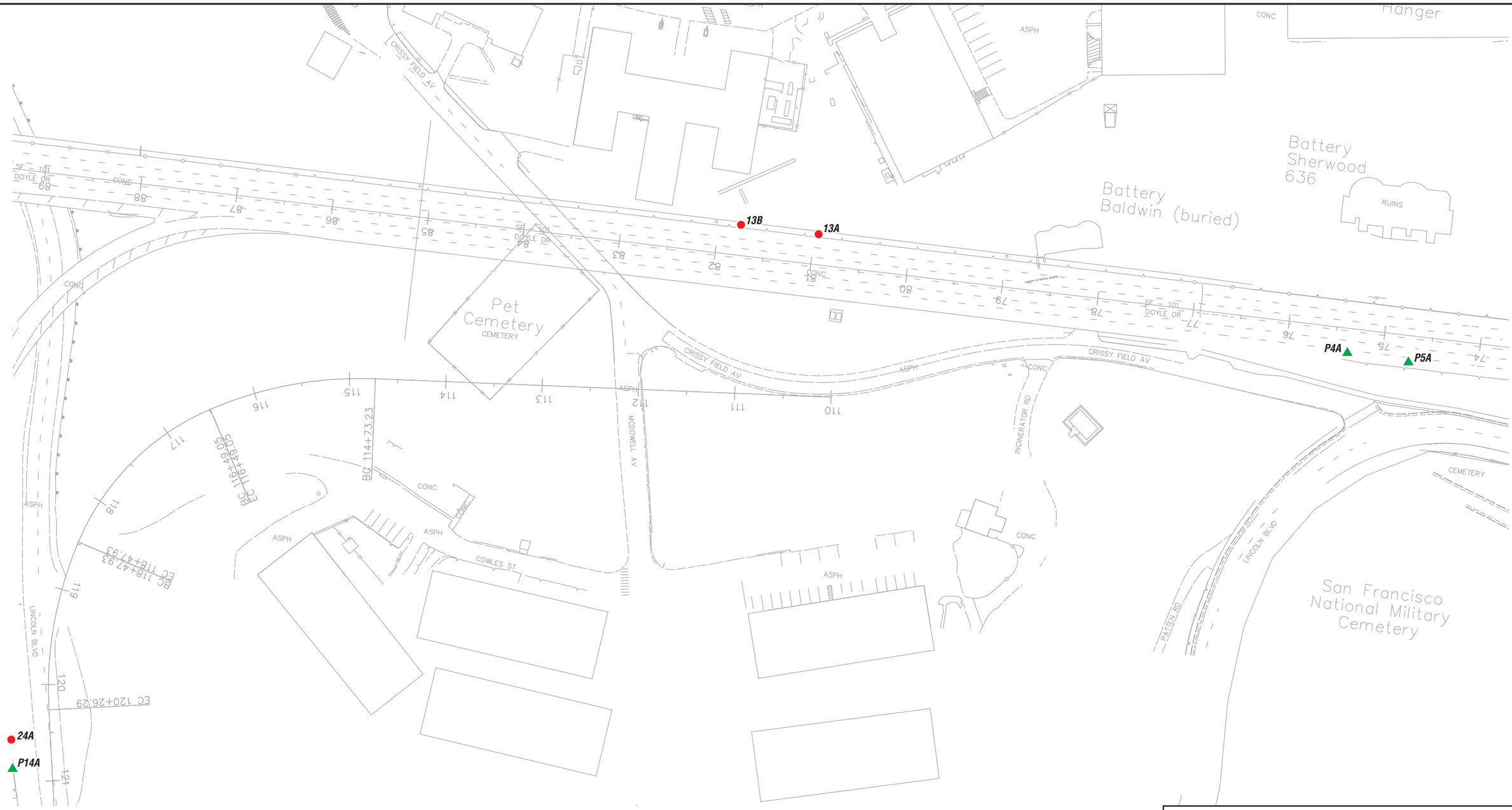
Doyle Drive ACM and LCM Project

San Francisco, California	**SITE PLAN**	
GEOCON Proj. No. E8435-06-24		
Task Order No. 24	August 2009	Figure 2b



LEGEND:

- Approximate Asbestos Sample Location
- Approximate Paint Sample Location

0 100

Scale in Feet

GEOCON CONSULTANTS, INC.
6671 BRISA STREET – LIVERMORE, CA 94550
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Doyle Drive ACM and LCM Project

San Francisco, California

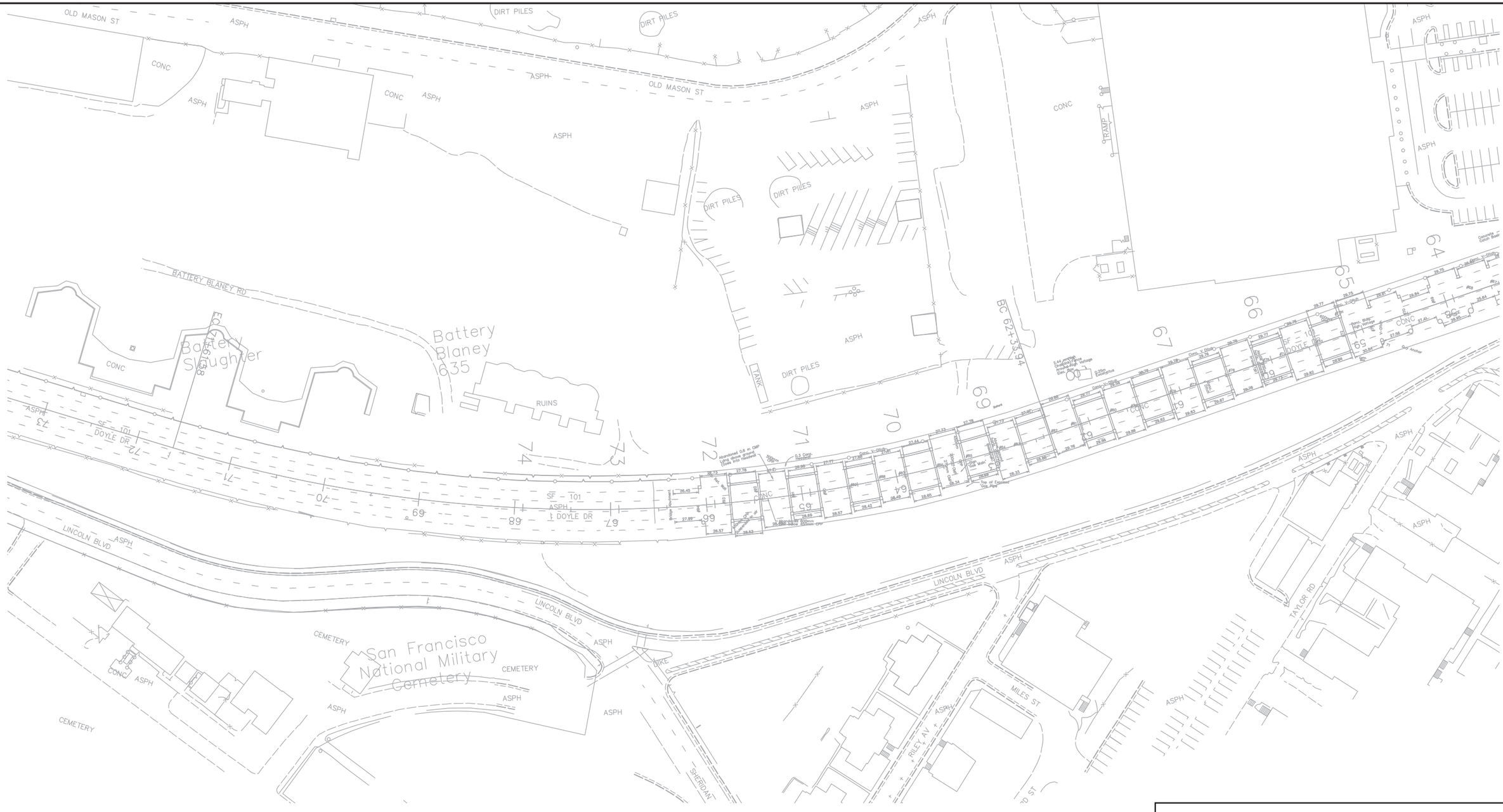
SITE PLAN

GEOCON Proj. No. E8435-06-24

Task Order No. 24

August 2009

Figure 2c



LEGEND:

- Approximate Asbestos Sample Location
- Approximate Paint Sample Location

0 100

Scale in Feet

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Doyle Drive ACM and LCM Project

San Francisco, California	**SITE PLAN**	
GEOCON Proj. No. E8435-06-24		
Task Order No. 24	August 2009	Figure 2d

LEGEND:

- ● Approximate Asbestos Sample Location
- ▲ Approximate Paint Sample Location

0 100

Scale in Feet

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Doyle Drive ACM and LCM Project

San Francisco, California

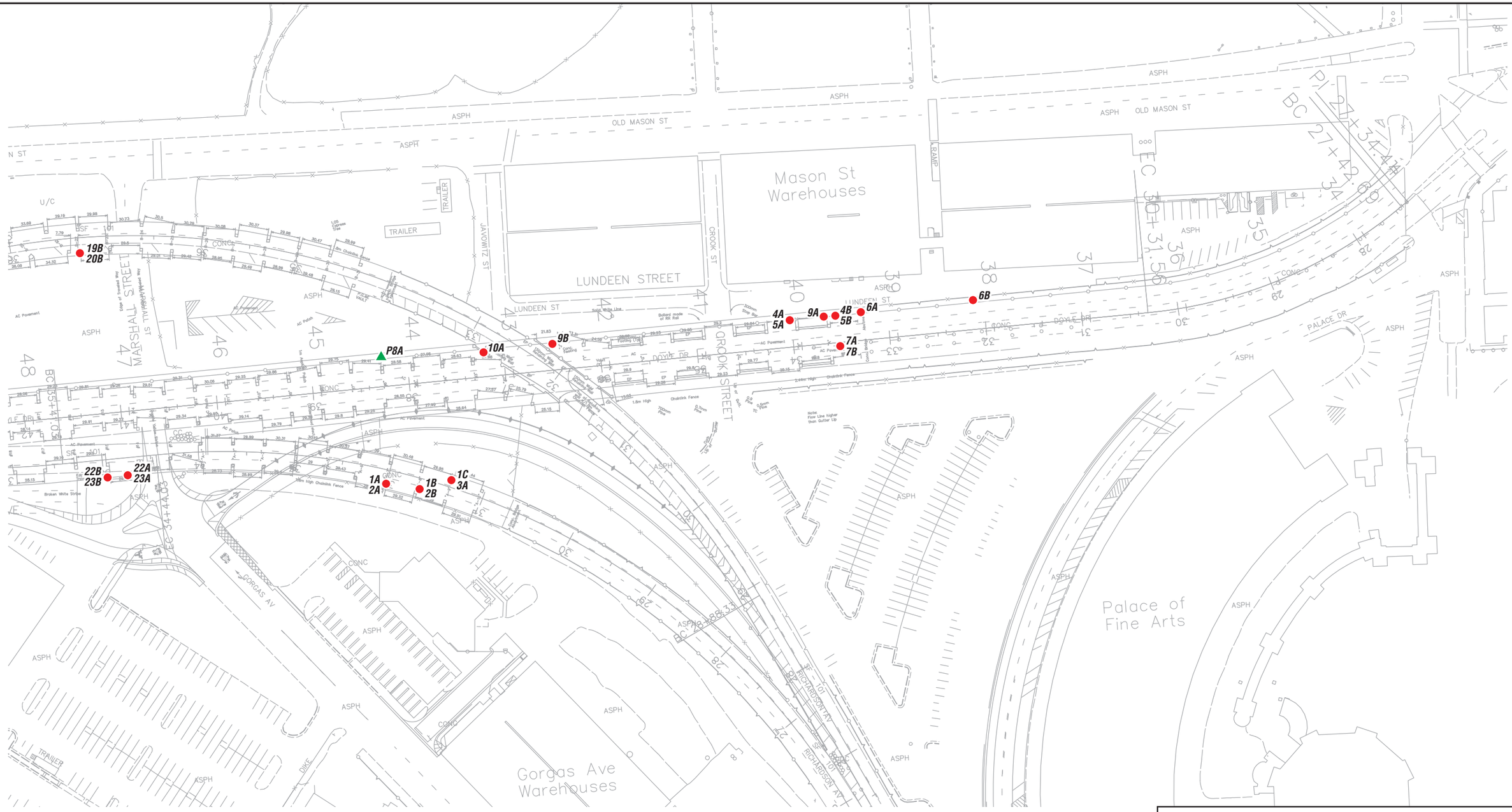
SITE PLAN

GEOCON Proj. No. E8435-06-24

Task Order No. 24

August 2009

Figure 2e



LEGEND:

- ● Approximate Asbestos Sample Location
- ▲ Approximate Paint Sample Location

0 100

Scale in Feet

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Doyle Drive ACM and LCM Project

San Francisco, California

SITE PLAN

GEOCON Proj. No. E8435-06-24

Task Order No. 24

August 2009

Figure 2f

Photo 1 – Richardson Avenue at the eastern end of the project limits, looking west

Photo 2 – Marina Viaduct (Bridge No. 34-0014) near the eastern end of the project limits, looking east

Photo 3 – Marina Viaduct (Bridge No. 34-0014) near the eastern end of the project limits, looking west

Photo 4 – Richardson Avenue at the eastern portion of the project area, looking west

Photo 5 – Richardson Avenue and the Marina Viaduct merge at the eastern portion of the project area, looking west

Photo 6 – Marina Viaduct (Bridge No. 34-0014) at the central portion of the project area, looking west

Photo 7 – Marina Viaduct (Bridge No. 34-0014) at the central portion of the project area, looking west

Photo 8 – Presidio Viaduct (Bridge No. 34-0019) at the western portion of the project area, looking west

Photo 9 – Doyle Drive near the western project limits, looking east

Photo 10 – Doyle Drive at the western end of the project limits, looking north towards the toll plaza

Photo 11 – Bridge bent fill material (styrene) on the underside of the Marina Viaduct (Bridge No. 34-0014) deck at the central and eastern portions of the project area (representative of Sample Group 1 material)

Photo 12 – Bridge bent fill material (brown fiberboard) on the underside of the Marina Viaduct deck at the central and eastern portions of the project area (representative of Sample Group 2 material)

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PHOTOGRAPHS 10, 11, & 12		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 13 – Brown fiberboard behind seismic retrofit cable covers on the underside of Marina Viaduct deck at the central and eastern portions of the project area (representative of Sample Group 3 and 7 materials)

Photo 14 – Bent joint material (styrene) and underlying black elastomeric material at the sides of Marina Viaduct at the central and eastern portions of the project area (representative of Sample Group 4 and 5 materials)

Photo 15 – Asbestos-containing black joint fill material on the Marina Viaduct abutment Drive near the eastern end of the project limits (representative of Sample Group 6 material)

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PHOTOGRAPHS 13, 14, & 15		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 16 – Asbestos-containing silver paint on the pedestrian stairway at the merge of Richardson Ave. and the Marina Viaduct (representative of Sample Group 8 material and paint sample 2A)

Photo 17 – Elastomeric deck joint material on the Marina Viaduct at the eastern portion of the project area (representative of Sample Group 9 material)

Photo 18 – Elastomeric deck joint material on Marina Viaduct at the eastern portion of the project area (representative of Sample Group 10 material)

Photo 19 – Elastomeric deck joint material on Richardson Avenue at the merge with the Marina Viaduct (representative of Sample Group 11 material)

Photo 20 – Asbestos-containing black (brittle) deck joint fill material at the Richardson Avenue merge with the Marina Viaduct (representative of Sample Group 12 material)

Photo 21 – Black sidewalk joint material on northbound Presidio Viaduct (Bridge No. 34-0019) (representative of Sample Group 13 material)

Photo 22 – Retaining wall joint fill material on the N101-S1 Connector PUC (Bridge No. 34-0025G) [pedestrian tunnel] (representative of Sample Group 14 material)

Photo 23 – Retaining wall joint fill material on the N1-N101 Connector PUC (Bridge No. 34-0023) [pedestrian tunnel] (representative of Sample Group 15 material)

Photo 24 – Black abutment joint fill material on the N101-S1 Connector (Bridge No. 34-0020) (representative of Sample Group 16 material)

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PHOTOGRAPHS 22, 23, & 24		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 25 – Bridge bent joint fill material (styrene) on underside of the Marina Viaduct deck at the eastern portion of the project area (representative of Sample Group 17 material)

Photo 26 – Elastomeric bent joint material on underside of southbound Marina Viaduct connector to Richardson Avenue at the eastern portion of the project area (representative of Sample Group 18 material)

Photo 27 – Bridge bent joint fill material (styrene and brown fiberboard) on Richardson Avenue connector to northbound Marina Viaduct (representative of Sample Group 19 and 20 materials)

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PHOTOGRAPHS 25, 26, & 27		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 28 – Drain pipe packing (foam sheeting) on Richardson Avenue connector to northbound Marina Viaduct (representative of Sample Group 21 material)

Photo 29 – Bridge bent joint fill material (styrene) on southbound Marina Viaduct connector to Richardson Avenue (representative of Sample Group 22 material)

Photo 30 – Asbestos-containing black deck joint material on southbound Marina Viaduct connector to Richardson Avenue (representative of Sample Group 23 material)

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PHOTOGRAPHS 28, 29, & 30		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 31 – Black joint fill material on Ruckman Avenue UC (Bridge No. 34-0018) (representative of Sample Group 24 material)

Photo 32 – Intact red paint on bent footings at Halleck Street beneath the Marina Viaduct

Photo 33 – Intact beige paint on seismic retrofit collar on the Marina Viaduct bridge bents

Photo 34 – Intact red paint on the Presidio Viaduct (Bridge No. 34-0019) girders and trusses

Photo 35 – Intact red paint on the Presidio Viaduct (Bridge No. 34-0019) girders

Photo 36 – Intact white paint on seismic retrofit collar on the Lincoln Boulevard UC (Bridge No. 34-0062) bents

Photo 37 – Intact off-white graffiti abatement paint on the Lincoln Boulevard UC (Bridge No. 34-0062) bent wall

Photo 38 – Deteriorated red paint on the Marina Viaduct (Bridge No. 34-0014) light posts

Photo 39 – Intact white roadway striping paint on the Marina Viaduct (Bridge No. 34-0014)

Photo 40 – Deteriorated green paint on pedestrian walkway railing at the Lincoln Boulevard UC (Bridge No. 34-0062)

Photo 41 – Intact multi-layered graffiti abatement paint on N101-S1 Connector PUC (Bridge No. 34-0025)

Photo 42 – Deteriorated red paint on Doyle Drive light posts (approach to Golden Gate Bridge toll plaza)

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PHOTOGRAPHS 40, 41, & 42		
Doyle Drive ACM and LCM Project San Francisco County, California		
E8435-06-24		August 2009

Photo 43 – Deteriorated green paint on pedestrian walkway fence adjacent to westbound Doyle Drive (approaching the Golden Gate Bridge toll plaza)

Photo 44 – Intact white paint on Ruckman Avenue UC (Bridge No. 34-0018) bents

APPENDIX A

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Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/09/09 2:50 PM
EMSL Order: 090902610

EMSL Proj: E8435-06-**
Analysis Date: 4/9/2009
Report Date: 4/17/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Location	Appearance	Non-Asbestos % Fibrous	Non-Asbestos % Non-Fibrous	Asbestos % Type
DD-1A, Bent joint fill material *090902610-0001*		White Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-1B, Bent joint fill material *090902610-0002*		White Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-1B, Mortar *090902610-0002A*		Gray Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-1C, Bent joint fill material *090902610-0003*		White Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-1D, Bent joint fill material *090902610-0004*		White Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-2A, Brown fiber board *090902610-0005*		Brown Fibrous Homogeneous	80% Cellulose	20% Non-fibrous (other)	**None Detected**
DD-2B, Brown fiber board *090902610-0006*		Brown Fibrous Homogeneous	80% Cellulose	20% Non-fibrous (other)	**None Detected**

Analyst(s)

Adam C. Fink (23)
Nonette Patron (11)

Baojia Ke, Laboratory Manager
or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. Samples reported as <1% or none detected may require additional testing by TEM to confirm asbestos quantities. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client.Samples received in good condition unless otherwise noted.
NVLAP Lab Code 101048-3

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Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos				Asbestos
Sample	**Location**	**Appearance**	**%**	**Fibrous**	**%**	**Non-Fibrous**	**% Type**
DD-3A, Brown fiber board *090902610-0007*		Brown Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-4A, Bent joint fill material *090902610-0008*		White Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**None Detected**
DD-4B, Bent joint fill material *090902610-0009*		White Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**None Detected**
DD-5A, Elastomeric deck jojnt material *090902610-0010*		Black Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**None Detected**
DD-5B, Elastomeric deck jojnt material *090902610-0011*		Black Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**None Detected**
DD-6A, Black abutment joint fill material *090902610-0012*		Black Non-Fibrous Homogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**

Analyst(s)

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Report Date: 4/17/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos				Asbestos
Sample	**Location**	**Appearance**	**%**	**Fibrous**	**%**	**Non-Fibrous**	**% Type**
DD-6A-A, Black Surfacing *090902610-0012A*		Black Non-Fibrous Homogeneous	5%	Cellulose	93%	Non-fibrous (other)	**2% Chrysotile**
DD-6A-B, Felt *090902610-0012B*		Black Non-Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-6B-A, Black abutment joint fill material *090902610-0013*		Black Non-Fibrous Homogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**
DD-6B-A, Black Surfacing *090902610-0013A*		Black Non-Fibrous Homogeneous	5%	Cellulose	93%	Non-fibrous (other)	**2% Chrysotile**
DD-7A, Brown fiberboard *090902610-0014*		Brown Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-7B, Brown fiberboard *090902610-0015*		Brown Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-8A, Silver paint *090902610-0016*		Silver Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**<1% Chrysotile**

Analyst(s)

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Analysis Date: 4/9/2009
Report Date: 4/17/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Location**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
DD-9A, Elastomeric deck jojnt material *090902610-0017*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-9B, Elastomeric deck jojnt material *090902610-0018*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-10A, Elastomeric deck jojnt material *090902610-0019*		Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-11A, Elastomeric deck jojnt material *090902610-0020*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-11B, Elastomeric deck jojnt material *090902610-0021*		Black Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-12A, Black joint fill material *090902610-0022*		Non-Fibrous Heterogeneous	10% Cellulose	88% Non-fibrous (other)	**2% Chrysotile**

Analyst(s)

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Nonette Patron (11)

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Analysis Date: 4/9/2009
Report Date: 4/17/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos				Asbestos
Sample	**Location**	**Appearance**	**%**	**Fibrous**	**%**	**Non-Fibrous**	**% Type**
DD-12B, Black abutment joint fill material *090902610-0023*		Black Non-Fibrous Heterogeneous	10%	Cellulose	88%	Non-fibrous (other)	**2% Chrysotile**
DD-13A, Sidewalk joint fill material *090902610-0024*		Black Non-Fibrous Heterogeneous	10%	Cellulose	90%	Non-fibrous (other)	**None Detected**
DD-13B, Sidewalk joint fill material *090902610-0025*		Black Non-Fibrous Heterogeneous	10%	Cellulose	90%	Non-fibrous (other)	**None Detected**
DD-14A, Retaining wall joint fill material *090902610-0026*		Black Non-Fibrous Heterogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**
DD-14B, Retaining wall joint fill material *090902610-0027*		Black Non-Fibrous Heterogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**
DD-15A, Retaining wall joint fill material *090902610-0028*		Black Non-Fibrous Heterogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**

Analyst(s)

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EMSL Proj: E8435-06-**
Analysis Date: 4/9/2009
Report Date: 4/17/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos				Asbestos
Sample	**Location**	**Appearance**	**%**	**Fibrous**	**%**	**Non-Fibrous**	**% Type**
DD-15B, Retaining wall joint fill material *090902610-0029*		Black Non-Fibrous Heterogeneous	20%	Cellulose	80%	Non-fibrous (other)	**None Detected**
DD-16A, Abutment joint fill material *090902610-0030*		Black Non-Fibrous Heterogeneous	5%	Cellulose	95%	Non-fibrous (other)	**None Detected**

Analyst(s)

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Nonette Patron (11)

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Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/09/09 2:50 PM
EMSL Order: 090902610

EMSL Proj: E8435-06-**
Analysis Date: 4/16/2009
Report Date: 4/17/2009

Asbestos Analysis of Bulk Material via EPA 600/R-93/116. Quantitation using the 1,000 Point Count Procedure

			Non-Asbestos		Asbestos
Sample	**Location**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
DD-8A, Silver paint *090902610-0016*		Silver Non-Fibrous Homogeneous		100.00% Non-fibrous (other)	**<0.1% Chrysotile**

Analyst(s)

Alan Tahran (1)

Baojia Ke, Laboratory Manager
or other approved signatory

NVLAP Lab Code 101048-3

PLMPointCount-1

THIS IS THE LAST PAGE OF THE REPORT.

090902789

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City & State: LIVERMORE, CA **Zip** 94550
Phone: 925-371-5900
☒ **Email Results** GIUNTOLI@GEOCONINC.COM
Project Name or Number: E8435-06-24

Third Party Billing **requires written authorization from third party*
EMSL-Bill to:
Contact:
Address:
City & State: **Zip**
Fax:
☐ **Fax results**
Purchase Order Number:

TURNAROUND TIME

☐ 3 Hours ☐ 6 Hours ☒ 24 Hours ☐ 48 Hours ☐ 72 Hours ☐ 5 Days ☐ 10 Days

SAMPLE MATRIX

☐ Air ☒ Bulk ☐ Soil ☐ Wipe ☐ Micro-Vac ☐ Drinking Water ☐ Wastewater ☐ Chips ☐ Other

ASBESTOS ANALYSIS

PCM - Air
☐ NIOSH 7400 (A) Issue 2: August 1994
☐ OSHA w/ Time Weighted Average

TEM AIR
☐ AHERA 40 CFR, Part 763 Subpart E
☐ NIOSH 7402 Issue 2
☐ EPA Level II

PLM - Bulk
☒ EPA 600/R-93/116
☐ + **Add Gravimetric Reduction (EPA NOB)**
PLM CARB 435 Level: ☐ A (0.25%) ☐ B (0.1%)
☐ NIOSH 9002
☐ EPA Point Count (400 Points)
☐ + **Add Gravimetric Reduction (EPA NOB)**
☐ EPA Point Count (1,000 Points)
☐ + **Add Gravimetric Reduction (EPA NOB)**
☐ Standard Addition Point Count

SOILS
PLM CARB 435 Level: ☐ A (0.25%) ☐ B (0.1%)
TEM CARB 435 Level: ☐ B (0.1%) ☐ C (0.01%) ☐ D (0.001%) ☐ E (0.0005%) ☐ F (0.0001%)
☐ EMSL MSD 9000 Method fibers/gram
☐ Superfund EPA 540-R097-028 (dust generation)
EPA Protocol ☐ Qualitative ☐ Quantitative

TEM BULK
☐ TEM EPA NOB, EPA 600/R-93/116 Section 2.5.5.1 (TEM % by VAE)
☐ Chatfield SOP-1988-02
☐ TEM EPA 600/R-93/116 Section 2.5.5.2 (TEM % by Mass)

TEM MICROVAC
☐ ASTM D 5755 (Quantitative)

TEM WIPE
☐ ASTM D-6480 (Quantitative)

TEM WATER
☐ EPA 100.2 (≥ 10 microns)
☐ Modified EPA 100.2 (≥ 0.5 microns)
OTHER:

LEAD ANALYSIS

Flame Atomic Absorption
☐ Wipe, SW846-7420 ☐ ASTM ☐ non ASTM
☐ Soil, SW846-7420
☐ Air, NIOSH 7082
☐ Chips, SW846-7420 or AOAC 5.009 (974.02)
☐ Wastewater, SW 846-7420

☐ TCLP LEAD SW846-1311/7420

Graphite Furnace Atomic Absorption
☐ Air, NIOSH 7105
☐ Wastewater, SW846-7421
☐ Soil, SW846-7421
☐ Drinking Water, EPA 239.2

ICP – Inductively Coupled Plasma
☐ Wipe, SW846-6010 ☐ ASTM ☐ non ASTM
☐ Soil, SW846-6010
☐ Air, NIOSH 7300

MATERIALS ANALYSIS

☐ Particle Identification
☐ Full Particle Identification
☐ Dust Mites and Insect Fragments
☐ Particle Size & Distribution
☐ Product Comparison
☐ Paint Characterization
☐ Failure Analysis
☐ Corrosion Analysis
☐ Glove Box Containment Study
☐ Petrographic Examination of Concrete
☐ Portland Cement in Workplace Atmospheres (OSHA ID-143)
☐ Man Made Vitrous Fibers – MMVF's
☐ Synthetic Fiber Identification
☐ Other:

MICROBIAL ANALYSIS

Air Samples
☐ Mold & Fungi by Air O Cell
☐ Mold & Fungi by Agar Plate count & id
☐ Bacterial Count and Gram Stain
☐ Bacterial Count and Identification

Water Samples
☐ Total Coliforms, Fecal Coliforms
☐ Escherichia Coli, Fecal Streptococcus
☐ Legionella
☐ Salmonella
☐ Giardia and Cryptosporidium

Wipe and Bulk Samples
☐ Mold & Fungi – Direct Examination
☐ Mold & Fungi – (Culture follow up to direct examination if necessary)
☐ Mold & Fungi – Culture (Count & ID)
☐ Mold & Fungi – Culture (Count only)
☐ Bacterial Count & Gram Stain
☐ Bacterial Count & Identification (3 most prominent types)
☐ Other:

IAQ ANALYSIS

☐ Nuisance Dust (NIOSH 0500 & 0600)
☐ Airborne Dust (PM10, TSP)
☐ Silica Analysis by XRD ☐ NIOSH 7500
☐ HVAC Efficiency
☐ Carbon Black
☐ Airborne Oil Mist
☐ Other:

Relinquished:	Chris Giuntoli	**Date:**	4/15/09	**Time:**	1730
Received:	Todd Arms	**Date:**	4/16/09	**Time:**	9 AM Fed Ex
Relinquished:		**Date:**		**Time:**	
Received:		**Date:**		**Time:**	

090902789

EMSL ANALYTICAL, INC.

EMSL – San Leandro ◆ 2235 Polvorosa Ave, Suite 230, San Leandro, CA 94577

	SAMPLE NUMBER	SAMPLE DESCRIPTION	LOCATION	VOLUME Air (L) Area (Inches sq.)
1	DD-17A	STYRENE BENT JOINT	FILL MATERIAL	
2	DD-17B	↓		
3	DD-18A	ELASTOMERIC BENT JOINT	MATERIAL	
4	DD-18B	↓		
5	DD-19A	STYRENE BENT JOINT	FILL MATERIAL	
6	DD-19B	↓		
7	DD-19C	↓		
8	DD-19D	↓		
9	DD-20A	BROWN FIBER BOARD		
10	DD-20B	↓		
11	DD-20C	↓		
12	DD-20D	↓		
13	DD-21A	FOAM DRAIN PIPE PACKING		
14	DD-22A	STYRENE BENT JOINT	FILL MATERIAL	
15	DD-22B	↓		
16	DD-22C	↓		
17	DD-23A	BLACK BENT JOINT	FILL MATERIAL	
18	DD-23B	↓		
19	DD-23C	↓		
20	DD-24A	ELASTOMERIC BENT JOINT	MATERIAL	
21				
22				
23				
24				
25				

Client Sample # (S) _____ - _____ TOTAL SAMPLE # 20

Relinquished: _____ Date: _____ Time: _____
Received: Ted Arnaz Date: 4/16/09 Time: 9 AM Fed Ex
Relinquished: _____ Date: _____ Time: _____
Received: _____ Date: _____ Time: _____

EMSL Analytical, Inc
2235 Polvorosa Ave , Suite 230, San Leandro, CA 94577
Phone: (510) 895-3675 Fax: (510) 895-3680 Email: milpitaslab@emsl.com

Attn: **Chris Giuntoli**
Geocon Consultants
6671 Brisa Street
Livermore, CA 94550

Fax: (925) 371-5915 Phone: (925) 371-5900
Project: **E8435-06-24**

Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/16/09 9:00 AM
EMSL Order: 090902789

EMSL Proj: E8435-06-**
Analysis Date: 4/16/2009
Report Date: 4/16/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Location**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
DD-17A-Styrene Bent Joint Fill Material *090902789-0001*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-17B-Styrene Bent Joint Material *090902789-0002*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-18A-Styrene Bent Joint Material *090902789-0003*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-18B-Elastomeric Bent Joint Material *090902789-0004*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-19A-Elastomeric Bent Joint Material *090902789-0005*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)	**None Detected**
DD-19B-Styrene Bent Joint Fill Material *090902789-0006*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**

Analyst(s)

Alan Tahran (20)

Baojia Ke, Laboratory Manager
or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. Samples reported as <1% or none detected may require additional testing by TEM to confirm asbestos quantities. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client.Samples received in good condition unless otherwise noted.
NVLAP Lab Code 101048-3

EMSL Analytical, Inc
2235 Polvorosa Ave , Suite 230, San Leandro, CA 94577
Phone: (510) 895-3675 Fax: (510) 895-3680 Email: milpitaslab@emsl.com

Attn: **Chris Giuntoli**
Geocon Consultants
6671 Brisa Street
Livermore, CA 94550

Fax: (925) 371-5915 Phone: (925) 371-5900
Project: **E8435-06-24**

Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/16/09 9:00 AM
EMSL Order: 090902789

EMSL Proj: E8435-06-**
Analysis Date: 4/16/2009
Report Date: 4/16/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos				Asbestos
Sample	**Location**	**Appearance**	**%**	**Fibrous**	**%**	**Non-Fibrous**	**% Type**
DD-19C-Styrene Bent Joint Fill Material *090902789-0007*		Gray/White Non-Fibrous Heterogeneous			100%	Non-fibrous (other)	**None Detected**
DD-19D-Styrene Bent Joint Fill Material *090902789-0008*		Gray/White Non-Fibrous Heterogeneous			100%	Non-fibrous (other)	**None Detected**
DD-20A-Fiber Board *090902789-0009*		White Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-20B-Fiber Board *090902789-0010*		Brown Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-20C-Fiber Board *090902789-0011*		Brown Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-20D-Fiber Board *090902789-0012*		Fibrous Homogeneous	80%	Cellulose	20%	Non-fibrous (other)	**None Detected**
DD-21A-Foam Drain Pipe Packing *090902789-0013*		White Non-Fibrous Homogeneous			100%	Non-fibrous (other)	**None Detected**

Analyst(s)

Alan Tahran (20)

Baojia Ke, Laboratory Manager
or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. Samples reported as <1% or none detected may require additional testing by TEM to confirm asbestos quantities. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client.Samples received in good condition unless otherwise noted.
NVLAP Lab Code 101048-3

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2235 Polvorosa Ave , Suite 230, San Leandro, CA 94577
Phone: (510) 895-3675 Fax: (510) 895-3680 Email: milpitaslab@emsl.com

Attn: **Chris Giuntoli**
Geocon Consultants
6671 Brisa Street
Livermore, CA 94550

Fax: (925) 371-5915 Phone: (925) 371-5900
Project: **E8435-06-24**

Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/16/09 9:00 AM
EMSL Order: 090902789

EMSL Proj: E8435-06-**
Analysis Date: 4/16/2009
Report Date: 4/16/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Location	Appearance	Non-Asbestos % Fibrous	Non-Asbestos % Non-Fibrous	Asbestos % Type
DD-22A-Styrene Bent Joint Fill Material *090902789-0014*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-22B-Styrene Bent Joint Fill Material *090902789-0015*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-22C-Styrene Bent Joint Fill Material *090902789-0016*		Gray/White Non-Fibrous Heterogeneous		100% Non-fibrous (other)	**None Detected**
DD-23A-Bent Joint Fill Material *090902789-0017*		Black Fibrous Homogeneous	30% Cellulose	67% Non-fibrous (other)	**3% Chrysotile**
DD-23B-Bent Joint Fill Material *090902789-0018*		Black Non-Fibrous Homogeneous	30% Cellulose	67% Non-fibrous (other)	**3% Chrysotile**
DD-23C-Bent Joint Fill Material *090902789-0019*		Black Non-Fibrous Heterogeneous	30% Cellulose	67% Non-fibrous (other)	**3% Chrysotile**

Analyst(s)

Alan Tahran (20)

Baojia Ke, Laboratory Manager
or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. Samples reported as <1% or none detected may require additional testing by TEM to confirm asbestos quantities. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client.Samples received in good condition unless otherwise noted.
NVLAP Lab Code 101048-3

EMSL Analytical, Inc
2235 Polvorosa Ave , Suite 230, San Leandro, CA 94577
Phone: (510) 895-3675 Fax: (510) 895-3680 Email: milpitaslab@emsl.com

Attn: **Chris Giuntoli**
Geocon Consultants
6671 Brisa Street
Livermore, CA 94550

Fax: (925) 371-5915 Phone: (925) 371-5900
Project: **E8435-06-24**

Customer ID: GECN21
Customer PO: E8435-06-24
Received: 04/16/09 9:00 AM
EMSL Order: 090902789

EMSL Proj: E8435-06-**
Analysis Date: 4/16/2009
Report Date: 4/16/2009

Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos			Asbestos
Sample	**Location**	**Appearance**	**% Fibrous**	**% Non-Fibrous**		**% Type**
DD-24A-Elastomeric Bent Joint Material *090902789-0020*		Black Non-Fibrous Homogeneous		100% Non-fibrous (other)		**None Detected**

Analyst(s)

Alan Tahran (20)

Baojia Ke, Laboratory Manager
or other approved signatory

Due to magnification limitations inherent in PLM, asbestos fibers in dimensions below the resolution capability of PLM may not be detected. Samples reported as <1% or none detected may require additional testing by TEM to confirm asbestos quantities. The above test report relates only to the items tested and may not be reproduced in any form without the express written approval of EMSL Analytical, Inc. EMSL's liability is limited to the cost of analysis. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client.Samples received in good condition unless otherwise noted.
NVLAP Lab Code 101048-3

090902789

EMSL – San Leandro ◆ 2235 Polvorosa Ave, Suite 230, San Leandro, CA 94577

EMSL ANALYTICAL, INC.

(888) 455-3675 ◆ Phone (510) 895-3675 ◆ Fax (510) 895-3680 ◆ sanleandrolab@emsl.com

EMSL Rep: DAN KOCHER
Company: GEOCON
Contact: CHRIS GIUNTOLI
Address: 6671 BRISA ST
City & State: LIVERMORE, CA **Zip** 94550
Phone: 925-371-5900
☒ **Email Results** GIUNTOLI@GEOCONINC.COM
Project Name or Number: E8435-06-24

Third Party Billing **requires written authorization from third party*
EMSL-Bill to:
Contact:
Address:
City & State: **Zip**
Fax:
☐ **Fax results**
Purchase Order Number:

TURNAROUND TIME

☐ 3 Hours ☐ 6 Hours ☒ 24 Hours ☐ 48 Hours ☐ 72 Hours ☐ 5 Days ☐ 10 Days

SAMPLE MATRIX

☐ Air ☒ Bulk ☐ Soil ☐ Wipe ☐ Micro-Vac ☐ Drinking Water ☐ Wastewater ☐ Chips ☐ Other

ASBESTOS ANALYSIS

PCM - Air
☐ NIOSH 7400 (A) Issue 2: August 1994
☐ OSHA w/ Time Weighted Average

TEM AIR
☐ AHERA 40 CFR, Part 763 Subpart E
☐ NIOSH 7402 Issue 2
☐ EPA Level II

PLM - Bulk
☒ EPA 600/R-93/116
☐ + **Add Gravimetric Reduction (EPA NOB)**
PLM CARB 435 Level: ☐ A (0.25%) ☐ B (0.1%)
☐ NIOSH 9002
☐ EPA Point Count (400 Points)
☐ + **Add Gravimetric Reduction (EPA NOB)**
☐ EPA Point Count (1,000 Points)
☐ + **Add Gravimetric Reduction (EPA NOB)**
☐ Standard Addition Point Count

SOILS
PLM CARB 435 Level: ☐ A (0.25%) ☐ B (0.1%)
TEM CARB 435 Level: ☐ B (0.1%) ☐ C (0.01%) ☐ D (0.001%) ☐ E (0.0005%) ☐ F (0.0001%)
☐ EMSL MSD 9000 Method fibers/gram
☐ Superfund EPA 540-R097-028 (dust generation)
EPA Protocol ☐ Qualitative ☐ Quantitative

TEM BULK
☐ TEM EPA NOB, EPA 600/R-93/116 Section 2.5.5.1 (TEM % by VAE)
☐ Chatfield SOP-1988-02
☐ TEM EPA 600/R-93/116 Section 2.5.5.2 (TEM % by Mass)

TEM MICROVAC
☐ ASTM D 5755 (Quantitative)

TEM WIPE
☐ ASTM D-6480 (Quantitative)

TEM WATER
☐ EPA 100.2 (≥ 10 microns)
☐ Modified EPA 100.2 (≥ 0.5 microns)
OTHER:

LEAD ANALYSIS

Flame Atomic Absorption
☐ Wipe, SW846-7420 ☐ ASTM ☐ non ASTM
☐ Soil, SW846-7420
☐ Air, NIOSH 7082
☐ Chips, SW846-7420 or AOAC 5.009 (974.02)
☐ Wastewater, SW 846-7420

☐ TCLP LEAD SW846-1311/7420

Graphite Furnace Atomic Absorption
☐ Air, NIOSH 7105
☐ Wastewater, SW846-7421
☐ Soil, SW846-7421
☐ Drinking Water, EPA 239.2

ICP – Inductively Coupled Plasma
☐ Wipe, SW846-6010 ☐ ASTM ☐ non ASTM
☐ Soil, SW846-6010
☐ Air, NIOSH 7300

MATERIALS ANALYSIS

☐ Particle Identification
☐ Full Particle Identification
☐ Dust Mites and Insect Fragments
☐ Particle Size & Distribution
☐ Product Comparison
☐ Paint Characterization
☐ Failure Analysis
☐ Corrosion Analysis
☐ Glove Box Containment Study
☐ Petrographic Examination of Concrete
☐ Portland Cement in Workplace Atmospheres (OSHA ID-143)
☐ Man Made Vitrous Fibers – MMVF's
☐ Synthetic Fiber Identification
☐ Other:

MICROBIAL ANALYSIS

Air Samples
☐ Mold & Fungi by Air O Cell
☐ Mold & Fungi by Agar Plate count & id
☐ Bacterial Count and Gram Stain
☐ Bacterial Count and Identification

Water Samples
☐ Total Coliforms, Fecal Coliforms
☐ Escherichia Coli, Fecal Streptococcus
☐ Legionella
☐ Salmonella
☐ Giardia and Cryptosporidium

Wipe and Bulk Samples
☐ Mold & Fungi – Direct Examination
☐ Mold & Fungi – (Culture follow up to direct examination if necessary)
☐ Mold & Fungi – Culture (Count & ID)
☐ Mold & Fungi – Culture (Count only)
☐ Bacterial Count & Gram Stain
☐ Bacterial Count & Identification (3 most prominent types)
☐ Other:

IAQ ANALYSIS

☐ Nuisance Dust (NIOSH 0500 & 0600)
☐ Airborne Dust (PM10, TSP)
☐ Silica Analysis by XRD ☐ NIOSH 7500
☐ HVAC Efficiency
☐ Carbon Black
☐ Airborne Oil Mist
☐ Other:

Relinquished:	Chris Giuntoli	**Date:**	4/15/09	**Time:**	1730
Received:	Todd Arms	**Date:**	4/16/09	**Time:**	9 AM Fed Ex
Relinquished:		**Date:**		**Time:**	
Received:		**Date:**		**Time:**	

090902789

EMSL ANALYTICAL, INC.

EMSL – San Leandro ◆ 2235 Polvorosa Ave, Suite 230, San Leandro, CA 94577

	SAMPLE NUMBER	SAMPLE DESCRIPTION	LOCATION	VOLUME Air (L) Area (Inches sq.)
1	DD-17A	STYRENE BENT JOINT	FILL MATERIAL	
2	DD-17B	↓		
3	DD-18A	ELASTOMERIC BENT JOINT	MATERIAL	
4	DD-18B	↓		
5	DD-19A	STYRENE BENT JOINT	FILL MATERIAL	
6	DD-19B	↓		
7	DD-19C	↓		
8	DD-19D	↓		
9	DD-20A	BROWN FIBER BOARD		
10	DD-20B	↓		
11	DD-20C	↓		
12	DD-20D	↓		
13	DD-21A	FOAM DRAIN PIPE PACKING		
14	DD-22A	STYRENE BENT JOINT	FILL MATERIAL	
15	DD-22B	↓		
16	DD-22C	↓		
17	DD-23A	BLACK BENT JOINT	FILL MATERIAL	
18	DD-23B	↓		
19	DD-23C	↓		
20	DD-24A	ELASTOMERIC BENT JOINT	MATERIAL	
21				
22				
23				
24				
25				

Client Sample # (S) _____ - _____ TOTAL SAMPLE # 20

Relinquished: _____ Date: _____ Time: _____
Received: Ted Arnaz Date: 4/16/09 Time: 9 AM Fed Ex
Relinquished: _____ Date: _____ Time: _____
Received: _____ Date: _____ Time: _____

April 13, 2009

Chris Giuntoli
Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
TEL: (925) 371-5900
FAX: (925) 371-5915

ELAP No.: 1838
NELAP No.: 02107CA
NEVADA.: CA-401
CSDLAC No.: 10196

Workorder No.: 104965

RE: CALTRANS-DOYLE DRIVE, E8435-06-24

Attention: Chris Giuntoli

Enclosed are the results for sample(s) received on April 10, 2009 by Advanced Technology Laboratories . The sample(s) are tested for the parameters as indicated in the enclosed chain of custody in accordance with the applicable laboratory certifications.

Thank you for the opportunity to service the needs of your company.

Please feel free to call me at (562)989-4045 if I can be of further assistance to your company.

Sincerely,

for Eddie F. Rodriguez
Laboratory Director

The cover letter and the case narrative are an integral part of this analytical report and cannot be reproduced in part or in its entirety without written permission from the client and Advanced Technology Laboratories.

CLIENT: Geocon Consultants, Inc.
Project: CALTRANS-DOYLE DRIVE, E8435-06-24
Lab Order: 104965

CASE NARRATIVE

Analytical Comments for Method 6010

Dilution was necessary for sample 104965-001A, due to sample matrix.

Advanced Technology Laboratories
3275 Walnut Avenue, Signal Hill, CA 90755 Tel: 562. 989.4045 Fax: 562.989.4040

CLIENT: Geocon Consultants, Inc. **Lab Order:** 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

Lab ID: 104965-001 **Collection Date:** 4/7/2009
Client Sample ID: DD-P1A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	19000	10		mg/Kg	5	4/13/2009 02:53 PM

Lab ID: 104965-002 **Collection Date:** 4/7/2009
Client Sample ID: DD-P2A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	76	2.0		mg/Kg	1	4/13/2009 02:57 PM

Lab ID: 104965-003 **Collection Date:** 4/7/2009
Client Sample ID: DD-P3A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	64	3.4		mg/Kg	1	4/13/2009 03:02 PM

Lab ID: 104965-004 **Collection Date:** 4/7/2009
Client Sample ID: DD-P4A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	76	2.0		mg/Kg	1	4/13/2009 03:16 PM

Qualifiers:
B Analyte detected in the associated Method Blank
H Holding times for preparation or analysis exceeded
S Spike/Surrogate outside of limits due to matrix interference
DO Surrogate Diluted Out
E Value above quantitation range
ND Not Detected at the Reporting Limit
Results are wet unless otherwise specified

CLIENT: Geocon Consultants, Inc. **Lab Order:** 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

Lab ID: 104965-005 **Collection Date:** 4/7/2009
Client Sample ID: DD-P5A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	480	2.0		mg/Kg	1	4/13/2009 03:20 PM

Lab ID: 104965-006 **Collection Date:** 4/7/2009
Client Sample ID: DD-P6A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	ND	2.0		mg/Kg	1	4/13/2009 03:24 PM

Lab ID: 104965-007 **Collection Date:** 4/7/2009
Client Sample ID: DD-P7A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
EPA 3050B / **EPA 6010B**						
RunID: ICP8_090413B QC Batch: 54640 PrepDate: 4/13/2009 Analyst: **CL**						
Lead	23	2.0		mg/Kg	1	4/13/2009 03:30 PM

Qualifiers:
B Analyte detected in the associated Method Blank
H Holding times for preparation or analysis exceeded
S Spike/Surrogate outside of limits due to matrix interference
DO Surrogate Diluted Out
E Value above quantitation range
ND Not Detected at the Reporting Limit
Results are wet unless otherwise specified

CLIENT: Geocon Consultants, Inc.
Work Order: 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 6010_S

Sample ID: **LCS-54640**	SampType: **LCS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694432**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	49.511	1.0	50.00	0	99.0	80	120				

Sample ID: **LCSD-54640**	SampType: **LCSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS02**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694433**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	45.058	1.0	50.00	0	90.1	80	120	49.51	9.42	20	

Sample ID: **MB-54640MS**	SampType: **MS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694444**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	109.881	1.0	125.0	0	87.9	33	120				

Sample ID: **MB-54640MSD**	SampType: **MSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694445**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	115.121	1.0	125.0	0	92.1	33	120	109.9	4.66	20	

Sample ID: **MB-54640**	SampType: **MBLK**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **PBS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694493**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	1.0									

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CHAIN OF CUSTODY RECORD

Pg 1 of 1

Advanced Technology Laboratories
3275 Walnut Avenue
Signal Hill, CA 90755
(562) 989-4045 • Fax (562) 989-4040

FOR LABORATORY USE ONLY:

P.O.#: _____

Logged By: _____ Date: 4/10/09

Method of Transport: Client ☐ ATL ☐ CA OverN ☐ FEDEX ☐ Other: GSO

Sample Condition Upon Receipt:
1. CHILLED Y☐ N☐ 4. SEALED Y☐ N☑
2. HEADSPACE (VOA) Y☐ N☐ N/A 5. # OF SPLS MATCH COC Y☑ N☐
3. CONTAINER INTACT Y☑ N☐ 6. PRESERVED Y☐ N☑

Client: GEOCON
Attn: CHRIS GIUNTOLI
Address: 6671 BRISA ST
City LIVERMORE State CA Zip Code 94550
TEL: (925) 371-5900
FAX: ( )

Project Name: CALTRANS - DOYLE DRIVE Project #: EB435-06-Z4 Sampler: (Printed Name) (Signature)

Relinquished by: (Signature and Printed Name)	Date: 4/9/09	Time: 1630	Received by: (Signature and Printed Name)		Date: 4/10/09	Time: 9:10
Relinquished by: (Signature and Printed Name)	Date:	Time:	Received by: (Signature and Printed Name)		Date:	Time:
Relinquished by: (Signature and Printed Name)	Date:	Time:	Received by: (Signature and Printed Name)		Date:	Time:

I hereby authorize ATL to perform the work indicated below:
Project Mgr /Submitter:
C GIUNTOLI 4/9/09
Print Name Date
Signature

Send Report To:
Attn: SEE ABOVE
Co: _____
Address _____
City _____ State _____ Zip _____

Bill To:
Attn: SAME
Co: _____
Address _____
City _____ State _____ Zip _____

Special Instructions/Comments:
* SOLUBLE LEAD MAY BE REQUESTED BASED ON TOTAL LEAD RESULTS
24-HR TAT INCLUDE EDD

Sample/Records - Archival & Disposal
Unless otherwise requested by client, all samples will be disposed 45 days after receipt and records will be disposed 1 year after submittal of final report.

Storage Fees (applies when storage is requested):
- Sample : $2.00 / sample / mo (after 45 days)
- Records : $1.00 / ATL workorder / mo (after 1 year)

Circle or Add Analysis(es) Requested

SPECIFY APPROPRIATE MATRIX

PRESERVATION

Q A / Q C
RTNE ☐
CT ☒
SWRCB ☐
Logcode ____
OTHER ____

ITEM	LAB USE ONLY: Batch #: / Lab No.	Sample Description: Sample I.D. / Location	Date	Time	8081A (Pesticides)	8082 (PCB)	8260B (Volatiles)	8270C (BNA)	6010B (Total Metal)	8015B (GRO) / 8020 (BTEX)	8015B (DRO)	8021 (BTEX)	TITLE 22 / CAM 17 (6010 / 7000)	TOTAL LEAD*	SOIL	WATER	GROUND WATER	WASTEWATER	PAINT CHIP	TAT	Container(s) #	Container(s) Type	REMARKS
	104965-001	DD-P1A	4/7/09										X					X		B	1	P B	
	2	DD-P2A																					
	3	DD-P3A																					
	4	DD-P4A																					
	5	DD-P5A																					
	6	DD-P6A																					
	7	DD-P7A																					

• TAT starts 8 a.m. following day if samples received after 3 p.m.

TAT: A= Overnight ≤ 24 hr B= Emergency Next workday C= Critical 2 Workdays D= Urgent 3 Workdays E= Routine 7 Workdays

Container Types: T=Tube V=VOA L=Liter P=Pint J=Jar B=Tedlar G=Glass P=Plastic M=Metal

Preservatives:
H=Hcl N=HNO_3 S=H_2SO_4 C=4°C
Z=$Zn(AC)_2$ O=NaOH T=$Na_2S_2O_3$

DISTRIBUTION: **White** with report, **Yellow** to folder, **Pink** to submitter.

April 29, 2009

Chris Giuntoli
Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
TEL: (925) 371-5900
FAX: (925) 371-5915

ELAP No.: 1838
NELAP No.: 02107CA
NEVADA.: CA-401
CSDLAC No.: 10196

Workorder No.: 104965

RE: CALTRANS-DOYLE DRIVE, E8435-06-24

Attention: Chris Giuntoli

Enclosed are the results for sample(s) received on April 10, 2009 by Advanced Technology Laboratories . The sample(s) are tested for the parameters as indicated in the enclosed chain of custody in accordance with the applicable laboratory certifications.

This is an addendum report. Please incorporate with documentation previously submitted.

Thank you for the opportunity to service the needs of your company.

Please feel free to call me at (562)989-4045 if I can be of further assistance to your company.

Sincerely,

Eddie F. Rodriguez
Laboratory Director

The cover letter is an integral part of this analytical report. This Laboratory Report cannot be reproduced in part or in its entirety without written permission from the client and Advanced Technology Laboratories.

CLIENT: Geocon Consultants, Inc.
Project: CALTRANS-DOYLE DRIVE, E8435-06-24
Lab Order: 104965

CASE NARRATIVE

Analytical Comments for Method 7420

Dilution was necessary for samples 104965-001A, 104965-002A and 104965-004A, due to sample matrix.

Matrix Spike (MS) and /or Matrix Spike Duplicate (MSD) are/is outside recovery criteria for samples 105193-001AMS and 105193-001AMSD; however, the analytical batch was validated by the Laboratory Control Sample (LCS).

Advanced Technology Laboratories
3275 Walnut Avenue, Signal Hill, CA 90755 Tel: 562. 989.4045 Fax: 562.989.4040

Advanced Technology Laboratories

Date: 4/29/2009

ANALYTICAL RESULTS

LEAD BY ATOMIC ABSORPTION (STLC)
WET/ EPA 7420

CLIENT:	Geocon Consultants, Inc.	**Lab Order:**	104965
Project:	CALTRANS-DOYLE DRIVE, E8435-06-24	**Date Received**	4/10/2009 9:10:00 AM
Project No:		**Matrix:**	Paint Chip
Analyte:	Lead	**Analyst:**	VV

Laboratory ID	Client Sample ID	Results	Units	QC Batch	PQL	DF	Date Collected	Date Analyzed
104965-002A	DD-P2A	7.2	mg/L	55009	2.5	10	4/7/2009	4/29/2009
104965-003A	DD-P3A	0.86	mg/L	55009	0.25	1	4/7/2009	4/29/2009
104965-004A	DD-P4A	5.2	mg/L	55009	2.5	10	4/7/2009	4/29/2009
104965-005A	DD-P5A	3.4	mg/L	55009	0.25	1	4/7/2009	4/29/2009

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

Advanced Technology Laboratories

Date: 4/29/2009

ANALYTICAL RESULTS

LEAD BY ATOMIC ABSORPTION (TCLP)
EPA 1311/ 7420

CLIENT:	Geocon Consultants, Inc.	**Lab Order:**	104965
Project:	CALTRANS-DOYLE DRIVE, E8435-06-24	**Date Received**	4/10/2009 9:10:00 AM
Project No:		**Matrix:**	Paint Chip
Analyte:	Lead	**Analyst:**	RQ

Laboratory ID	Client Sample ID	Results	Units	QC Batch	PQL	DF	Date Collected	Date Analyzed
104965-001A	DD-P1A	100	mg/L	55028	5.0	20	4/7/2009	4/28/2009
104965-005A	DD-P5A	0.28	mg/L	55028	0.25	1	4/7/2009	4/28/2009

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

CLIENT: Geocon Consultants, Inc.
Work Order: 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 6010_S

Sample ID: **LCS-54640**	SampType: **LCS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694432**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	49.511	1.0	50.00	0	99.0	80	120				

Sample ID: **LCSD-54640**	SampType: **LCSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS02**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694433**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	45.058	1.0	50.00	0	90.1	80	120	49.51	9.42	20	

Sample ID: **MB-54640MS**	SampType: **MS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694444**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	109.881	1.0	125.0	0	87.9	33	120				

Sample ID: **MB-54640MSD**	SampType: **MSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694445**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	115.121	1.0	125.0	0	92.1	33	120	109.9	4.66	20	

Sample ID: **MB-54640**	SampType: **MBLK**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **PBS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694493**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	1.0									

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_ST

Sample ID: **MB-55009**	SampType: **MBLK**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **PBS**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704179**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **LCS-55009**	SampType: **LCS**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **LCSS**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704180**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	4.859	0.25	5.000	0	97.2	80	120				

Sample ID: **105193-001A-DUP**	SampType: **DUP**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704182**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	23.624	1.2						23.84	0.893	20	

Sample ID: **105193-001A-MS**	SampType: **MS**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704183**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	28.541	1.2	5.000	23.84	94.1	80	120				

Sample ID: **105193-001A-MSD**	SampType: **MSD**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704184**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	27.651	1.2	5.000	23.84	76.3	80	120	28.54	3.17	20	S

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_TC

Sample ID: **MB-55028A**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703567**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **MB-55007A TCLP**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703568**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **LCS-55028**	SampType: **LCS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **LCSS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703569**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	1.079	0.25	1.000	0	108	80	120				

Sample ID: **105017-434A-DUP**	SampType: **DUP**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703579**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	0.420	0.25						0.4245	1.18	20	

Sample ID: **105017-434A-MS**	SampType: **MS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703580**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	3.051	0.25	2.500	0.4245	105	70	130				

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104965
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_TC

Sample ID: **MB-55028B**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703581**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **MB-55007B TCLP**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703582**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **105193-001A-DUP**	SampType: **DUP**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703588**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	7.636	0.25						7.599	0.494	20	

Sample ID: **105193-001A-MS**	SampType: **MS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703589**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	6.918	0.50	2.500	7.599	-27.2	70	130				S

Sample ID: **105193-001A-MSD**	SampType: **MSD**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703590**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	6.734	0.50	2.500	7.599	-34.6	70	130	6.918	2.69	20	S

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

Diane Galvan

From: Chris Giuntoli [giuntoli@geoconinc.com]
Sent: Friday, April 24, 2009 3:50 PM
To: Diane Galvan
Subject: RE: Results/EDD - CALTRANS-DOYLE DRIVE (104965)

Hi Diane,

For workorder 104965, please run WETs for lead on a 72-hour TAT for the following samples:

DD-P2A
DD-P3A
DD-P4A
DD-P5A

And run TCLPs for lead on a 72-hour TAT for samples DD-P1A and DD-P5A.

Thanks,
Chris

April 13, 2009

Chris Giuntoli
Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
TEL: (925) 371-5900
FAX: (925) 371-5915

ELAP No.: 1838
NELAP No.: 02107CA
NEVADA.: CA-401
CSDLAC No.: 10196

Workorder No.: 104966

RE: CALTRANS-DOYLE DRIVE, E8435-06-24

Attention: Chris Giuntoli

Enclosed are the results for sample(s) received on April 10, 2009 by Advanced Technology Laboratories . The sample(s) are tested for the parameters as indicated in the enclosed chain of custody in accordance with the applicable laboratory certifications.

Thank you for the opportunity to service the needs of your company.

Please feel free to call me at (562)989-4045 if I can be of further assistance to your company.

Sincerely,

for Eddie F. Rodriguez
Laboratory Director

The cover letter and the case narrative are an integral part of this analytical report and cannot be reproduced in part or in its entirety without written permission from the client and Advanced Technology Laboratories.

CLIENT: Geocon Consultants, Inc.
Project: CALTRANS-DOYLE DRIVE, E8435-06-24
Lab Order: 104966

CASE NARRATIVE

Analytical Comments for Method 6010

Dilution was necessary for sample 104966-001A, 104966-003A, 104966-005A and 104966-006A, due to sample matrix.

Advanced Technology Laboratories
3275 Walnut Avenue, Signal Hill, CA 90755 Tel: 562. 989.4045 Fax: 562.989.4040

CLIENT: Geocon Consultants, Inc. **Lab Order:** 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

Lab ID: 104966-001 **Collection Date:** 4/9/2009
Client Sample ID: DD-P8A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413B	QC Batch: 54640			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	32000	20		mg/Kg	10	4/13/2009 03:43 PM

Lab ID: 104966-002 **Collection Date:** 4/9/2009
Client Sample ID: DD-P9A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413B	QC Batch: 54640			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	28	1.0		mg/Kg	1	4/13/2009 03:47 PM

Lab ID: 104966-003 **Collection Date:** 4/9/2009
Client Sample ID: DD-P10A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413B	QC Batch: 54640			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	130000	100		mg/Kg	100	4/13/2009 01:28 PM

Lab ID: 104966-004 **Collection Date:** 4/9/2009
Client Sample ID: DD-P11A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413C	QC Batch: 54641			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	13	2.0		mg/Kg	1	4/13/2009 03:56 PM

Qualifiers:
B Analyte detected in the associated Method Blank
H Holding times for preparation or analysis exceeded
S Spike/Surrogate outside of limits due to matrix interference
DO Surrogate Diluted Out
E Value above quantitation range
ND Not Detected at the Reporting Limit
Results are wet unless otherwise specified

CLIENT: Geocon Consultants, Inc. **Lab Order:** 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

Lab ID: 104966-005 **Collection Date:** 4/9/2009
Client Sample ID: DD-P12A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413C	QC Batch: 54641			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	52000	100		mg/Kg	100	4/13/2009 02:17 PM

Lab ID: 104966-006 **Collection Date:** 4/9/2009
Client Sample ID: DD-P13A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413C	QC Batch: 54641			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	220000	200		mg/Kg	100	4/13/2009 02:21 PM

Lab ID: 104966-007 **Collection Date:** 4/9/2009
Client Sample ID: DD-P14A **Matrix:** PAINT CHIP

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
ICP METALS						
	EPA 3050B			**EPA 6010B**		
RunID: ICP8_090413C	QC Batch: 54641			PrepDate: 4/13/2009	Analyst: **CL**	
Lead	100	4.1		mg/Kg	1	4/13/2009 03:59 PM

Qualifiers:

B	Analyte detected in the associated Method Blank
H	Holding times for preparation or analysis exceeded
S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out
E	Value above quantitation range
ND	Not Detected at the Reporting Limit
	Results are wet unless otherwise specified

CLIENT: Geocon Consultants, Inc.
Work Order: 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 6010_S

Sample ID: **LCS-54640**	SampType: **LCS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694432**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	49.511	1.0	50.00	0	99.0	80	120				

Sample ID: **LCSD-54640**	SampType: **LCSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **LCSS02**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694433**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	45.058	1.0	50.00	0	90.1	80	120	49.51	9.42	20	

Sample ID: **MB-54640MS**	SampType: **MS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694444**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	109.881	1.0	125.0	0	87.9	33	120				

Sample ID: **MB-54640MSD**	SampType: **MSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **ZZZZZZ**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694445**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	115.121	1.0	125.0	0	92.1	33	120	109.9	4.66	20	

Sample ID: **MB-54640**	SampType: **MBLK**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108041**
Client ID: **PBS**	Batch ID: **54640**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694493**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	1.0									

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 6010_S

Sample ID: **MB-54641**	SampType: **MBLK**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108046**
Client ID: **PBS**	Batch ID: **54641**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694494**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	1.0									

Sample ID: **LCS-54641**	SampType: **LCS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108046**
Client ID: **LCSS**	Batch ID: **54641**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694495**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	47.403	1.0	50.00	0	94.8	80	120				

Sample ID: **LCSD-54641**	SampType: **LCSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108046**
Client ID: **LCSS02**	Batch ID: **54641**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694496**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	46.691	1.0	50.00	0	93.4	80	120	47.40	1.51	20	

Sample ID: **MB-54641MS**	SampType: **MS**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108046**
Client ID: **ZZZZZZ**	Batch ID: **54641**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694501**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	122.043	1.0	125.0	0	97.6	33	120				

Sample ID: **MB-54641MSD**	SampType: **MSD**	TestCode: **6010_S**	Units: **mg/Kg**	Prep Date: **4/13/2009**	RunNo: **108046**
Client ID: **ZZZZZZ**	Batch ID: **54641**	TestNo: **EPA 6010B**	**EPA 3050B**	Analysis Date: **4/13/2009**	SeqNo: **1694502**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	132.783	1.0	125.0	0	106	33	120	122.0	8.43	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CHAIN OF CUSTODY RECORD

Pg 1 of 1

Advanced Technology Laboratories
3275 Walnut Avenue
Signal Hill, CA 90755
(562) 989-4045 • Fax (562) 989-4040

FOR LABORATORY USE ONLY:

P.O.#: _____

Logged By: _____ Date: 4/10/09

Method of Transport: Client ☐ ATL ☐ CA OverN ☐ FEDEX ☐ Other: GSO

Sample Condition Upon Receipt:
1. CHILLED Y☐ N☑ 4. SEALED Y☐ N☐
2. HEADSPACE (VOA) Y☐ N☐ N/A 5. # OF SPLS MATCH COC Y☑ N☐
3. CONTAINER INTACT Y☑ N☐ 6. PRESERVED Y☐ N☑

Client: GEOCON
Address: 6671 BRISA ST
TEL: (925) 371-5900
Attn: CHRIS GIUNTOLI
City LIVERMORE State CA Zip Code 94550
FAX: ( )

Project Name: CALTRANS - DOYLE DRIVE Project #: E8435-06-24 Sampler: (Printed Name) C GIUNTOLI (Signature)

Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Mary Date: 4/10/09 Time: 9:10

Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:

Relinquished by: (Signature and Printed Name) Date: Time: Received by: (Signature and Printed Name) Date: Time:

I hereby authorize ATL to perform the work indicated below:
Project Mgr /Submitter:
CGIUNTOLI 4/9/09
Print Name Date
Signature

Send Report To:
Attn: SEE ABOVE
Co: _____
Address _____
City _____ State____ Zip____

Bill To:
Attn: SAME
Co: _____
Address _____
City _____ State____ Zip____

Special Instructions/Comments:
*SOLUBLE LEAD MAY BE REQUESTED BASED ON TOTAL LEAD RESULTS
24-HR TAT INCLUDE EDD

Sample/Records - Archival & Disposal
Unless otherwise requested by client, all samples will be disposed 45 days after receipt and records will be disposed 1 year after submittal of final report.

Storage Fees (applies when storage is requested):
- Sample : $2.00 / sample / mo (after 45 days)
- Records : $1.00 / ATL workorder / mo (after 1 year)

ITEM	LAB USE ONLY: Batch #: / Lab No.	Sample Description: Sample I.D. / Location	Date	Time
	104966-001	DD-P8A	4/9/09	
	2	DD-P9A		
	3	DD-P10A		
	4	DD-P11A		
	5	DD-P12A		
	6	DD-P13A		
	7	DD-P14A		

Circle or Add Analysis(es) Requested

8081A (Pesticides)	8082 (PCB)	8260B (Volatiles)	8270C (BNA)	6010B (Total Metal)	8015B (GRO) / 8020 (BTEX)	8015B (DRO)	8021 (BTEX)	TITLE 22 / CAM 17 (6010 / 7000)	TOTAL LEAD *	SPECIFY APPROPRIATE MATRIX: SOIL	WATER	GROUND WATER	WASTEWATER	PAINT CHIPS	TAT	Container(s) #	Container(s) Type	PRESERVATION
									X					X	B	1	P / B	

QA/QC: RTNE ☐ CT ☒ SWRCB ☐ Logcode ____ OTHER ____

REMARKS

- TAT starts 8 a.m. following day if samples received after 3 p.m.

TAT: A= Overnight ≤ 24 hr B= Emergency Next workday C= Critical 2 Workdays D= Urgent 3 Workdays E= Routine 7 Workdays

Container Types: T=Tube V=VOA L=Liter P=Pint J=Jar B=Tedlar G=Glass P=Plastic M=Metal

Preservatives: H=Hcl N=HNO_3 S=H_2SO_4 C=4°C Z=$Zn(AC)_2$ O=NaOH T=$Na_2S_2O_3$

DISTRIBUTION: **White** with report, **Yellow** to folder, **Pink** to submitter.

April 29, 2009

Chris Giuntoli
Geocon Consultants, Inc.
6671 Brisa Street
Livermore, CA 94550
TEL: (925) 371-5900
FAX: (925) 371-5915

ELAP No.: 1838
NELAP No.: 02107CA
NEVADA.: CA-401
CSDLAC No.: 10196

Workorder No.: 104966

RE: CALTRANS-DOYLE DRIVE, E8435-06-24

Attention: Chris Giuntoli

Enclosed are the results for sample(s) received on April 10, 2009 by Advanced Technology Laboratories . The sample(s) are tested for the parameters as indicated in the enclosed chain of custody in accordance with the applicable laboratory certifications.

This is an addendum report. Please incorporate with documentation previously submitted.

Thank you for the opportunity to service the needs of your company.

Please feel free to call me at (562)989-4045 if I can be of further assistance to your company.

Sincerely,

Eddie F. Rodriguez
Laboratory Director

The cover letter is an integral part of this analytical report. This Laboratory Report cannot be reproduced in part or in its entirety without written permission from the client and Advanced Technology Laboratories.

CLIENT: Geocon Consultants, Inc.
Project: CALTRANS-DOYLE DRIVE, E8435-06-24
Lab Order: 104966

CASE NARRATIVE

Analytical Comments for Method 7420

Dilution was necessary for samples 104966-001A, 104966-003A and 104966-005A, due to sample matrix.

Matrix Spike (MS) and /or Matrix Spike Duplicate (MSD) are/is outside recovery criteria for samples 105193-001AMS and 105193-001AMSD; however, the analytical batch was validated by the Laboratory Control Sample (LCS).

Advanced Technology Laboratories
3275 Walnut Avenue, Signal Hill, CA 90755 Tel: 562. 989.4045 Fax: 562.989.4040

Advanced Technology Laboratories

Date: 4/29/2009

ANALYTICAL RESULTS

LEAD BY ATOMIC ABSORPTION (STLC)
WET/ EPA 7420

CLIENT:	Geocon Consultants, Inc.	**Lab Order:**	104966
Project:	CALTRANS-DOYLE DRIVE, E8435-06-24	**Date Received**	4/10/2009 9:10:00 AM
Project No:		**Matrix:**	Paint Chip
Analyte:	Lead	**Analyst:**	VV

Laboratory ID	Client Sample ID	Results	Units	QC Batch	PQL	DF	Date Collected	Date Analyzed
104966-007A	DD-P14A	1.9	mg/L	55009	0.25	1	4/9/2009	4/29/2009

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

Advanced Technology Laboratories

Date: 4/29/2009

ANALYTICAL RESULTS

LEAD BY ATOMIC ABSORPTION (TCLP)
EPA 1311/ 7420

CLIENT:	Geocon Consultants, Inc.	**Lab Order:**	104966
Project:	CALTRANS-DOYLE DRIVE, E8435-06-24	**Date Received**	4/10/2009 9:10:00 AM
Project No:		**Matrix:**	Paint Chip
Analyte:	Lead	**Analyst:**	RQ

Laboratory ID	Client Sample ID	Results	Units	QC Batch	PQL	DF	Date Collected	Date Analyzed
104966-001A	DD-P8A	67	mg/L	55028	5.0	20	4/9/2009	4/28/2009
104966-003A	DD-P10A	9.5	mg/L	55028	0.50	2	4/9/2009	4/28/2009
104966-005A	DD-P12A	54	mg/L	55028	5.0	20	4/9/2009	4/28/2009
104966-006A	DD-P13A	3.7	mg/L	55028	0.25	1	4/9/2009	4/28/2009

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	ND	Not Detected at the Reporting Limit
S	Spike/Surrogate outside of limits due to matrix interference		Results are wet unless otherwise specified
DO	Surrogate Diluted Out		

CLIENT: Geocon Consultants, Inc.
Work Order: 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_ST

Sample ID: **MB-55009**	SampType: **MBLK**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **PBS**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704179**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **LCS-55009**	SampType: **LCS**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **LCSS**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704180**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	4.859	0.25	5.000	0	97.2	80	120				

Sample ID: **105193-001A-DUP**	SampType: **DUP**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704182**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	23.624	1.2						23.84	0.893	20	

Sample ID: **105193-001A-MS**	SampType: **MS**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704183**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	28.541	1.2	5.000	23.84	94.1	80	120				

Sample ID: **105193-001A-MSD**	SampType: **MSD**	TestCode: **7420_ST**	Units: **mg/L**	Prep Date: **4/27/2009**	RunNo: **108596**
Client ID: **ZZZZZZ**	Batch ID: **55009**	TestNo: **WET/ EPA 74 WET**		Analysis Date: **4/29/2009**	SeqNo: **1704184**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	27.651	1.2	5.000	23.84	76.3	80	120	28.54	3.17	20	S

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_TC

Sample ID: **MB-55028A**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703567**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **MB-55007A TCLP**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703568**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **LCS-55028**	SampType: **LCS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **LCSS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703569**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	1.079	0.25	1.000	0	108	80	120				

Sample ID: **105017-434A-DUP**	SampType: **DUP**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703579**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	0.420	0.25						0.4245	1.18	20	

Sample ID: **105017-434A-MS**	SampType: **MS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703580**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	3.051	0.25	2.500	0.4245	105	70	130				

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

CLIENT: Geocon Consultants, Inc.
Work Order: 104966
Project: CALTRANS-DOYLE DRIVE, E8435-06-24

ANALYTICAL QC SUMMARY REPORT

TestCode: 7420_TC

Sample ID: **MB-55028B**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703581**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **MB-55007B TCLP**	SampType: **MBLK**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **PBS**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703582**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	ND	0.25									

Sample ID: **105193-001A-DUP**	SampType: **DUP**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703588**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	7.636	0.25						7.599	0.494	20	

Sample ID: **105193-001A-MS**	SampType: **MS**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703589**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	6.918	0.50	2.500	7.599	-27.2	70	130				S

Sample ID: **105193-001A-MSD**	SampType: **MSD**	TestCode: **7420_TC**	Units: **mg/L**	Prep Date: **4/28/2009**	RunNo: **108555**
Client ID: **ZZZZZZ**	Batch ID: **55028**	TestNo: **EPA 1311/ 74**	**EPA3010A**	Analysis Date: **4/28/2009**	SeqNo: **1703590**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Lead	6.734	0.50	2.500	7.599	-34.6	70	130	6.918	2.69	20	S

Qualifiers:

B	Analyte detected in the associated Method Blank	E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit	R	RPD outside accepted recovery limits	S	Spike/Surrogate outside of limits due to matrix interference
DO	Surrogate Diluted Out		Calculations are based on raw values		

Diane Galvan

From: Chris Giuntoli [giuntoli@geoconinc.com]
Sent: Friday, April 24, 2009 3:53 PM
To: Diane Galvan
Subject: RE: Results/EDD - CALTRANS-DOYLE DRIVE (104966)

Hi Diane,

For workorder 104966, please run WET for lead on a 72-hour TAT for sample DD-P14A

And run TCLPs for lead on a 72-hour TAT for the following samples:

DD-P8A
DD-P10A
DD-P12A
DD-P13A

Thanks,
Chris

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

QUOTATION #0909-0064Q-rev. 1

Date: October 22nd, 2009

To: Sabine VanderSluis
Parsons Brinckerhoff
303 Second Street, Suite 700 North
San Francisco CA 94107-1317

Job: **Ca. Doyle Drive Project**

Dear Ms. VanderSluis;

Attached please find our quotation for the lease/rental of 24" QMB Moveable Barrier, Barrier Transfer Machine BTM and Absorb 350 for the following periods. If you need the addressee changed to a Caltrans person or addressee please let me know and I will resend it to you with the correct information.

Series 200 Construction Barrier - Lease/Rental

6,580 L.ft (2,006m) "black" hardware and reinforcements (not painted, galvanized, or epoxy coated). Does not include reflectors or striping.
Barriers may be new or used.
We can supply more or fewer units at the same unit prices.

Term of Lease	Price per Lineal Foot*	Additional Months
6 months	$42.00	$3.60 per L.ft per month
12 months	$55.00	$3.60 per L.ft per month
18 months	$70.00	$3.60 per L.ft per month
24 months	$84.00	$3.60 per L.ft per month

Variable Length Barrier - VLB

All VLB's for the job as designed will be included in the price above. VLB units will be substituted one for one for concrete and will be charged at the same unit price as concrete units. (Exact amounts will be determine after reviewing the proposed layout of the systems and the road geometry)

QMB ABSORB 350 TL-3 (Sale Item Only)

$7,900.00 each (To be supplied by local distributor – Statewide Safety Systems)

QMB Barrier Transfer Machine

One Standard Machine with No Options per Specification TB 960515 Rev 2

(The type of machine will be determined after reviewing the proposed layout of the systems and the road geometry). Machine may be new or reconditioned.

Term of Lease	Price Per Each*	Additional Months
6 months	$103,000.00	$14,000.00 per month
12 months	$171,000.00	$14,000.00 per month
18 months	$236,000.00	$14,000.00 per month
24 months	$248,000.00	$14,000.00 per month

* The full lease amount is payable net 30 days from date of invoice. If additional months are then required, they are payable monthly in advance.

NOTE: Machines will be shipped partially disassembled. The mainframe has lifting lugs and a 20-ton crane or similar equipment must be available for unloading. In conjunction with training, we will furnish a technician to supervise the assembly of the machines using your men and equipment. The approximate time required is two men for a day. The equipment required in addition to the crane for unloading is a forklift and a set of general mechanic's tools.

Cost of machine includes 2 consecutive days' set-up and training (2 weeks notice required). Additional training days are available as follows:

Additional consecutive days: $1,300.00 per day
Additional non-consecutive days: $1,300.00 per day
(portal to portal) plus air fare.

Barriers are one meter long and will be billed as 3.28 feet per barrier times the per foot price for the number of barriers needed to fulfill the linear foot requirement of the order. By necessity, the lineal feet billed may be up to 3.27 feet more than the quantity ordered.

Maintenance: Regular maintenance of the machine is required and periodic adjustment of the wall may be necessary.

Lessor will provide all parts to maintain the machine to factory specifications (not including consumables such as fuel, lubrication and hydraulic fluids). Lessor will also provide quarterly inspections to help Lessee maintain the machine to factory specifications. Lessee is responsible for providing access to the machine for Lessor's employees and for providing the labor for routine maintenance. Any parts damaged due to an accident or negligence will be the responsibility of Lessee.

If additional information is required, please contact our Engineering Department at 707-374-6800.

Taxes: This quotation is exclusive of federal, state and local taxes, which the parties agree are the responsibility of the lessee. Lessor will add the amount of any applicable federal, state or local sales or equivalent taxes to the quotation unless the Lessee provides seller with an acceptable resale or exemption certificate.

Insurance: Lessee will provide both liability and casualty insurance with a minimum limit of $1 million for bodily injury and Property Damage and a $10 million umbrella limit.

Storage: Finished parts will be stored at no charge for 30 days following completion of the order. Additional storage time, if required, may be available. Arrangements for additional storage time must be made by the Lessee with the landlord of the property where the barrier is stored.

Delivery Point:

Barriers: Barriers will be available for pickup at a designated yard within 100 miles of jobsite. Lessee is responsible to load and unload the barriers for shipment.

Machine: Rio Vista, CA., freight prepaid & add (Lessee is responsible for all shipping charges)

VLB's: Rio Vista, Ca., freight prepaid & add (Lessee is responsible for all shipping charges)

Specifications:

24” Series 200 barriers will be manufactured by the wet or dry cast method using forms. Minimum concrete 28 day compressive strength shall be 4000 PSI. "Bugholes" caused by trapped air bubbles will be permitted. Rock pockets or other voids caused by inadequate consolidation of the concrete shall be filled. Used barriers may have non-structural damage such as chipped edges or corners, etc.

All materials shall be on the approved list of the State in which the barriers are manufactured. Air entrainment shall be as specified by the ordering agency plus or minus 1-1/2 percentage points. All steel hardware and reinforcements shall be "black" (not galvanized, painted, or epoxy coated) unless otherwise quoted. All materials shall be of U.S. origin except that up to 5% by value foreign origin material may be used if required.

All inspections shall be performed by Barrier Systems Sales & Service (B.S.S.&S.) who will certify that the product is in compliance with their specifications and shop drawings. If additional State specifications and/or inspections are required, an additional charge may be made which will be quoted upon receipt of additional specifications.

Terms of Payment: Lease/rental payments shall be due and payable as follows:

Barrier: Lease Period starts upon delivery. The full lease amount is payable net 30 days from date of invoice, upon approval of credit. No retentions will be withheld from Lessor. No rebates will be allowed.

Machine: Lease Period starts upon delivery. The full lease amount is payable net 30 days from date of invoice, upon approval of credit. No retentions will be withheld from Lessor. No rebates will be allowed.

* If additional month-by-month lease/rental is continued, payment is due monthly, in advance.

Finance Charge: A Financing Charge of 1-1/3% per month (16% per annum) will be computed on past due amounts. Lessee agrees that all collection

costs, court costs, investigation costs, legal fees and all other incidental costs incurred in the collection of his past due account will be paid by the lessee.

PLEASE NOTE THAT THE TERMS OF THIS QUOTATION ARE INDEPENDENT OF THE TERMS OF PAYMENT BY THE STATE TO THE LESSEE.

Return on Completion of Project:

All barrier shall be returned to a designated site within 100 miles of the project. Lessee is responsible for loading, trucking, unloading and stacking (see TB-000626 Rev.0) items for and from shipment. (Lessee is responsible for all shipping charges)

Machines and VLB's will be returned to Rio Vista Freight Prepaid with Insurance. (Lessee is responsible for all shipping charges)

Lessee will be responsible for unloading barriers at Lessor's yard and for loading machine for return to Rio Vista, Ca.

All items shall be returned in "as received" condition less ordinary wear and tear.

All barrier sections, which are not reusable, will be invoiced at $492 per 24" barrier and $6,000 per VLB.

Unusual damage or wear to the machine will be repaired at Lessee's expense.

Delivery:

Barrier: Available 60 days after receipt and acceptance of a signed Lease Agreement.

Machine: Available 60 days after receipt and acceptance of a signed Lease Agreement.

Note: These quotation prices are valid and locked up to April 1st, 2010 and are **subject to the execution of a satisfactory lease/rental agreement.**

PLEASE NOTE: **Any modifications, including additions or reductions in quantity, or additions to the terms hereof will constitute a counteroffer by lessee. Any such modifications or additions may result in adjustments to the lease/rental price.**

Warranty and Terms: This quotation is subject to the following attachments which are herewith made a part of this quotation:

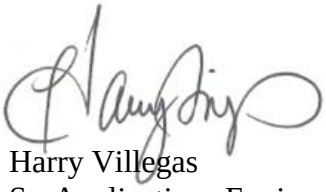
Warranty - W030587 Rev. 6
24" QMB Barrier Specification - TB 950222 Rev. 2
BTM Specification - TB 960515 Rev 2
Barrier Deployment – TB 941025 Rev 3
QMB 24" Barrier Stacking Specification – TB000626 Rev. 0
Allowable transfer widths TB 980202 Rev. 1

Thank you for giving us this opportunity to quote on this project. **Please advise when barrier and machines will be required, giving at least 30 days of advance notice.**

If a different lease period is required please let us know and we will provide additional pricing.

Cordially,

BARRIER SYSTEMS SALES AND SERVICE LLC

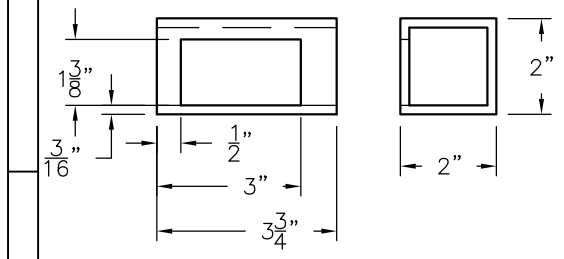


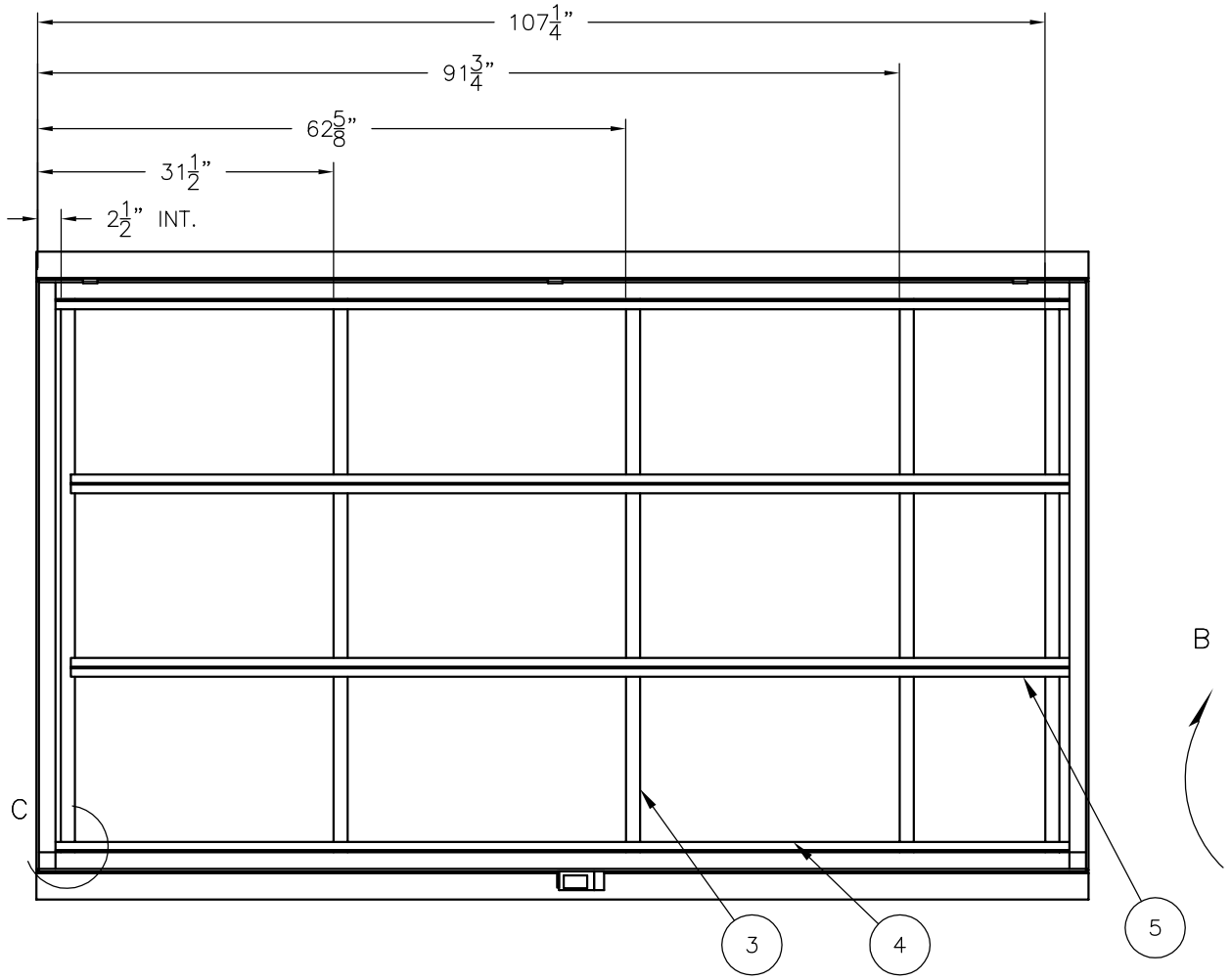
Harry Villegas
Sr. Applications Engineer

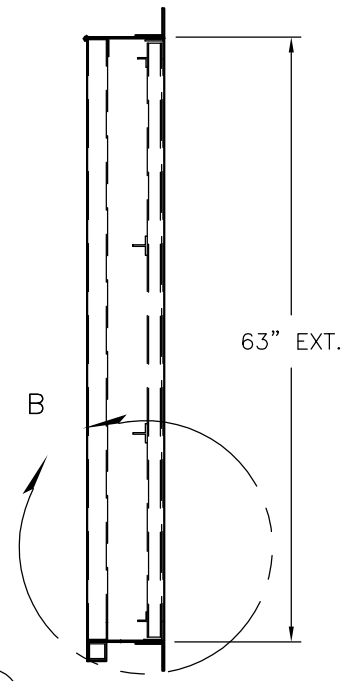
VARIABLE MESSAGE SIGN (VMS) DETAILS

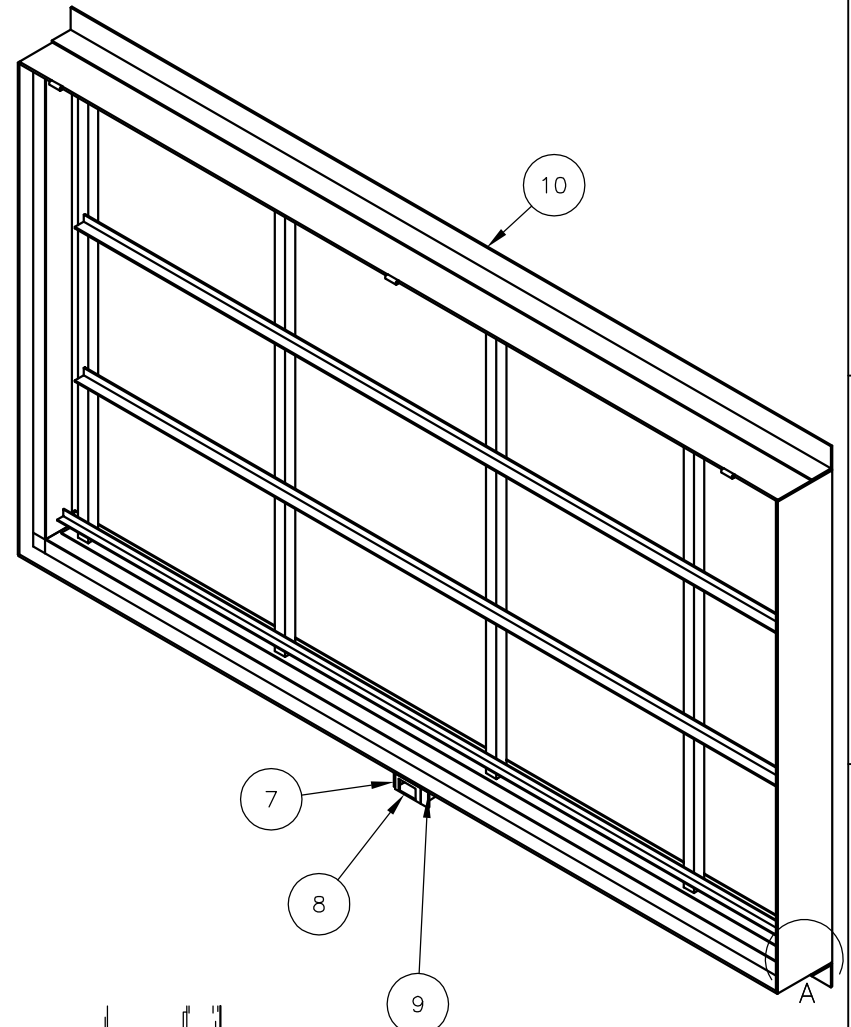
1. Dimensions: 69” (h) x 112” (l) x 9”(d)
2. Weight: 500 lbs
3. Distance Arm: Specific to each location.
4. Walkway: Specific to each location.
5. Flashing Beacons: No
6. Connection: One Angle Bar -3”(h) x 3”(w) x 112”(l) x 1/4”(thick)- at the top. One Angle Bar -3”(h) x 3”(w) x 112”(l) x 1/4”(thick)- at the bottom, with an Aluminum Tubing in the center as well.
7. Manufacturer: Ver Mac (ver-mac.com)

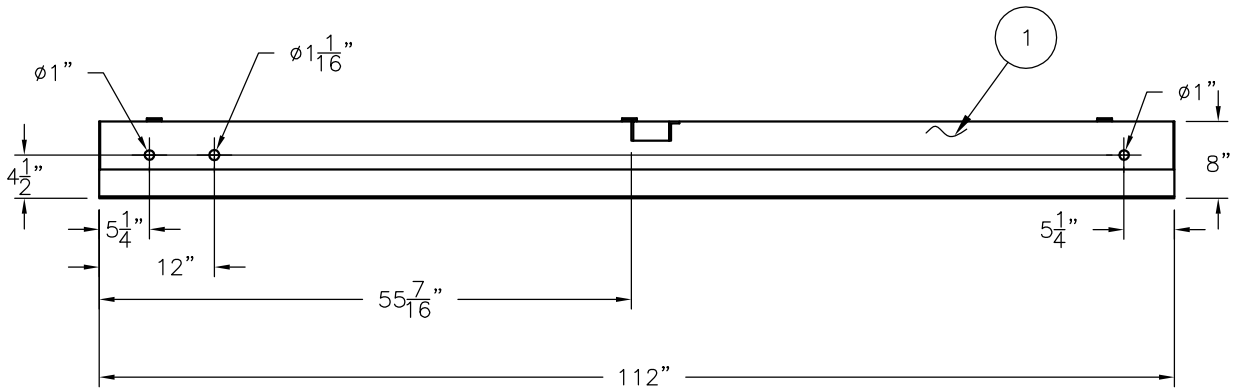
ITEM #8
(SCALE 1:6)

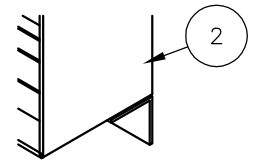




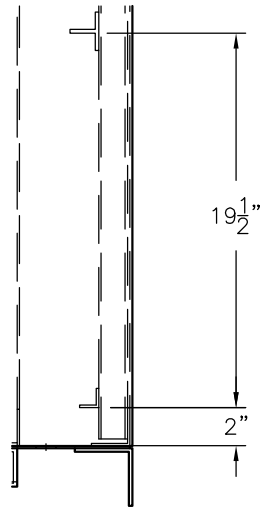




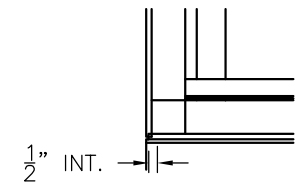




VIEW A



VIEW B



VIEW C

STEP	QTY	NAME	LINEAR FOOT	JIG.	#VER–MAC
1	1	EXTENDED 320 SIGN CASE	REF.		A–1130
2	2	ALUMINUM ANGLE 3/16"X2"X2"X111" LG.	18.5'		A–75
3	5	ALUMINUM TUBING 1/8"X1 1/2"X1 1/2"X61 7/8"LG.	26		A–122
4	2	ALUMINUM ANGLE 1/8"X1"X1"X111" LG.	18.5'		A–87
5	2	ALUMINUM T BAR 1/8"X1 1/2"X1 1/2"X111" LG.	18.5'		A–1702
6	–	------	–		–
7	1	ALUMINUM FLAT BAR 3/16"X2"X1 3/4" LG.	0.1'		A–240
8	1	ALUMINUM TUBING 3/16"X2"X2"X3 3/4" LG.	0.3125'		A–415
9	1	ALUMINUM ANGLE 3/16"X2"X2"X2" LG.	0.17'		A–75
10	2	ALUMINUM ANGLE 1/4"X3"X3"X112" LG.	19'		A–104

REVISION	#	DATE	DESCRIPTION	BY

SIGNALISATION VER-MAC INC.

PROJECT :	REF :
	SCALE. 1:20
TITLE : EXTENDED 320 SIGN CASE	:
DRAWING # : CAI-S13	REVISION # :
DRAWN BY : L.G.	DATE :AUGUST 16 2006
APPROVED BY :	DATE :

SHEET : 1 DE 1

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. MINH HA
Chief, Structure Design Branch 4
Division of Engineering Services

Date: July 14, 2009

Attn: Linan Wang

File: 04-SF-1/101, PM 9.0
04-163701
Retaining Wall 6

From: TUNG NGUYEN TN
Transportation Engineer
Office of Geotechnical Design-West
Geotechnical Services
Division of Engineering Services

M. Momenzadeh
MAHMOOD MOMENZADEH
Chief, Branch C
Office of Geotechnical Design-West
Geotechnical Services
Division of Engineering Services

Subject: Foundation Report for RW 6

INTRODUCTION

This Foundation Report (FR) provides geotechnical recommendations for Retaining Wall 6 (RW 6) of Contract No 4, Doyle Drive Replacement Project. The overall project proposes to replace existing Doyle Drive from Marina Boulevard and Lombard Streets to the southern approach of the Golden Gate Bridge on State Route (SR) 101 from Post Mile (PM) 8.3 to PM 9.4 (KP 13.4 to KP 15.1).

This FR documents site geology and subsurface conditions, provides analyses of site conditions as they pertain to the project and recommends geotechnical input for the foundation design.

To accomplish the above stated purpose, the following works were conducted:

- Field reconnaissance to observe and document site conditions
- Review geology open file
- Site subsurface investigation
- Engineering analyses for foundation design

PROJECT LOCATION

RW 6 is located between Battery Tunnel and Presidio Viaduct Substation on the 101 Southbound. As we understand, a segment of RW 6 adjacent to the Battery Tunnel is

designed by ARUP. The other segment of RW 6 adjacent to Presidio Viaduct Substation to retain the fill of maximum 8 ft as shown in the provided General Plan of June 24, 2009 is designed by CALTRANS.

GEOLOGY AND SUBSURFACE CONDITIONS

Regional Geology

The project site location falls in the Coast Range geomorphic province, which is characterized by a series of nearly parallel mountain ranges that trend obliquely to the coast in a northwesterly direction. This trend in direction is emphasized by the alignment of the fault zone, the fold axes and geologic units.

The San Francisco Bay area has long record of seismic activity. The entire project area has also been strongly influenced by changes related to the Pleistocene glaciers and the presence of the San Francisco Bay trough, resulting in variable thickness of recent deposits of soft to medium stiff Holocene clays (Bay Mud), an older stiffer Pleistocene clay (Old Bay Mud) and sand deposits.

Site Specific Geologic Conditions

The varying topography within the project site is the result of a diverse range of geologic conditions. Shallow bedrock of the Franciscan Formation generally dominates at the project location overlain by a relatively thin cover of soil. The Franciscan Formation consists of heavily folded and sheared assemblage of Shale, Sandstone, and Greywacke. The overburden soils are made up of slope debris, dune sand, and/or the Colma sand, which is medium dense to very dense.

SUBSURFACE INVESTIGATION

The Office of Geotechnical Design-West and ARUP conducted a subsurface investigation consisted of 4 mud rotary borings in February and April of 2008. The following table, lists borings and their locations including Northing and Easting coordinates, and elevations of these borings:

Table No 1. List of Borings

Boring	Northing	Easting	Elevation (ft)	Depth (ft)
RW6-R1-PZ	2120380.700	5994101.938	+108.507	64.0
RW6-R2-PZ-D	2120270.083	5993967.843	+108.659	114.7
RW6-R2-PZ-S	2120266.257	5993963.449	+108.315	29.0
34-0157SB-A1	2120481.342	5993926.250	+81.209	99.5

The mud rotary borings were advanced using a self-casing wireline drilling method to depths shown on the above table. Borings were drilled by using CME-550, CME-750 and Fraste Multi-Drill drill rigs with an automatic hammer. Sampling was achieved by using a Standard Penetration Test (SPT) sampler at 5 ft intervals, Modified California sampler, and continuous rock coring. Selected soil samples were collected and submitted for laboratory testing.

Groundwater levels are monitored periodically by piezometers installed at borings RW6-R1-PZ, RW6-R2-PZ-D and RW6-R2A-PZ-S. Boring RW6-R1-PZ is located about 120 ft east of the RW 6 segment designed by CALTRANS. The other two borings (RW6-R2-PZ-D and RW6-R2A-PZ-S) are located about 140 ft south of the RW 6 alignment and were drilled for the post-construction bluff monitoring program required by the National Park Services. Therefore, for the portion of RW 6 designed by CALTRANS, only boring 34-0157SB-A1 is included in the log of test boring (LOTB) as shown in the Appendix.

SUBSURFACE CONDITIONS

The subsurface condition at this site can be characterized as following: below surface is 0 to 11 ft of fill consisted of loose to medium dense sand underlain by very dense silty sand and Colma sand to the depth of 20 to 26 ft with SPT blow count varying from 42 to refusal. Below these layers are decomposed to slightly weathered, very soft to very hard sandstone and shale to the maximum depth of exploration. Sandstone has a RQD varying from 0 to 70%.

Groundwater level was recorded at about 20 ft and 28 ft below the ground surface at borings RW6-R1-PZ and RW6-R2-PZ-S on June 9, 2008 and July 18, 2008, respectively. The groundwater level is subject to fluctuations.

SCOUR POTENTIAL

The structure does not span any watercourse. Therefore, there is no scour potential at the site.

LIQUEFACTION POTENTIAL

Liquefaction is not anticipated for this site.

CORROSION

The following table summarizes laboratory data of corrosion tests on soil samples taken from borings:

Table No 2. Corrosivity Test Results

Boring No.	Depth (ft)	pH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
34-0157SB-A1	5-6.5	6.32	2886	-	-
34-0157SB- A1	15-16.5	7.41	4171	-	-

Based on the results of corrosion analyses and Caltrans criteria of 2003, soils are non-corrosive. However, due to site proximity to the San Francisco Bay and the past existence of a tidal marsh, the retaining wall should be designed for corrosive environment.

ENVIRONMENTAL/HAZARDOUS CONSIDERATIONS

District 4 Division of Environmental Planning & Engineering completed an extensive soil investigation for the Doyle Drive project. The draft report titled "Soil Investigation Report" is in the process of being finalized and will be available as part of the supplemental handout for the contractor and will include the characterization of the soil and groundwater of the entire Doyle Drive project for potential contaminants and hazardous waste. This includes testing and characterization of project areas subject to both roadway and structure excavation and the testing of all existing structures within the project for asbestos and lead-based paint.

For further information, please contact Mr. Ray Boyer, District Branch Chief - Hazardous Waste, Office of Environmental Engineering, Division of Environmental Planning & Engineering, Caltrans - District 04, at (510) 286-5668.

FAULT AND SEISMIC DATA

Hossain Salimi of the Office of Geotechnical Design-West will provide seismic recommendations for this structure.

FOUNDATION RECOMMENDATIONS

We do not anticipate settlement or bearing capacity issues at this location and therefore, Standard Retaining Wall (Type I) on spread footing will be appropriate at this location. The retaining walls should be designed with the following loading and allowable bearing pressure as provided in Table 3.

Table No 3. Earth Pressures for RW 6

Stage	Equivalent At-Rest Earth Pressure (pcf)	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Earth Pressure (psf)
Construction	63	42	375	-
Final	55	35	442	27H

H is the design height

The allowable bearing pressure of the foundation soils exceeds the required 2,200 psf toe pressure for 8 ft high wall type I under loading case I condition. For the above passive pressure, a safety factor of 2.0 should be used to compute the passive lateral pressure.

Global stability is not an issue for this retaining wall.

RW 6 is essentially extension of the proposed battery tunnel, and the construction is likely to be contagious with the tunnel. Therefore, the design of this wall should be performed in coordination with the other portion of the wall next to the tunnel.

CONSTRUCTION CONSIDERATIONS

We recommend the temporary cut slope for construction of RW 6 not steeper than 1:1. The excavation should follow the Cal/OSHA excavation requirements.

The recommendations contained in this report are based on specific project information including structure type, support locations, and design loads that have been provided by the Office of Bridge Design-West. If any changes are made during final project design, the Office of Geotechnical Design-West, should review those changes to determine if these foundation recommendations are still applicable

If you have any questions or need additional information, please contact Tung Nguyen at 510-622-1775 or Mahmood Momenzadeh at 510-286-5732.

c. TPokrywka, MMomenzadeh, CChen, HSalimi, Daily File, Route File, Translab File
John Mook, PCE-PPRM
Project Manager
District Design Chief

TNguyen/mm

APPENDIX

LOG OF TEST BORING

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	I. 101			

7-16-09
CERTIFIED ENGINEERING GEOLOGIST

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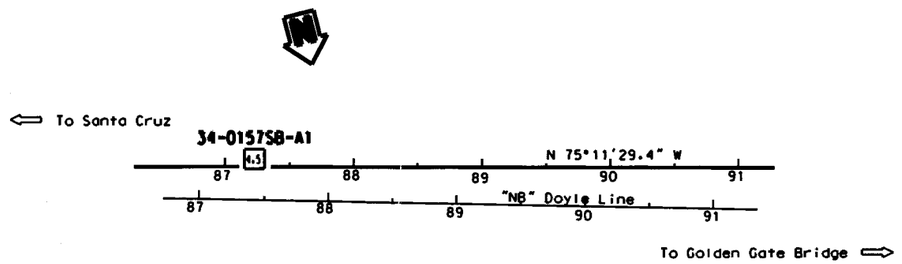
This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock Logging, Classification & Presentation Manual (June 2007) with the exception of Section 2.3.

BENCH MARK

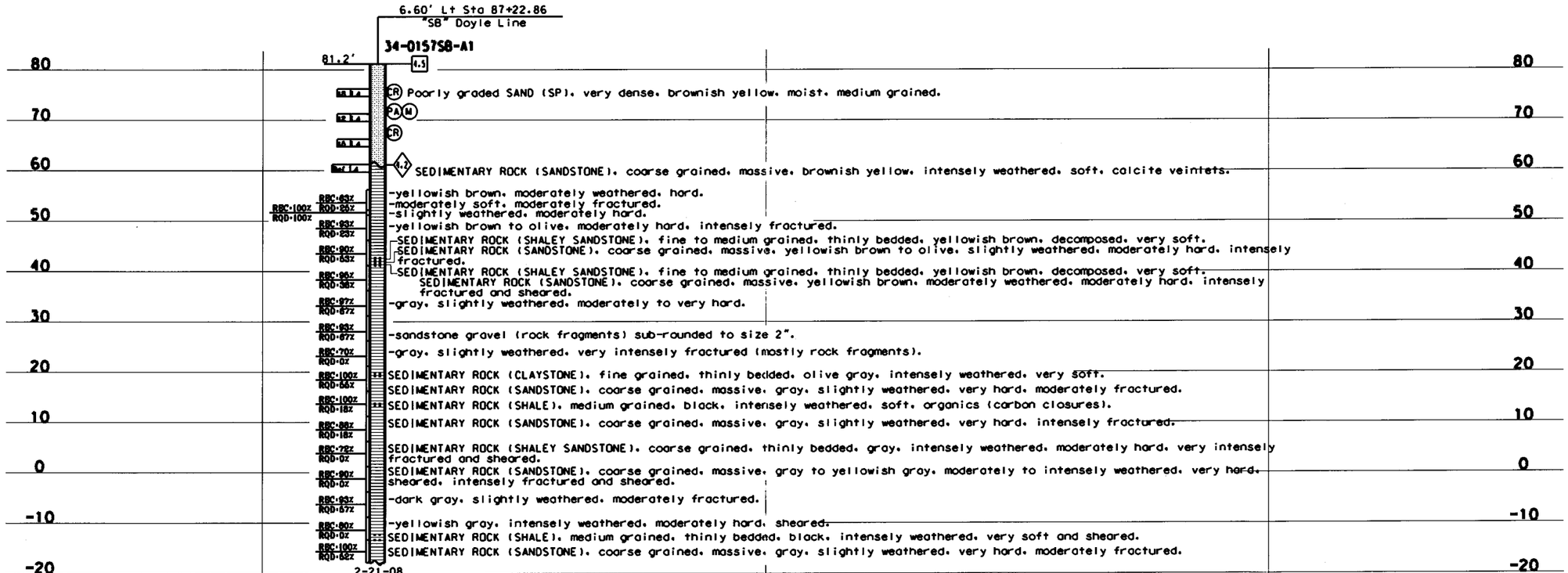
SURVEY CONTROL

CM-131
Fnd Mag. Nail & Washer
43.66 FT Lt. "SB" Line
Sta. 89+63.11
N 2.1205.06.93
E 5.993.684.52
Elev. = 52.78

CM-134
Fnd Mag. Nail & Washer
0.54 FT Rt. "NB" Line
Sta. 87+18.23
N 2.120.508.72
E 5.993.944.09
Elev. = 82.45
NAVD 1998 Datum



PLAN
1" = 50'



PROFILE
HOR. 1"=10'
VER. 1"=10'

ENGINEERING SERVICES		GEOTECHNICAL SERVICES		STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	RETAINING WALL 6
FUNCTIONAL SUPERVISOR	DRAWN BY: P. Nguyen 3/09, I.G-Remmen 7/09	FIELD INVESTIGATION BY:			DESIGN BRANCH	POST MILES 9.0	LOG OF TEST BORINGS 1 OF 4
NAME T. Pokrywka	CHECKED BY: R. Price	R. Nashed					
CU 04 EA 163731							

OSD CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DRAWING PRINTED BEFORE EARLIER REVISION DATES →

REVISION DATES: 07-15-09

SHEET OF

FILE -) $REQUEST

USERNAME -)USER DATE PLOTTED -)DATE TIME PLOTTED -)TIME

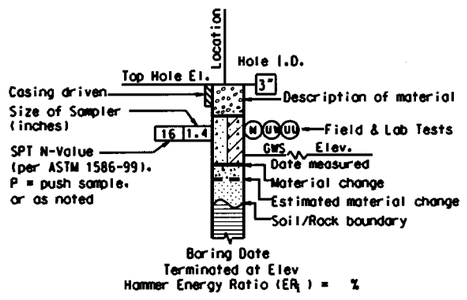
REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

CEMENTATION	
Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

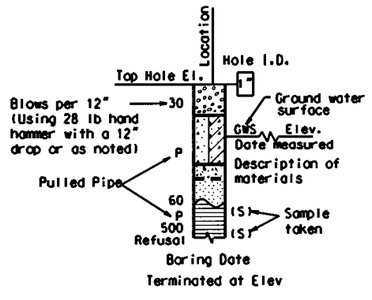
BOREHOLE IDENTIFICATION		
Symbol	Hole Type	Description
	A	Auger Boring
	R P	Rotary drilled boring Rotary percussion boring (air)
	R	Rotary drilled diamond core
	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778-95)
	O	Other
Note: Size in inches.		

CONSISTENCY OF COHESIVE SOILS				
Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	≤ 0.25	≤ 0.25	≤ 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	¢ 4.0	¢ 4.0	¢ 2.0	Indented by thumbnail with difficulty

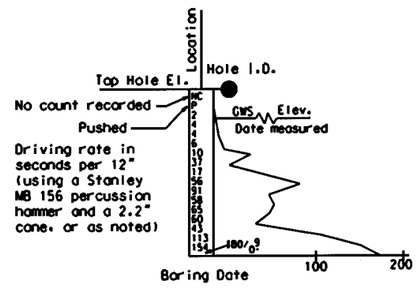
PLASTICITY OF FINE-GRAINED SOILS	
Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.



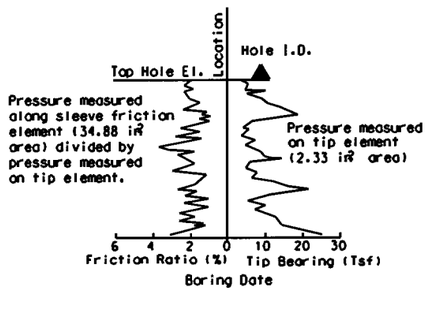
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	1, 101			

7-15-09
CERTIFIED ENGINEERING GEOLOGIST

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ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	RETAINING WALL 6
	PREPARED BY: I.G-REMMEN, 7/09	DEPARTMENT OF TRANSPORTATION	DESIGN BRANCH	POST MILE 9.02	LOG OF TEST BORINGS 2 OF 4

OF LOTS SOIL LOGGING

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04 EA 163731

DISREGARD PRINTS DRAWING EARLIER REVISION DATES →

REVISION DATES							SHEET	OF
07-15-09								

FILE -> $REQUEST

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REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic/Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (PP) Pocket Penetrometer
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (TV) Pocket Torvane
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)
- (VS) Vane Shear (AASHTO T 223)

DIST	COUNTY	ROUTE	POST MILES TOTAL	POST MILES PROJECT	SHEET No	TOTAL SHEETS
04	SF	1, 101				

7-16-09
CERTIFIED ENGINEERING GEOLOGIST

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APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	¢ 50

MOISTURE

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		¢ 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

ENGINEERING SERVICES	GEOTECHNICAL SERVICES PREPARED BY: I.G-REMMEN, 7/09	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH
BRIDGE NO.	RETAINING WALL 6		
POST MILE 9.02	LOG OF TEST BORINGS		3 OF 4

CU 04 EA 163731

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

DESIGNER: PRINTS DRAWING EARLIEST REVISION DATE → 07-15-09

REVISION DATES | SHEET | OF

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FILE =\REQUEST

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	1, 101			

7-15-09
CERTIFIED ENGINEERING GEOLOGIST

Great Wilcox
No. 2309
Exp. 4-30-10
CERTIFIED ENGINEERING GEOLOGIST
REGISTERED GEOLOGIST
STATE OF CALIFORNIA

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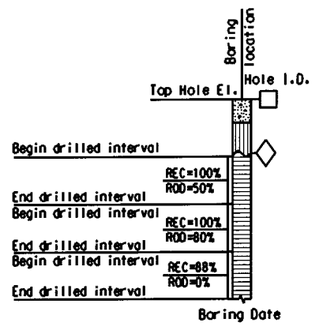
PERCENT CORE RECOVERY (REC) & ROCK QUALITY DESIGNATION (RQD)

$$REC = \frac{\sum \text{Length of the recovered core pieces (inches)}}{\text{Total length of core run (inches)}} \times 100\%$$

$$RQD = \frac{\sum \text{Length of intact core pieces} \geq 4"}{\text{Total length of core run (inches)}} \times 100\%$$



RELATIVE STRENGTH OF INTACT ROCK

Term	Uniaxial Compressive Strength (PSI)
Extremely Strong	¢ 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	≤ 150

BEDDING SPACING

Description	Thickness / Spacing
Massive	Greater than 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8" to 1 ft
Thinly bedded	1-1/4" to 3-5/8"
Very thinly bedded	3/8" to 1-1/4"
Laminated	Less than 3/8"

LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

ROCK HARDNESS

Description	Criteria
Extremely Hard	Specimen cannot be scratched with a pocket knife or sharp pickt can only be chipped with repeated heavy hammer blows.
Very Hard	Specimen cannot be scratched with a pocket knife or sharp pick. Breaks with repeated heavy hammer blows.
Hard	Specimen can be scratched with a pocket knife or sharp pick with difficulty (heavy pressure). Heavy hammer blows required to break specimen.
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure. Core breaks with moderate hammer blows.
Moderately Soft	Specimen can be grooved 1/6" deep with a pocket knife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Specimen can be grooved or gouged easily by a pocket knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very Soft	Specimen can be readily indented, grooved or gouged with fingernail, or carved with a pocket knife. Breaks with light manual pressure.

FRACTURE DENSITY

Description	Observed Fracture Density
Unfractured	No fractures.
Very slightly fractured	Lengths greater than 3 feet.
Slightly fractured	Lengths from 1 to 3 feet with few lengths less than 1 foot or greater than 3 feet.
Moderately fractured	Lengths mostly in 4" to 1 foot range with most lengths about 8"
Intensely fractured	Lengths average from 1 to 4" with scattered fragmented intervals with lengths less than 4"
Very intensely fractured	Mostly chips and fragments with a few scattered short core lengths.

Combination descriptors (such as "Very intensely to intensely fractured") are used where equal distribution of both fracture density characteristics is present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions. Only two adjacent descriptors may be combined.

WEATHERING DESCRIPTORS FOR INTACT ROCK

Description	Diagnostic features					General Characteristics
	Chemical Weathering-Discoloration and/or oxidation		Mechanical Weathering-Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Texture and Solutioning		
	Body of Rock	Fracture Surfaces		Texture	Solutioning	
Fresh	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change.	No solutioning.	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in-situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Combination descriptors (such as "slightly weathered to fresh") are permissible where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant, identifiable zones can be delineated. Only two adjacent descriptors may be combined. "Very intensely weathered" is the combination descriptor for "intensely weathered to decomposed."

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	RETAINING WALL 6
	PREPARED BY: I.G-REMMEN, 7/09		DESIGN BRANCH	POST MILE 9.0	LOG OF TEST BORINGS 4 OF 4
OR LOG ROCK LEGEND	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04 EA [6373]	DRAWING PRINTS DRAWING ELEVATION DATUM →	REVISION DATES 07-15-09	SHEET OF

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State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. ROUPEN DONIKIAN
Parson Brinkerhoff

Date: August 18, 2009

Attention: Larry Johnson

File: 04-SF-101-KP 13.4/15.1
(PM 8.3/9.4)
04-163741
Doyle Drive Replacement
Retaining Wall No 8

From: TUNG NGUYEN
Transportation Engineer
Office of Geotechnical Design – West
Geotechnical Services
Division of Engineering Services

MAHMOOD MOMENZADEH
Chief, Branch C
Office of Geotechnical Design-West
Geotechnical Services
Division of Engineering Services

Subject: Foundation Report for RW 8 (Revision)

INTRODUCTION

This Foundation Report (FR) provides geotechnical recommendations for Retaining Wall 8 (RW 8) of Contract No 4, Doyle Drive Replacement Project. The overall project proposes to replace existing Doyle Drive from Marina Boulevard and Lombard Streets to the southern approach of the Golden Gate Bridge on State Route (SR) 101 from Post Mile (PM) 8.3 to PM 9.4 (KP 13.4 to KP 15.1).

This FR documents site geology and subsurface conditions, provides analyses of site conditions as they pertain to the project and recommends geotechnical input for the foundation design.

To accomplish the above stated purpose, the following works were conducted:

- Field reconnaissance to observe and document site conditions
- Review geology open file
- Site subsurface investigation
- Engineering analyses for foundation design

PROJECT LOCATION

RW 8 is located on the southbound SR 101 between the southbound Main Post Tunnel (34-0163L) and the southbound Battery Tunnel (34-0161L). According to Structure Plans of May 31, 2009, RW 8 begins at Station SB 65+00.000 (or Station 65+00.00 LOL) and ends at Station SB 76+18.22 (or Station 76+64.29 LOL) with offsets varying from 56.00 to 64.25 ft on the left side of SB to support a cut into the existing bluff. The maximum height of the permanent wall is about 37 ft. However, the wall height between Stations 75+75.00 to 76+64.29 LOL will be increased temporarily by 8 ft to accommodate the temporarily additional cut below the proposed grade for Battery Tunnel construction. Furthermore, the latest structure plans of August 2009 showed that RW 8 ends at Station SB 76+26.81 (or Station 76+74.09 LOL). Building 106 located about 18 ft behind the wall layout line at the approximate Station SB ±65+80 shall not be impacted during RW 8 construction at the request of the Presidio Trust. In addition, a utility ductbank and a 36-inch drainage pipe are proposed crossing the RW 8 at approximate Stations RW8 LOL 66+83 and RW8 LOL 70+60, respectively.

REGIONAL GEOLOGY

The project site location falls in the Coast Range geomorphic province, which is characterized by a series of nearly parallel mountain ranges that trend obliquely to the coast in a northwesterly direction. This trend in direction is emphasized by the alignment of the fault zone, the fold axes and geologic units.

The San Francisco Bay area has long record of seismic activity. The entire project area has also been strongly influenced by changes related to the Pleistocene glaciers and the presence of the San Francisco Bay trough, resulting in variable thickness of recent deposits of soft to medium stiff Holocene clays (Bay Mud), an older stiffer Pleistocene clay (Old Bay Mud) and sand deposits.

SITE SPECIFIC GEOLOGIC CONDITIONS

The varying topography within the project site is the result of a diverse range of geologic conditions. At the west end, bedrock of the Franciscan Formation is underlain Colma Formation at a depth of 44.5 ft below the existing ground surface. The bedrock dips steeply to the east and it was not encountered at the 150 ft deep boring drilled at the east end. The Franciscan Formation consists of intensely weathered and sheared assemblage

of Sandstone, Serpentinite, and Shale. The overburden soils are made up of fill, sandy silt and clay, and the Colma Formation, which is medium dense to very dense, unconsolidated fine to medium-grained sand unit with clay beds.

The specific subsurface conditions at each of proposed structure locations are discussed in the following section.

SUBSURFACE INVESTIGATION

The Office of Geotechnical Design-West and ARUP conducted a subsurface investigation consisted of 9 mud rotary borings from November 2007 to June 2008. The following table lists borings and their locations including Northing and Easting coordinates, and elevations used for RW 8:

Table No 1. List of Borings

Boring	Northing	Easting	Elevation (ft)	Depth (ft)	Segment No
MPTSB-R1	2120587.017	5996204.009	+16.609	59.0	1
RW8-R5-PZ	2120487.547	5995958.508	+42.437	147.5	
RW8-HZ	2120503.166	5995837.187	+24.145	39.0	
RW8-R4-PZ	2120309.559	5995559.224	+61.569	101.5	2
RW8-R3	2120250.149	5995361.004	+72.094	91.5	3
RW8-R2	2120192.938	5995167.458	+82.348	80.0	
RW8-R1A-PZ	2120200.018	5995013.992	+90.063	46.5	
RW8-R1-PZ	2120199.669	5995008.466	+90.616	130.0	
BTSB-R2	2120218.262	5994858.344	+92.121	115.0	

The mud rotary borings were advanced using a self-casing wireline drilling method to depths shown on the above table. Borings were drilled by using CME-750, Failing 1500, Fraste Multi-Drill, and Mobile B53 drill rigs with an automatic hammer to perform in-situ Standard Penetration Tests (SPT) at 5 ft intervals. The SPT involve the driving of a hollow thick-walled tube into the ground by 140 lbs automatic hammer with 30-inch drop, measuring number of blows N to achieve three successive increments 6 inch each. The N of the last two increments is counted as blow count per foot. Soil/rock sampling was achieved by using a split spoon sampler, Modified California sampler, Shelby tube, and

continuous rock coring. Selected soil/rock samples were collected and submitted for laboratory testing.

Suspension P-S velocity loggings were conducted at borings BTSB-R2, RW8-R1-PZ, and RW8-R5-PZ by GEOVision Inc. of Corona, California to obtain information about the stiffness characteristics of the soil and rock adjacent to retaining walls. Location and Log of Test Borings (LOTB) are shown in the Appendix A, except for boring RW8-R1A-PZ. This boring was drilled next to the boring RW8-R1-PZ to install piezometer due to the abandonment of boring RW8-R1-PZ.

Piezometers were also installed at borings RW8-R4-PZ and RW8-R5-PZ to periodically monitor groundwater levels. Current groundwater level data are presented in Appendix B.

LABORATORY TESTS

Soil and rock samples taken from exploration borings were tested for moisture content, grain size, Atterberg limits, undrained shear strength, and corrositivity. Laboratory test data are included in the Appendix B.

SUBSURFACE CONDITIONS

The subsurface conditions described herein are based on the information from subsurface investigations performed for RW 8, Battery Tunnel, and Main Post Tunnel of this project and review of pertinent available reports. For simplicity, the soil/rock and groundwater conditions described in this report have been subdivided into three segments based on structure locations and site geologic similarity.

Segment 1, Stations 65+00 LOL to 68+00.00 LOL:

The surficial soil is about 4 ft very loose fill of clayey sand with gravel. Below fill is 3 ft very loose sandy silt underlain by approximate 17 ft dense silty sand, sand with silt, and sand. From a depth of about 24 ft to 32 ft is medium dense silty, clayey sand underlain by dense to very dense clayey sand, silty sand, sand with clay and silt, silt with sand and gravel to the maximum depth of exploration. Stiff to hard clay layers were encountered in boring RW8-R5-PZ from a depth of about 107 to 127 ft. The measured shear wave velocity of medium dense to very dense sand and stiff to hard clay varies from 700 to

1600 ft/sec. The soil profile and the interpreted engineering properties used for design of this wall segment are shown below:

Depth, ft		Total Unit Weight, pcf	Friction Angle ϕ, degree
From	To		
0	7	110	28
7	24	130	35
24	32	125	32
Below 32'		135	40

Groundwater level was recorded at about 28 ft below the ground surface at boring RW8-R5-PZ on 06/11/08. The groundwater level is subject to fluctuations.

Segment 2, Stations 68+00 LOL to 71+70.00 LOL:

Below the existing ground surface is about 20 ft of medium dense clayey, silty sand underlain by very dense clayey sand with a medium dense clayey sand sublayer. The soil profile and the interpreted engineering properties used for design of this wall segment are shown below:

Depth, ft		Total Unit Weight, pcf	Friction Angle ϕ, degree
From	To		
0	10	120	30
10	20	125	32
20	29	130	35
29	49	135	40
49	54	125	32
54	67	135	38

Groundwater level was recorded at about 45.9 ft below the ground surface at boring RW8-R4-PZ on 07/18/2008. The groundwater level is subject to fluctuations.

Segment 3, Stations 71+70 LOL to 76+74.09 LOL:

The surficial soil is about 7 ft very loose to loose fill of silty sand, sand with silt. Below fill is 4 ft loose poorly graded sand underlain by approximate 12 ft very soft to very stiff sandy lean clay, silty clay, and lean clay. Below these layers are dense to very dense

clayey sand. At boring RW8-R1-PZ, sandstone and serpentine overlain by 5.5 ft stiff to very stiff lean clay were encountered at a depth of 47 to the maximum of exploration. At boring, RW8-R2, shale was encountered at a depth of 65 ft. The measured shear wave velocity of medium dense to very dense sandy, stiff to very stiff clayey materials varies from 700 to 1800 ft/sec. The measured shear wave velocity of sandstone and serpentine varies from 1200 to 4900 ft/sec. The soil profile and the interpreted engineering properties used for design of this wall segment are shown below:

Depth, ft		Total Unit Weight, pcf	Friction Angle ϕ, degree	Cohesion, psf
From	To			
0	11	110	28	0
11	17	110	0	300
17	23	130	0	1500
Below 23'		130	35	0

Groundwater level was recorded about 38.7 ft below the ground surface at boring RW8-R1A-PZ on 07/18/2008. The groundwater level is subject to fluctuations.

SCOUR EVALUATION

Scour is not a concern for this portion of the Doyle Drive Replacement project.

CORROSION EVALUATION

The following table summarizes laboratory data of corrosion tests on soil samples taken from borings:

Table No 2. Soil Corrosion Test Summary

Location	Depth (ft)	Minimum Resistivity (Ohm-Cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
RW8-R3	5-10	3,800	8.2	16	51
RW8-R3	20-25	3,648	7.5	-	-
RW8-R4-PZ	5-10	2,500	6.7	25	51
RW8-R4-PZ	15-20	3,317	8.2	-	-
RW8-R4-PZ	35-40	3,806	8.0	-	-
BTSB-R2	22.8-24.0	5,500	7.2	-	15

Based on the results of corrosion analyses and Caltrans criteria of 2003, soils are non-corrosive. However, due to site proximity to the San Francisco Bay and the past existence of a tidal marsh, the retaining wall should be designed for corrosive environment.

SEISMIC STUDY

Seismic studies were performed by Norm A. Abrahamson, Inc. and AMEC Geomatrix to provide rock design ground motions and site response analysis.

The rock design ground motions were developed for two levels: the Safety Evaluation Earthquake (SEE) with a 1000-year return period and the Functional Evaluation Earthquake (FEE) with a 50% chance of being exceeded in 75 years (108-year return period) as shown in the Ground Motions for the Doyle Drive Project Report of December 2008. For each level, two rock shear wave velocities (V_{s30}) of 3000 and 5000 ft/sec were used to develop rock motion spectra.

The site response analyses were conducted for three structures along the project alignment: Main Post Tunnels, RW 8, and Battery Tunnels based on that two rock design ground motions as shown in the Site Response Analysis Report of May 2009.

For RW 8, two profiles were developed using shear wave velocity from borings RW8-R1-PZ and RW8-R5-PZ. The maximum accelerations were computed for SEE level with V_{S30} = 3000 ft/sec varying from 1.0 to 1.2g for this wall, or A = 1.1g in average. Therefore, a horizontal seismic coefficient K_h of 0.55 (50% of spectral acceleration as per AASHTO recommendation) corresponding with K_v of 0.15 is used to determine the seismic earth pressures for the proposed wall, except for the wall portions to accommodate crossing utility ductbank and drainage pipe, we recommend to excavate and replace natural soils to a depth of about 25 ft below the existing ground surface with structure backfill. At these locations, K_h of 0.275 and K_v of 0.15 are used for seismic earth pressure evaluation based on A = 0.55g at 28 ft below the ground surface.

The liquefaction potential at the RW 8 site is very low.

FOUNDATION RECOMMENDATIONS

Segment 1

The wall construction as well as wall performance should not impact the existing buildings, especially, historic building 106. Therefore, tangent pile wall is recommended for this segment, except for the section B crossed by utility ductbank at the Station RW8 LOL 66+83, where a retaining wall type 1 supported by Cast in Drilled Hole (CIDH) piles is used.

We recommend tangent pile retaining wall designed using loadings of Table No 3 in the form of equivalent fluid pressure.

Table No 3. Earth Pressures for RW 8-Segment 1, Tangent Pile Wall Section

Stage	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Earth Pressure (pcf)
Construction	33.3	433	-
Final	33.3	433	94

Static components of the soil force act at 1/3 height, while the additional seismic force acts at 0.6 height. For the above passive pressure, a safety factor of 1.5 should be used to compute the allowable passive lateral pressure.

Based on our analyses and CT-Flex program, the 20-foot high tangent pile wall should be supported by 30-inch diameter, 51-ft long piles (a minimum of 31-foot embedment). The computed deflections at the top of the wall are 1.75 inch and 0.54 inch under seismic and static conditions, respectively. Please refer to Figures 1 through 3 for the results of CT-Flex program.

At the utility ductbank location (Section B), we recommend the retaining wall designed using loadings of Table No 4 in the form of equivalent fluid pressure.

Table No 4. Earth Pressures for RW 8-Segment 1, Retaining Wall Type 1 Section

Stage	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Active Earth Pressure P_{AE} (pcf)
Construction	33.3	433	-
Final	33.3	433	60

We recommend 30-inch diameter, 30-foot long CIDH piles to support this wall section to meet the axial and lateral loads provided to us by Structure Design as shown in Tables No 5 through 8. Note that the computed deflections at the top of the pile are 0.14 inch and 0.09 inch under seismic and static lateral loading conditions, respectively. Please refer to Figures 4 through 9 for pile lateral analysis. Furthermore, structure backfill shall be placed 5 ft behind the footing on the retaining side.

Table No 5. General Foundation Information Provided by Structure Designer

Support Location	Pile Type	Original Ground Elevation (ft)	Pile Cut-off Elevation (ft)	Permissible Settlement Under Service Load
Section B Cantilever Retaining Wall 8	30-inch CIDH	-	+17.5	-

Table No 6. Foundation Design Loads Provided by Structure Designer

Support Location	**Service 1 Limit State (kips)**			**Strength Limit State (Controlling Group, kips)**				**Extreme Event Limit State (Controlling Group, kips)**			
	Total Loads		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max Per Pile	Per Support	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile
Section B Cantilever Retaining Wall 8	1407	188	1334	1794	262	0	0	1334	264	0	0

Lateral Loads per Pile: 41 kips (Service) and 62 kips (Extreme Event)

Foundation Design Recommendations for Section B location are provided in the following two tables. Nominal Resistance is provided by side resistance only.

Table No 7. Foundation Design Recommendations for Section B, Cantilever Retaining Wall 8

Support Location	Pile Type And size	Cut-Off Elevation (ft)	Service-I Limit State Load per Support (kips)	Total Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Pile Tip Elevation (ft)	Specified Pile Tip Elevation (ft)
					Strength Limit		Extreme Event			
					Comp. (φ=0.7)	Tension (φ=0.7)	Comp. (φ=1)	Tension (φ=1)		
Section B Cantilever Retaining Wall 8	30-inch CIDH with	+17.5	1407	0.5	262	0	264	0	-0.5 (a) -12.5 (b) -5.5 (c) -12.5(d)	-12.5

Notes:

1) *The design tip elevations are controlled by (a) Settlement, (b) Compression (Strength Limit), (c) Compression (Extreme Event), (d) Lateral Loads.*
2) *The design tip elevation is controlled by: (b) Compression (Strength Limit) and (d) Lateral Loads.*

Table No 8. Pile Data Table

Location	Pile Type and Size	Nominal Resistance		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression (kips)	Tension (kips)		
Section B Cantilever Retaining Wall 8	30 inch CIDH	380	0	-12.5 (b,d)	-12.5

Global stability is not an issue for these retaining walls.

Segment 2

Tangent pile wall is recommended for this segment, except for the section C crossed by a 36-inch drainage pipe at Station RW8 LOL 70+60, where a retaining wall type 1 supported by CIDH piles is used.

The tangent pile retaining wall should be designed with the following loading as provided of Table No 9 in the form of equivalent fluid pressure.

Table No 9. Earth Pressures for RW 8-Segment 2, Tangent Pile Wall Section

Stage	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Earth Pressure (pcf)
Construction	38.0	379	-
Final	38.0	379	91

Static components of the soil force act at 1/3 height, while the additional seismic force acts at 0.6 height. For the above passive pressure, a safety factor of 1.5 should be used to compute the allowable passive lateral pressure.

Based on our analyses and CT-Flex program, the 10-foot and 20-foot high tangent pile walls should be supported by 30-inch piles with the lengths of 27 ft (a minimum of 17-foot embedment) and 51 ft (a minimum of 31-foot embedment), respectively. The deflections computed at the top of a 20-foot high wall are 1.75 inch and 0.58 inch under seismic and static conditions, respectively. Under these conditions, the deflections for a 10-foot high wall are less than 0.1 inch. Please refer to Figures 10 through 14 for the results of CT-Flex program.

At the proposed 36-inch drainage pipe location (Section C), we recommend the retaining wall designed using loadings of Table No 10 in the form of equivalent fluid pressure.

Table No 10. Earth Pressures for RW 8-Segment 2, Retaining Wall Type 1 Section

Stage	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Active Earth Pressure P_{AE} (pcf)
Construction	38.0	379	-
Final	33.3	433	60

We recommend 30-inch diameter, 35-foot long CIDH piles to support this wall section to meet the axial and lateral loads provided to us by Structure Design as shown in Tables No 11 through 14. Note that the computed deflections at the top of the pile are 0.15 inch and 0.09 inch under seismic and static lateral loading conditions, respectively. Please refer to Figures 15 through 20 for pile lateral analysis. Furthermore, structure backfill shall be placed 5 ft behind the footing on the retaining side.

Table No. 11. General Foundation Information Provided by Structure Designer

Support Location	Pile Type	Original Ground Elevation (ft)	Pile Cut-off Elevation (ft)	Permissible Settlement Under Service Load
Section C Cantilever Retaining Wall 8	30-inch CIDH	-	+32.5	-

Table No 12. Foundation Design Loads Provided by Structure Designer

Support Location	**Service 1 Limit State (kips)**			**Strength Limit State (Controlling Group, kips)**				**Extreme Event Limit State (Controlling Group, kips)**			
	Total Loads		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max Per Pile	Per Support	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile
Section C Cantilever Retaining Wall 8	1425	200	1350	1825	280	0	0	1700	325	0	0

Lateral Loads per Pile: 45 kips (Service) and 69 kips (Extreme Event)

Foundation Design Recommendations for the Section C location are provided in the following two tables. Nominal Resistance is provided by side resistance only.

Table No 13. Foundation Design Recommendations for Section C, Cantilever Retaining Wall 8

Support Location	Pile Type And size	Cut-Off Elevation (ft)	Service-I Limit State Load per Support (kips)	Total Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Pile Tip Elevation (ft)	Specified Pile Tip Elevation (ft)
					Strength Limit		Extreme Event			
					Comp. (φ=0.7)	Tension (φ=0.7)	Comp. (φ=1)	Tension (φ=1)		
Section C Cantilever Retaining Wall 8	30-inch CIDH with	+32.5	1425	0.5	280	0	325	0	+12.0 (a) -2.5 (b) +3.0 (c) +5.5(d)	-2.5

Notes:

1) *The design tip elevations are controlled by (a) Settlement, (b) Compression (Strength Limit), (c) Compression (Extreme Event), (d) Lateral Loads.*
2) *The design tip elevation is controlled by: (b) Compression (Strength Limit).*

Table No 14. Pile Data Table

Location	Pile Type and Size	Nominal Resistance		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression (kips)	Tension (kips)		
Section C Cantilever Retaining Wall 8	30 inch CIDH	400	0	-2.5 (b)	-2.5

Global stability is not an issue for these retaining walls.

In the transition zone between Segments 2 and 3, a section D cantilever retaining wall is proposed between Stations RW8 LOL 71+43.71 and 71+98.09. Standard retaining wall type I supporting by CIDH piles is used. We recommend the retaining wall designed using loadings of Table No 15 in the form of equivalent fluid pressure.

Table No 15. Earth Pressures for RW 8-Segment 2/3, Retaining Wall Type 1 Section

Stage	Active Earth Pressure (pcf)	Passive Earth Pressure (pcf)	Seismic Active Earth Pressure P_{AE} (pcf)
Construction	38.0	379	-
Final	33.3	433	60

We recommend 30-inch diameter, 35-foot long CIDH piles to support this wall section to meet the axial and lateral loads provided to us by Structure Design as shown in Tables No 16 through 19. Note that the computed deflections at the top of the pile are 0.16 inch and 0.08 inch under seismic and static lateral loading conditions, respectively. Please refer to Figures 21 through 26 for pile lateral analysis. Furthermore, structure backfill shall be placed 5 ft behind the footing on the retaining side.

Table No 16. General Foundation Information Provided by Structure Designer

Support Location	Pile Type	Original Ground Elevation (ft)	Pile Cut-off Elevation (ft)	Permissible Settlement Under Service Load
Subsection D1 Cantilever Retaining Wall 8	30-inch CIDH	-	+35.5	-
Subsection D2 Cantilever Retaining Wall 8	30-inch CIDH	-	+36.5	-

Table No 17. Foundation Design Loads Provided by Structure Designer

Support Location	Service 1 Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Loads		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max Per Pile	Per Support	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile
Subsection D1 Cantilever Retaining Wall 8	3490	195	3330	4400	270	0	0	3330	290	0	0
Subsection D2 Cantilever Retaining Wall 8	3490	195	3330	4400	270	0	0	3330	290	0	0

Lateral Loads per Pile: 47 kips (Service) and 74 kips (Extreme Event)

Foundation Design Recommendations for the Section D location are provided in the following two tables. Nominal Resistance is provided by side resistance only.

Table No 18. Foundation Design Recommendations for Section D, Cantilever Retaining Wall 8

Support Location	Pile Type And size	Cut-Off Elevation (ft)	Service-I Limit State Load per Support (kips)	Total Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Pile Tip Elevation (ft)	Specified Pile Tip Elevation (ft)
					Strength Limit		Extreme Event			
					Comp. (φ=0.7)	Tension (φ=0.7)	Comp. (φ=1)	Tension (φ=1)		
Subsection D1 Cantilever Retaining Wall 8	30-inch CIDH with	+35.5	3490	0.5	270	0	290	0	+15.0 (a) +0.5 (b) +8.5 (c) +8.5(d)	+0.5
Subsection D2 Cantilever Retaining Wall 8	30-inch CIDH with	+36.5	3490	0.5	270	0	290	0	+16.0 (a) +1.5 (b) +9.5 (c) +9.5(d)	+1.5

Notes:

3) The design tip elevations are controlled by (a) Settlement, (b) Compression (Strength Limit), (c) Compression (Extreme Event), (d) Lateral Loads.

4) The design tip elevation is controlled by: (b) Compression (Strength Limit).

Table No 19. Pile Data Table

Location	Pile Type and Size	Nominal Resistance		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
		Compression (kips)	Tension (kips)		
Subsection D1 Cantilever Retaining Wall 8	30 inch CIDH	385	0	+0.5 (b)	+0.5
Subsection D2 Cantilever Retaining Wall 8	30 inch CIDH	385	0	+1.5 (b)	+1.5

Segment 3

Tangent pile wall with multiple levels of tiebacks is recommended for this segment with the following design loads as provided in Table No 20 for 35-foot high wall.

Table No 20. Earth Pressures for RW 8, Tangent Pile Wall with Multiple Levels of Tiebacks

Stage	Active Earth Pressure (psf)	Passive Earth Pressure (psf)	Seismic Earth Pressure* (psf)
Construction	796	5,298	-
Final	796	5,298	1,955

*Uniform Seismic Earth Pressure

For the above passive pressure, a safety factor of 1.5 should be used to compute the allowable passive lateral pressure.

Based on our analyses and CT-Flex program, the 35-foot high tangent pile wall with tiebacks should be supported by 46-foot long (a minimum of 11-foot embedment), 30-inch diameter piles. Four rows of tiebacks with 15-degree inclination, 8-foot vertical and horizontal spacing, and average load of 106 kips are required to support this wall. The first row of tiebacks is located at a depth of 6 ft from the existing ground surface. Due to the presence of very soft to stiff clay to the depth of 23 ft, the unbonded lengths of the first two rows should be extended beyond that zone. The following table summarizes the tieback data design:

Table No 21. Tieback Data for 35-foot High Wall

Tieback Row No	Load T (kips)	Unbonded Length (ft)
1	106	64
2	106	34
3	106	15
4	106	15

The above option requires tieback length of about 85 ft for the first row. If the available easement is not sufficient, we recommend 5 rows of tiebacks with 20-degree inclination, 3.5-foot and 7-foot horizontal spacings for the first row and subsequent rows, respectively, 6-foot to 7-foot vertical spacing to support the wall as an alternative design. The alternative tieback data design is shown in the Table No 22. Based on our analyses and CT-Flex program, this tangent pile wall with 5 rows of tieback should be supported by 44-foot long (a minimum of 9-foot embedment), 30-inch diameter piles. Please refer to Figures 27 through 32 for the results of CT-Flex program.

Table No 22. Alternative Tieback Data for 35-foot High Wall

Tieback Row No	Depth (ft)	Load T (kips)	Unbonded Length (ft)
1	7	45	47
2	13	90	30
3	19	90	15
4	25	90	15
5	32	90	15

The above alternative tieback design can be used for a 37-foot high tangent pile wall as shown in Figures 33 through 35 and Table No 23. The piles to support this wall shall be 50-foot long (a minimum of 13-foot embedment) and 30 inch in diameter.

Table No 23. Tieback Data for 37-foot High Wall

Tieback Row No	Depth (ft)	Load T (kips)	Unbonded Length (ft)
1	7	45	47
2	13	90	30
3	19	90	15
4	26	90	15
5	33	90	15

Furthermore, for a 45-foot high wall under temporary construction condition, an additional row of tieback is recommended as presented in Figures 36, 37, and Table No 24. Based on our analyses and CT-Flex program, this tangent pile wall with 6 rows of tieback should be supported by 62-foot long (a minimum of 17-foot embedment), 30-inch diameter piles.

Table No 24. Tieback Data for 45-foot High Wall

Tieback Row No	Depth (ft)	Load T (kips)	Unbonded Length (ft)
1	7	45	47
2	13	90	30
3	19	90	15
4	26	90	15
5	33	90	15
6	41	90	15

Global stability is not an issue for these retaining walls.

CONSTRUCTION CONSIDERATIONS

The maximum temporary cut slopes for construction of sections B and C are not steeper than 1.0:1.5.

Difficult tieback installation is anticipated due to the presence of caving and very dense soils, groundwater, and underground utilities.

Due to the presence of groundwater and loose sandy materials, the use of temporary steel casing shall be expected during the drilling holes to maintain the integrity of the piles. The bottom of the pier excavation should be free of debris and loose materials. Because of the potential caving and groundwater condition, wet method of CIDH construction shall be used to construct the proposed CIDH piles. Performance PVC monitoring tubes should be provided to allow for the construction quality of control by gamma-gamma logging. Construction of piles shall be made to minimize the effects on the existing structures. Difficult drilling conditions are anticipated due to the presence of caving soils, groundwater and very dense and very stiff materials.

The excavation should follow the Cal/OSHA excavation requirements.

A monitoring program should be conducted to minimize construction impact on adjacent buildings/facilities. This includes complete pre and post-survey of the buildings and

periodic monitoring of the facilities during the construction. The monitoring program should consist of the survey of fixed point on the building foundations and the structures.

The recommendations contained in this report are based on specific project information regarding structure type and location. If any conceptual changes are made during final project design, the Office of Geotechnical Design – West, Design Branch C should review those changes to determine if these foundation recommendations are still applicable. Any questions regarding the above recommendations should be directed to the attention of Tung Nguyen, 510-622-1775 or Mahmood Momenzadeh, 510-286-5732, at the Office of Geotechnical Design-West, Branch C.

c: TPokrywka, MMomenzadeh, TNguyen, Daily File, Route File, Translab File
John Mook, PCE-PPRM
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FIGURES

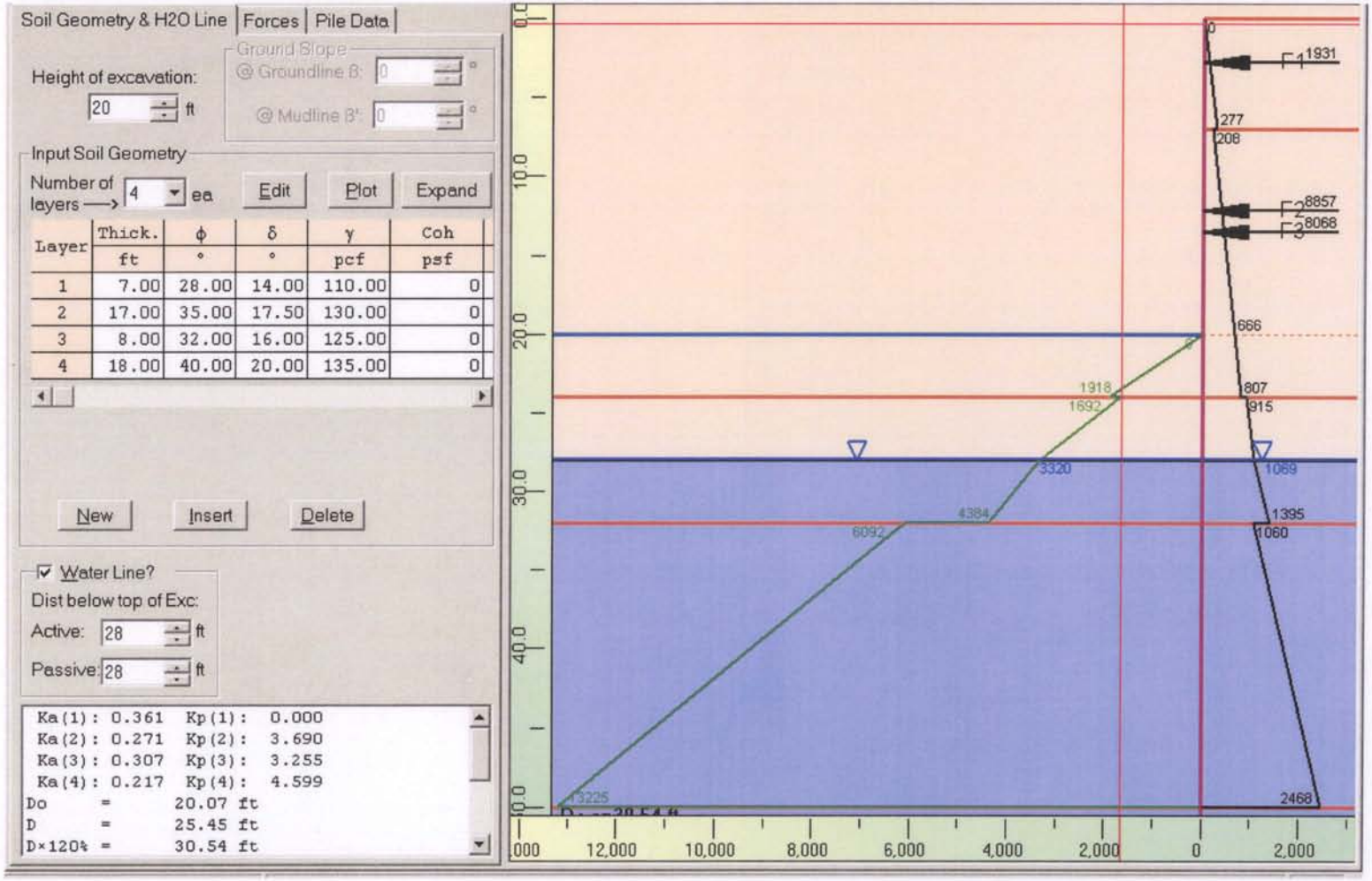


Figure 1: Pressure Diagrams, Segment 1 - RW 8 - Sta. 65+00 to 68+00 LOL

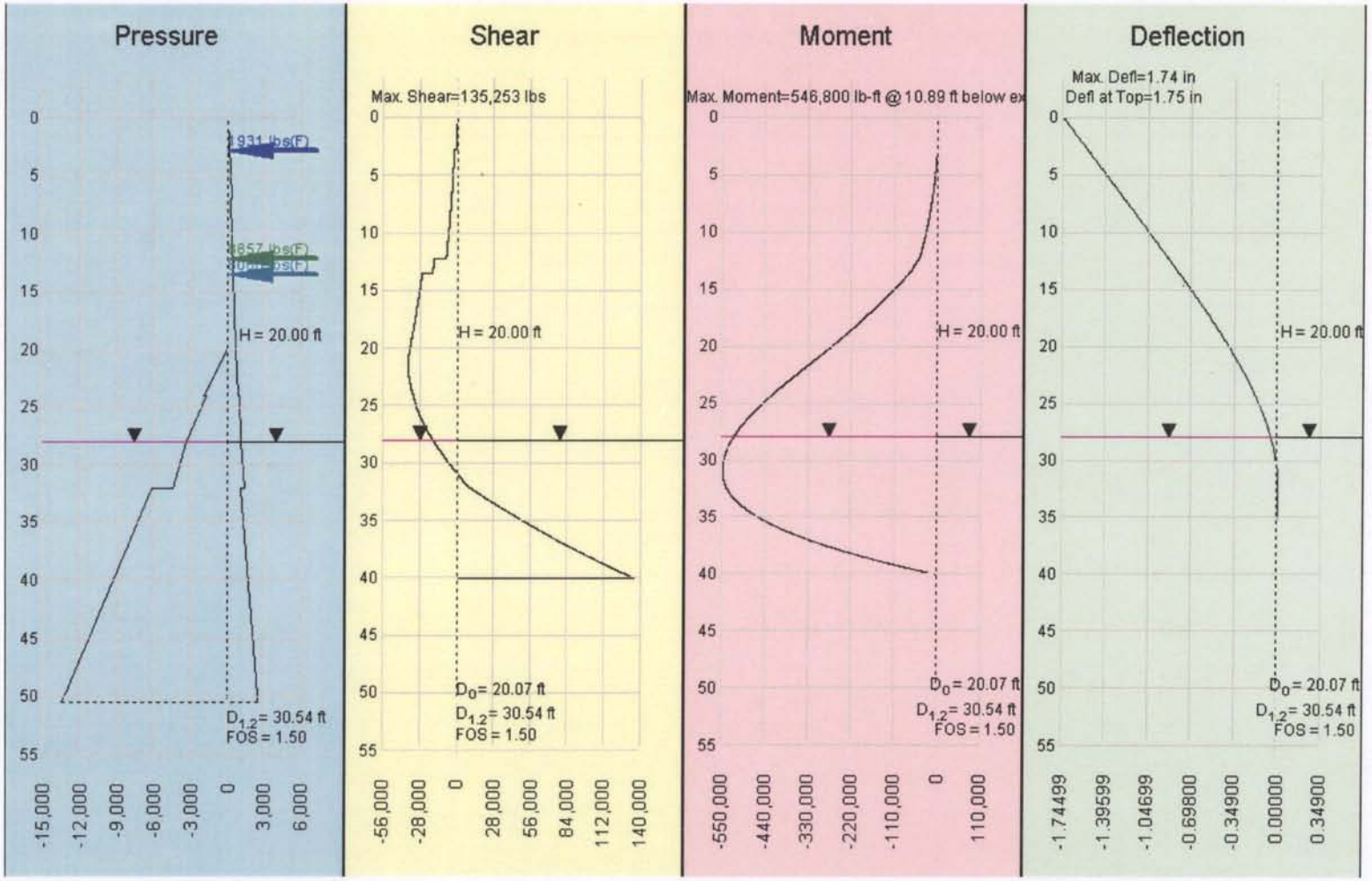


Figure 2: Seismic Analysis for Tangent Pile Wall, Segment 1 - RW 8 - Sta. 65+00 to 68+00 LOL (H = 20 ft)

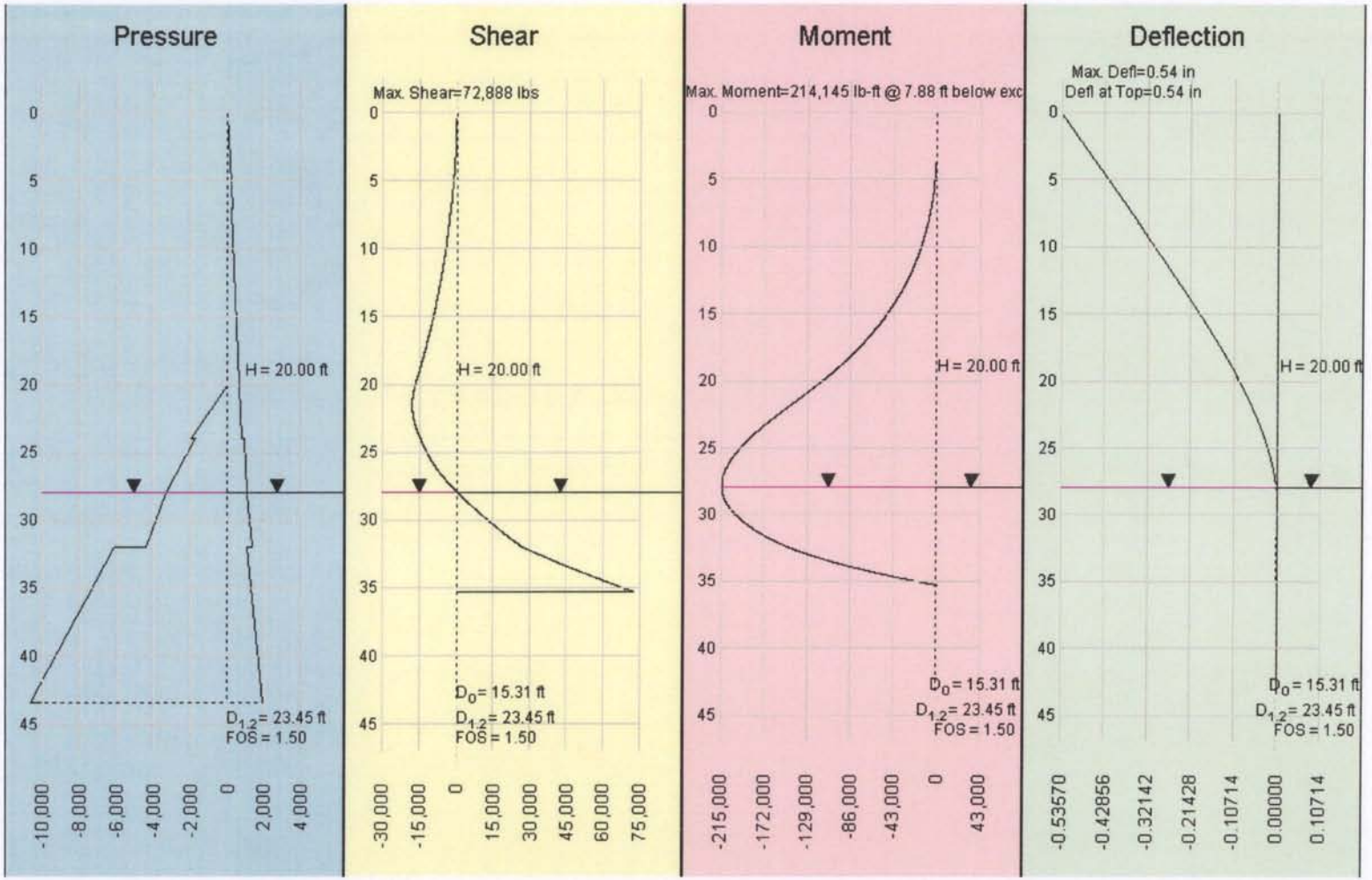


Figure 3: Static Analysis for Tangent Pile Wall, Segment 1 - RW 8 - Sta. 65+00 to 68+00 LOL (H = 20 ft)

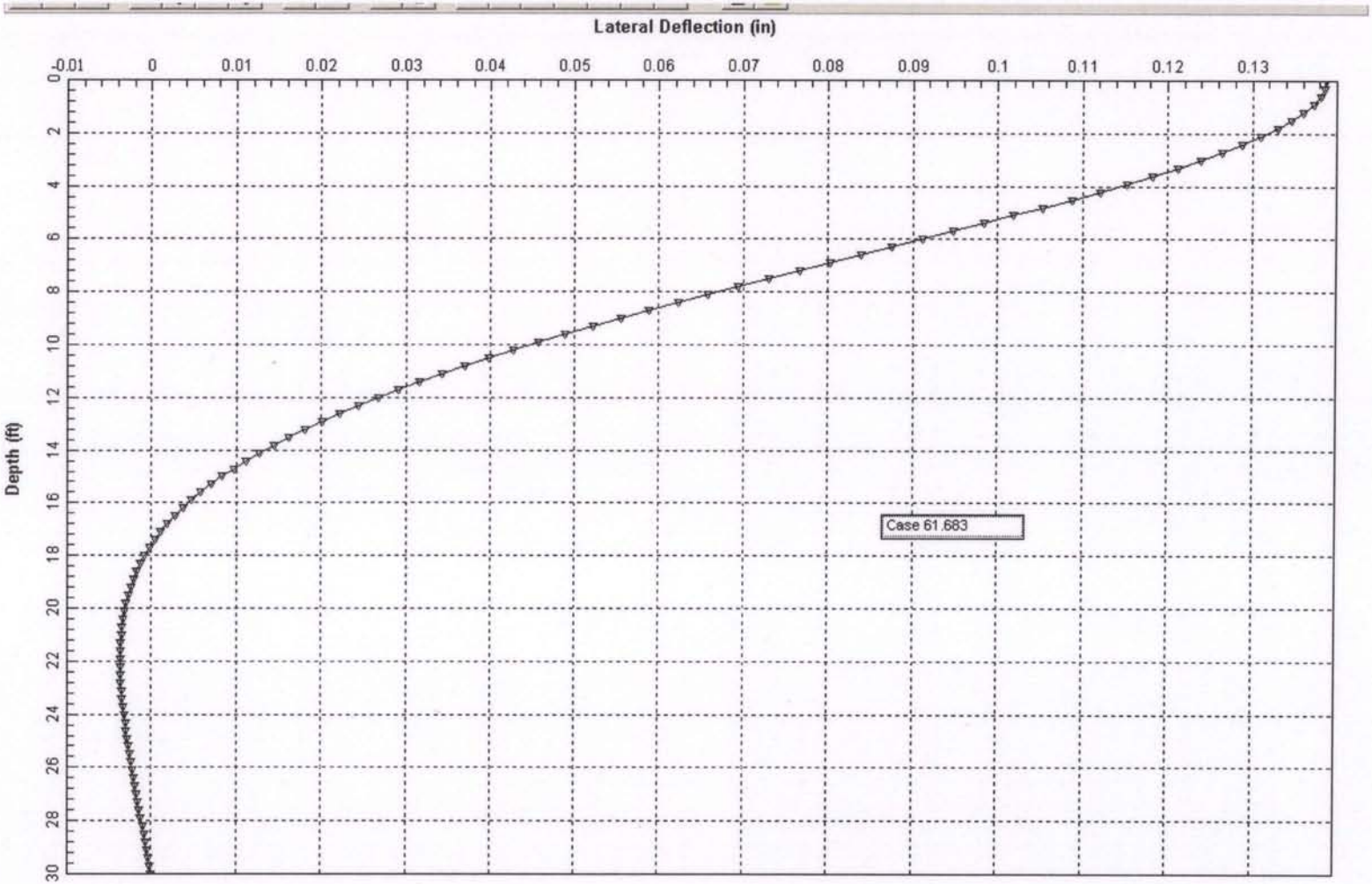


Figure 4: 30" CIDH Pile Deflection – Seismic Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

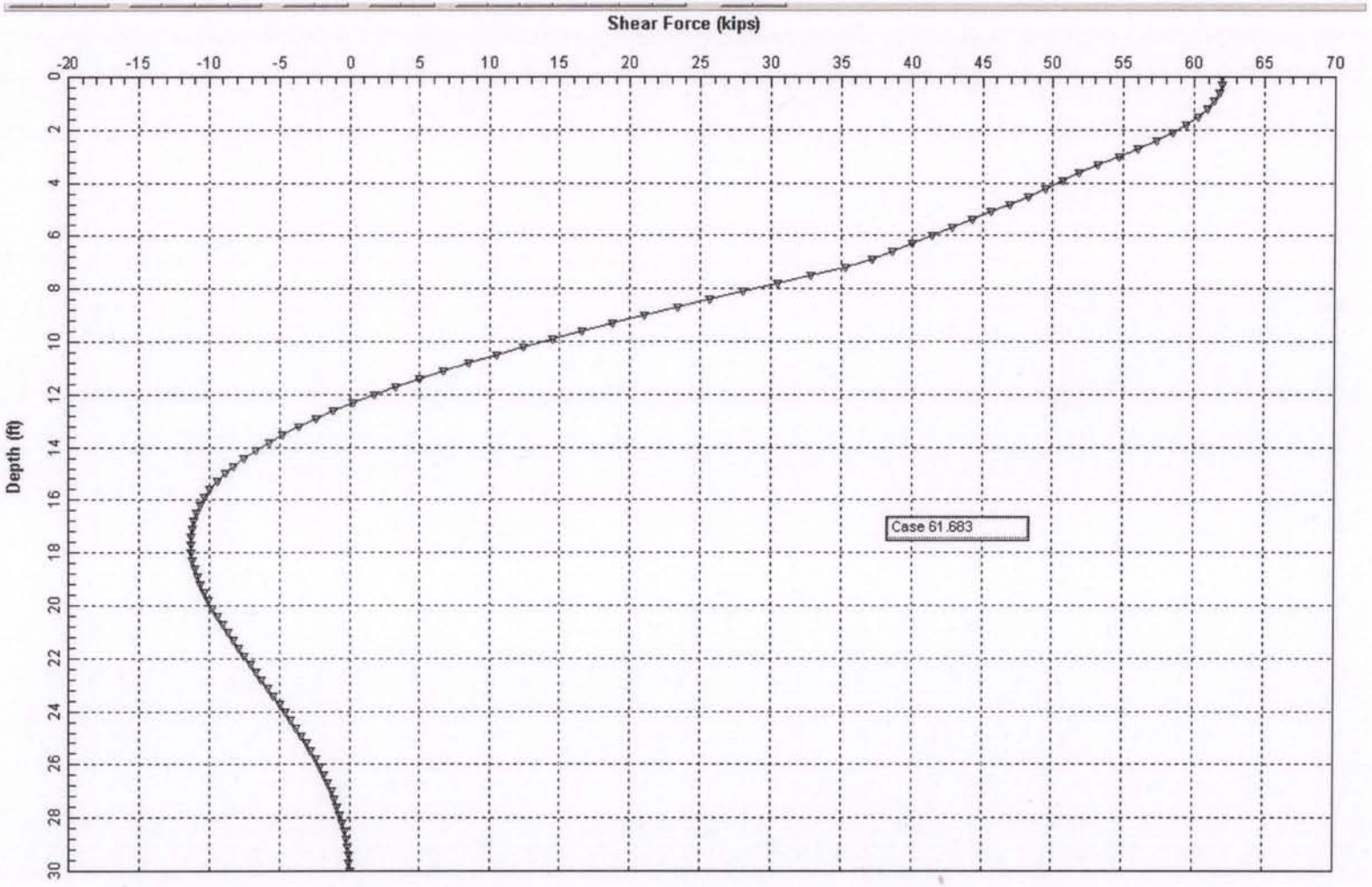


Figure 5: 30" CIDH Pile Shear Force – Seismic Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

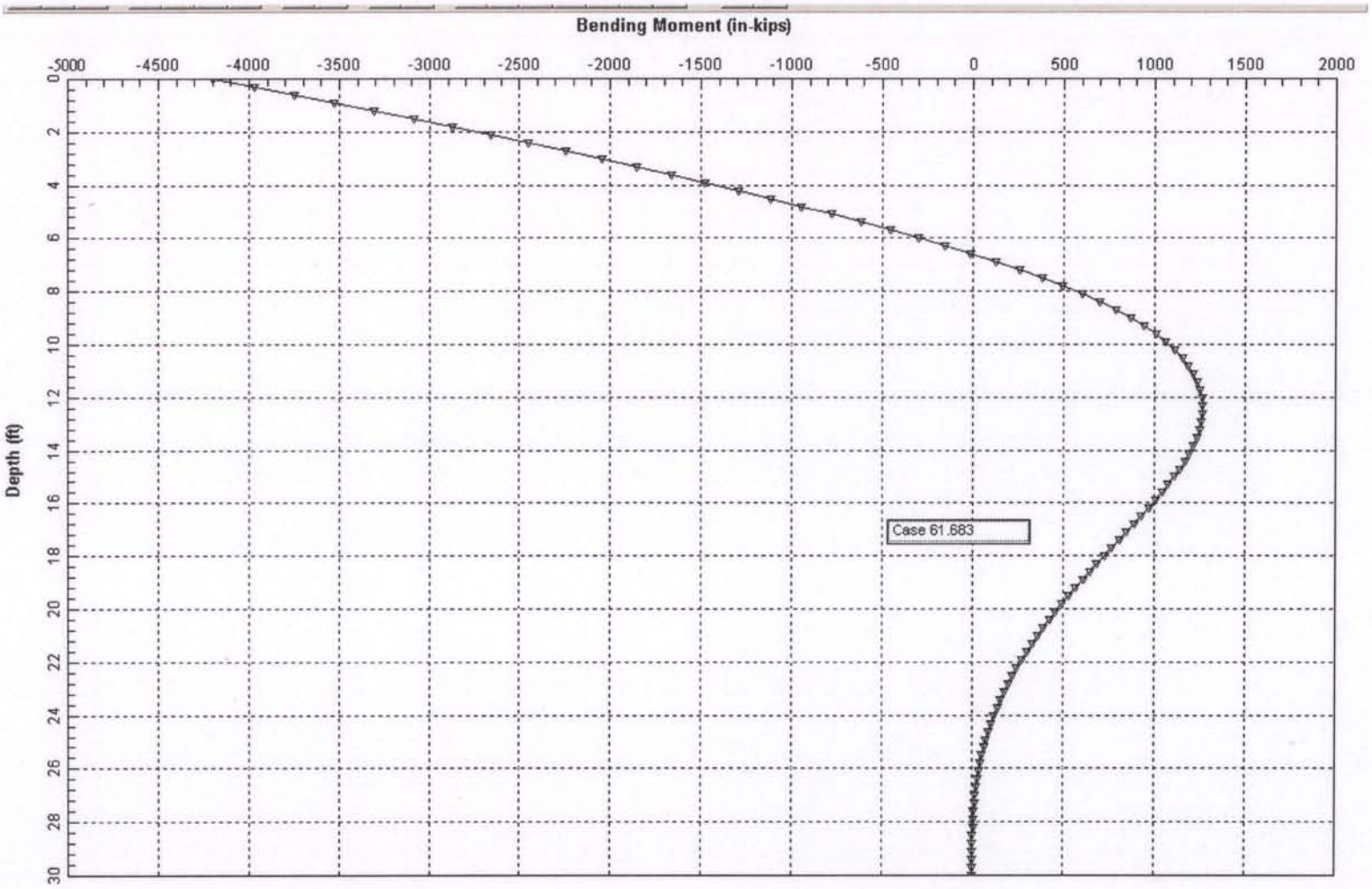


Figure 6: 30" CIDH Pile Bending Moment – Seismic Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

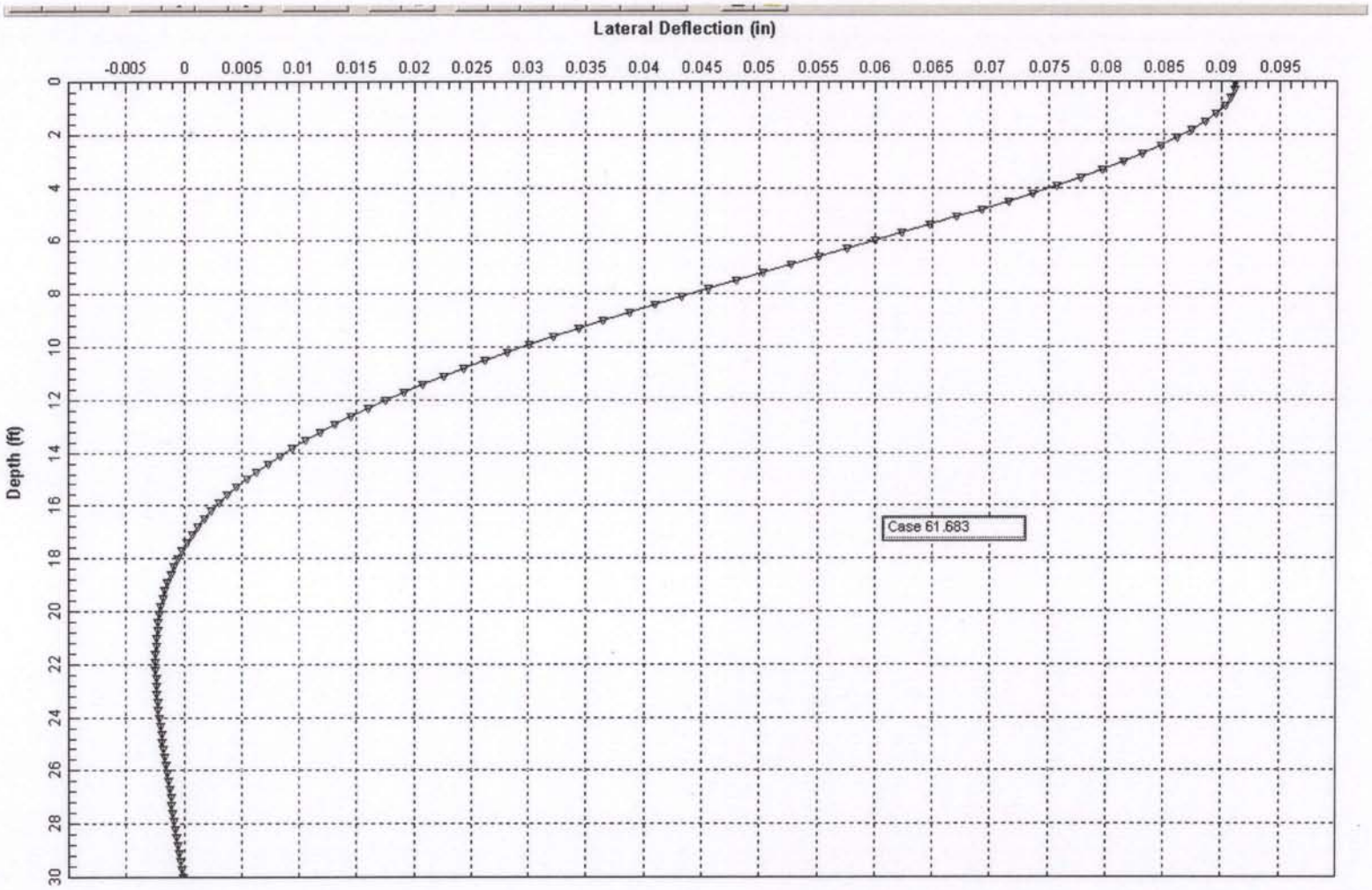


Figure 7: 30" CIDH Pile Deflection – Static Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

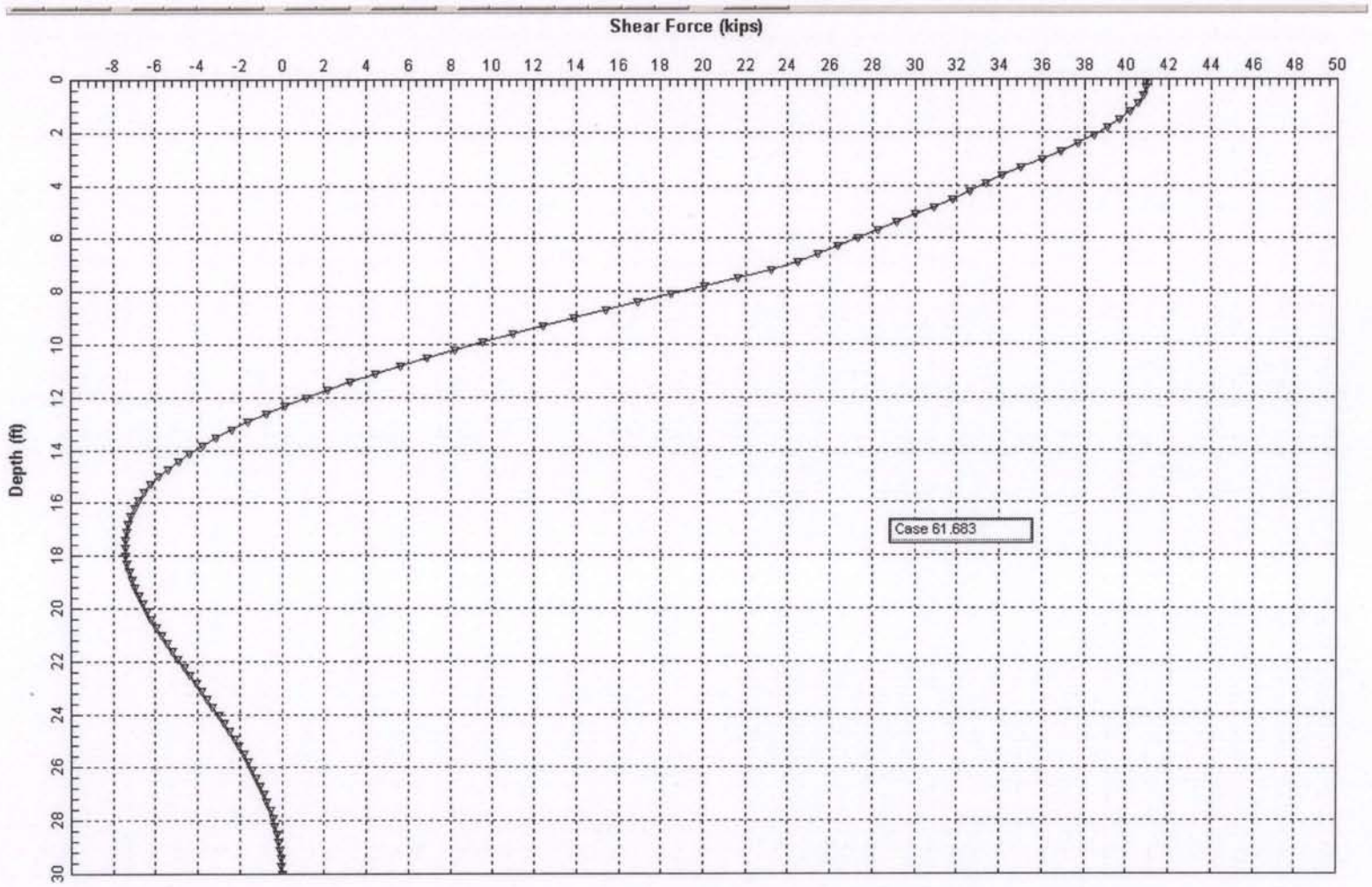


Figure 8: 30" CIDH Pile Shear Force – Static Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

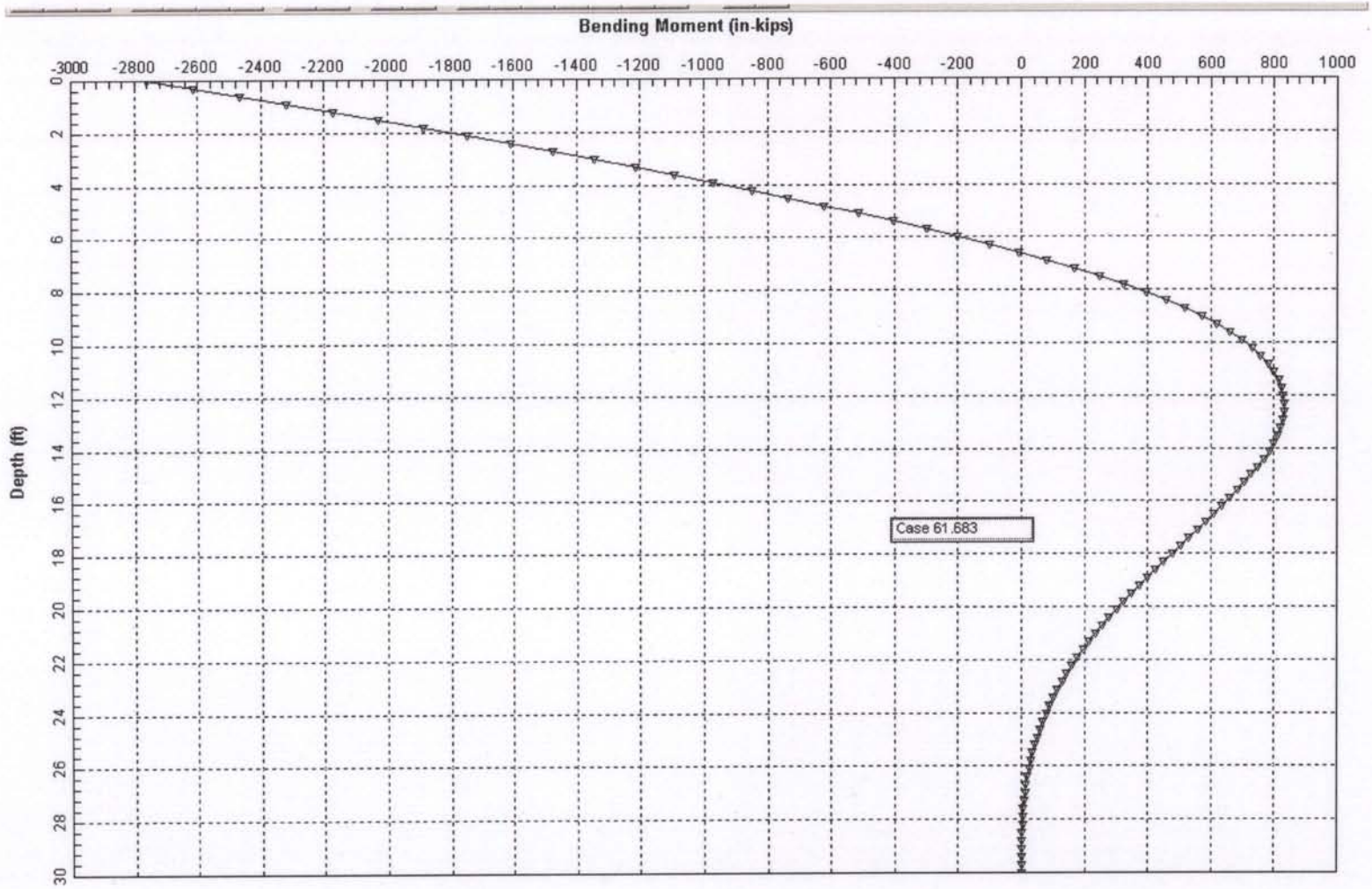


Figure 9: 30" CIDH Pile Bending Moment – Static Lateral Analysis, Section B – RW8 Sta. 66+83 LOL

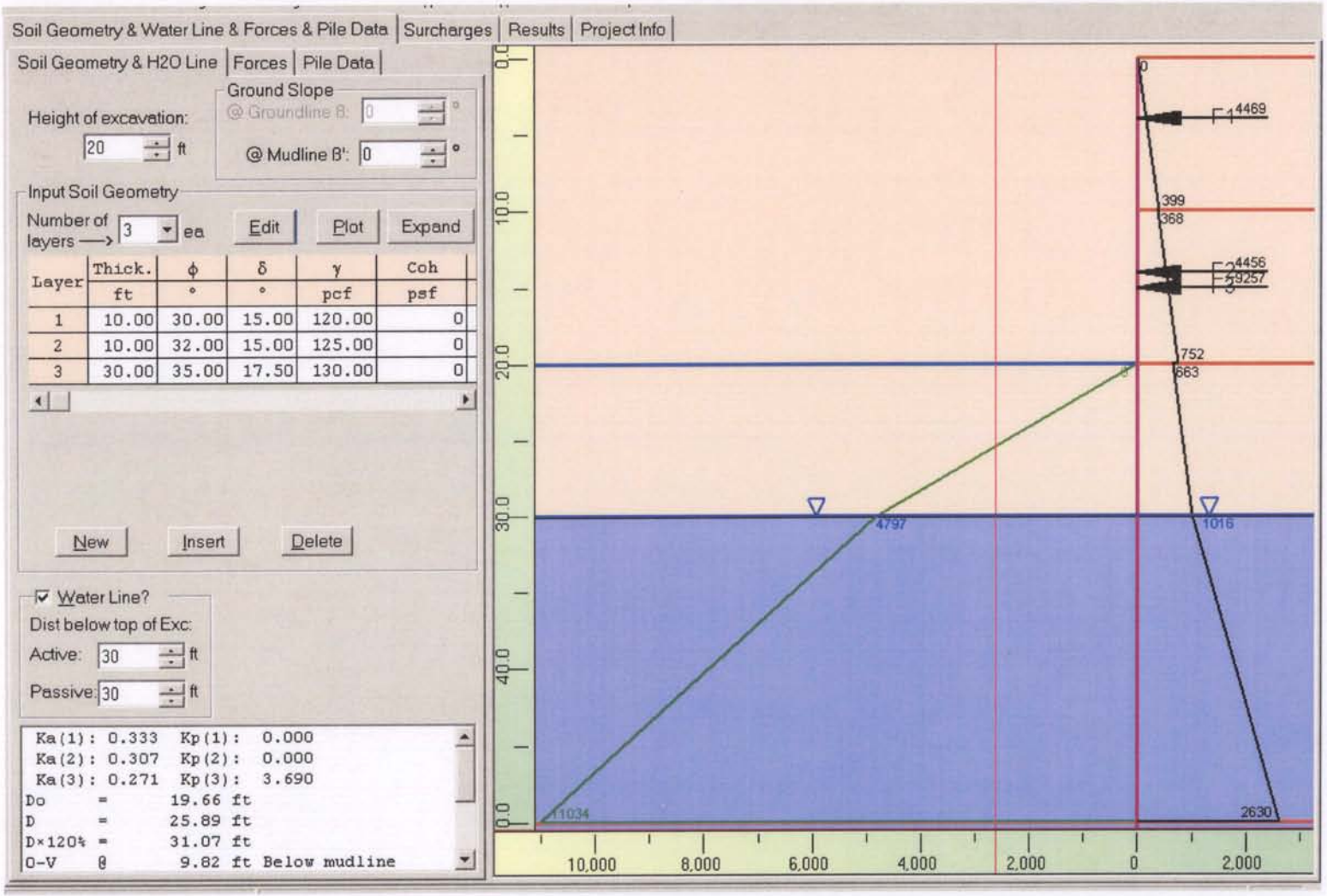


Figure 10: Pressure Diagrams, Segment 2 - RW 8 - Sta. 68+00 to 71+70 LOL

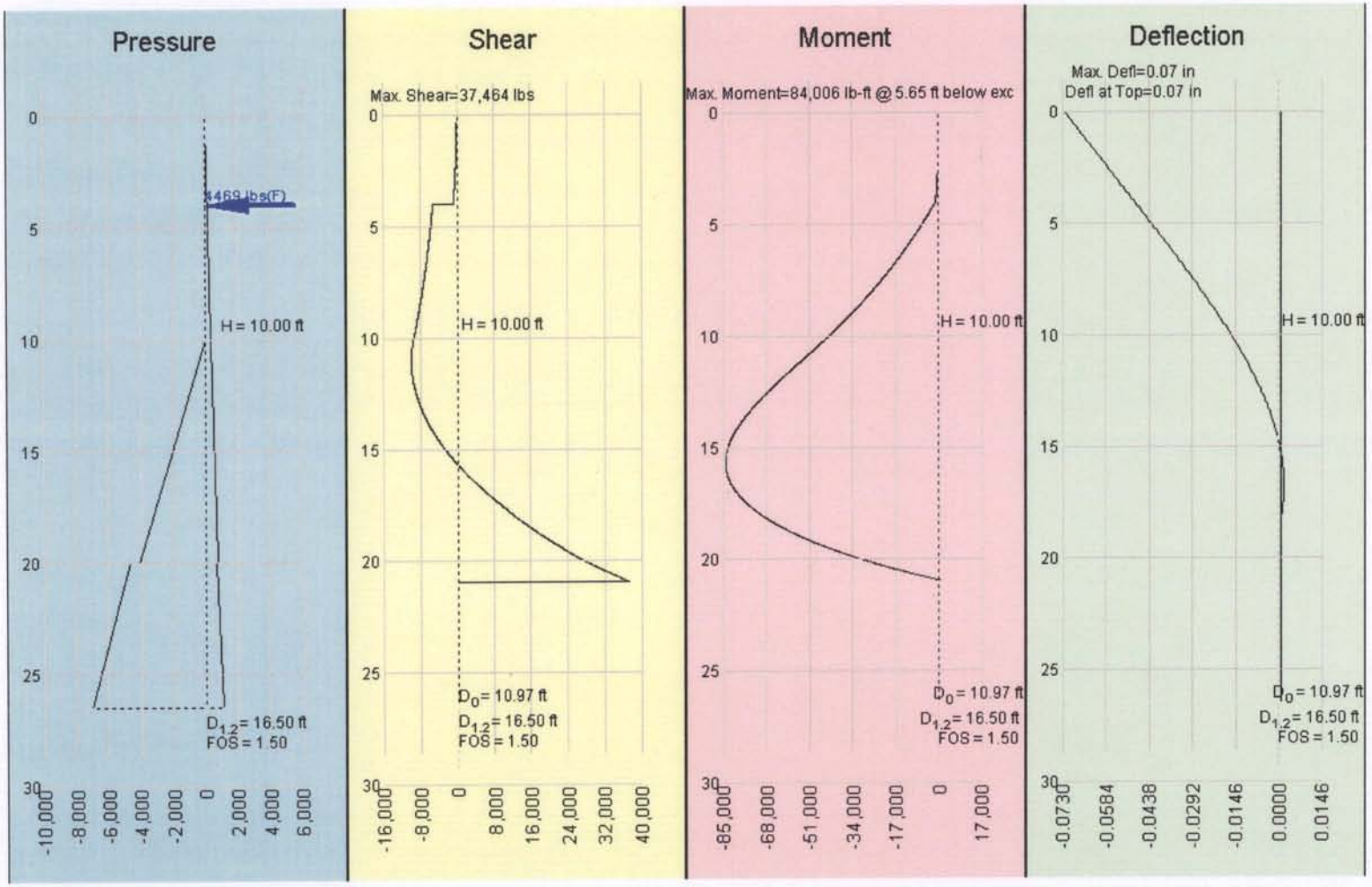


Figure 11: Seismic Analysis for Tangent Pile Wall, Segment 2 - RW 8 - Sta. 68+00 to 71+70 LOL (H = 10 ft)

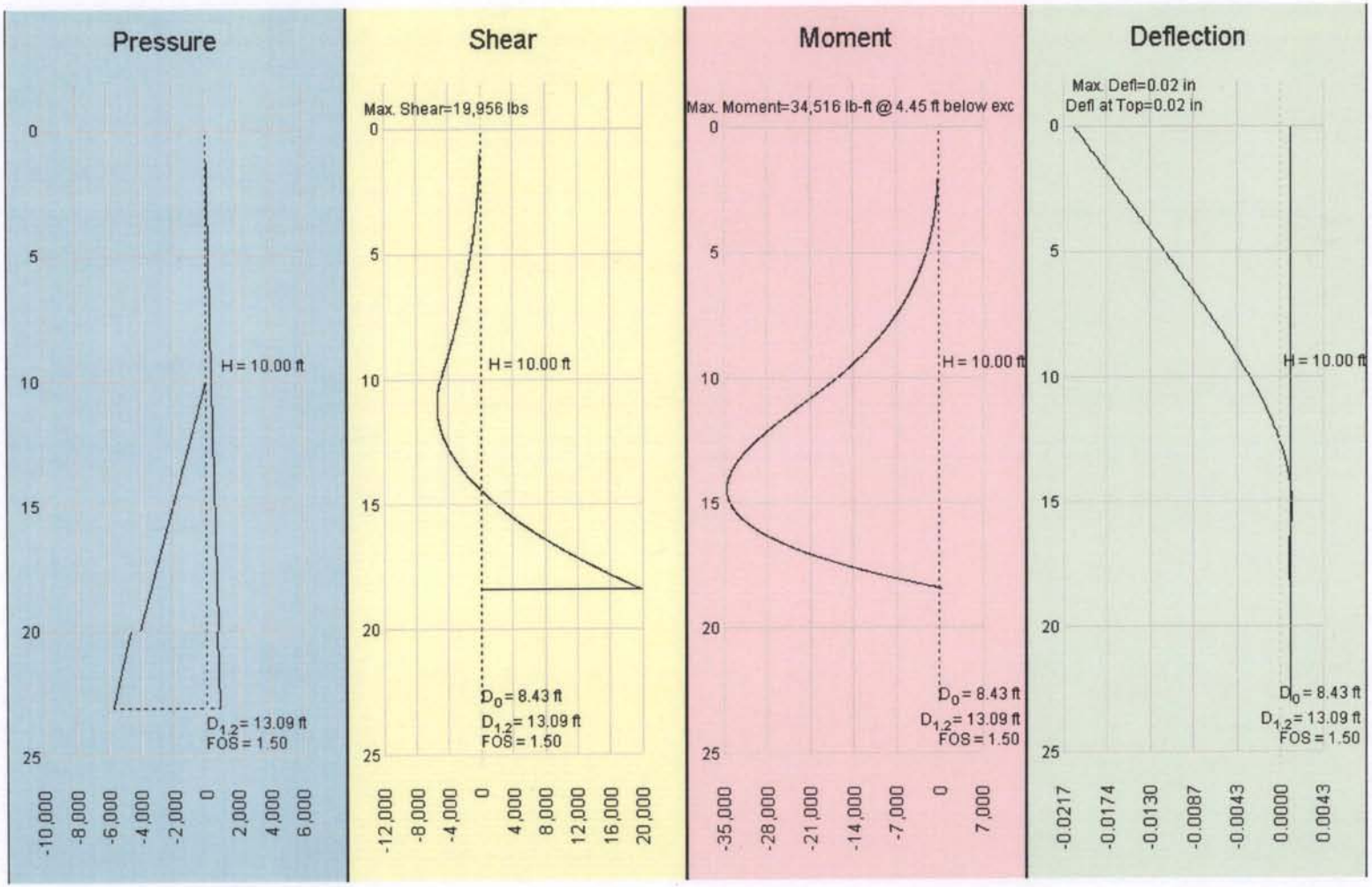


Figure 12: Static Analysis for Tangent Pile Wall, Segment 2 - RW 8 - Sta. 68+00 to 71+70 LOL (H = 10 ft)

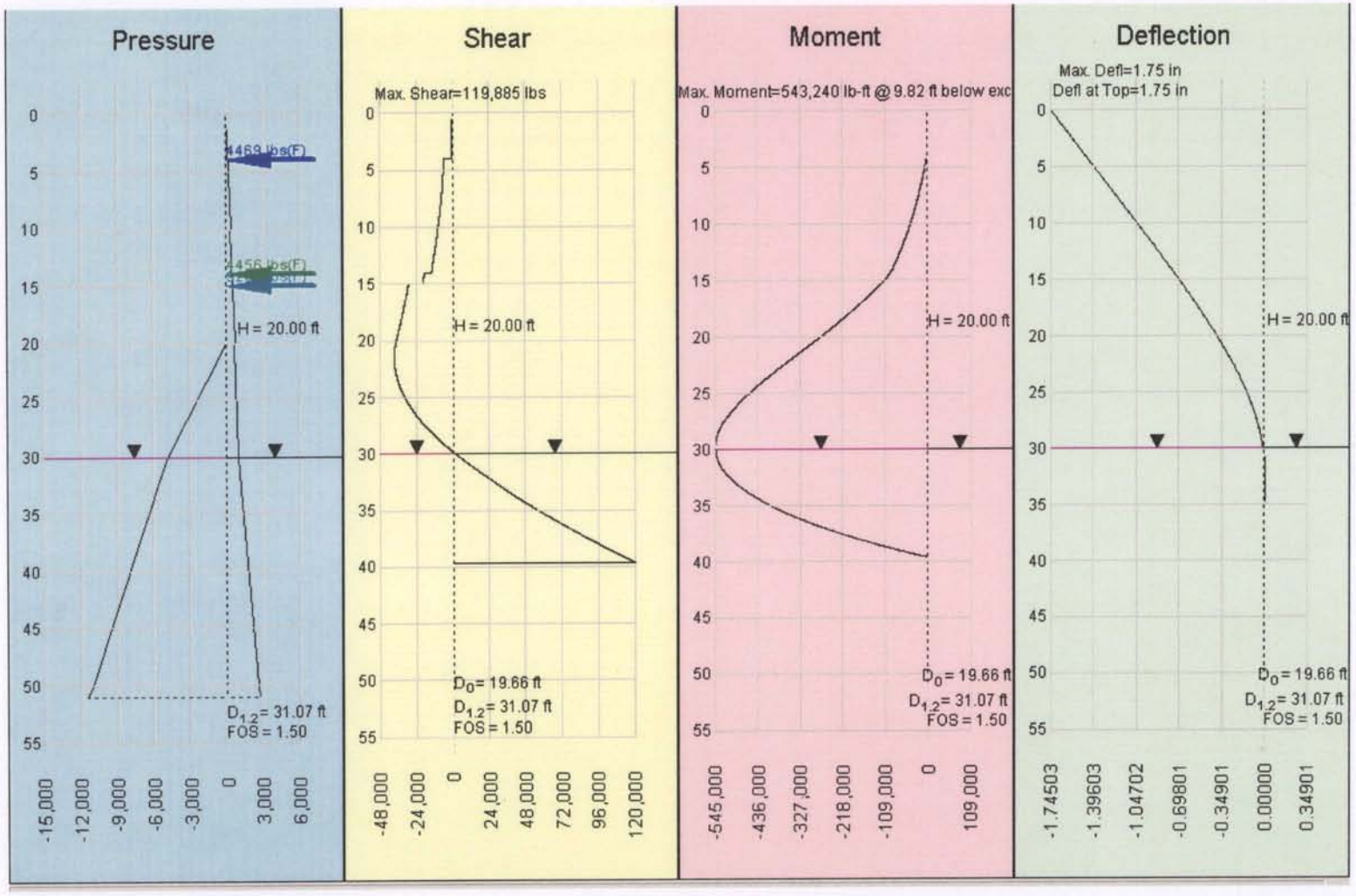


Figure 13: Seismic Analysis for Tangent Pile Wall, Segment 2 - RW 8 - Sta. 68+00 to 71+70 LOL (H = 20 ft)

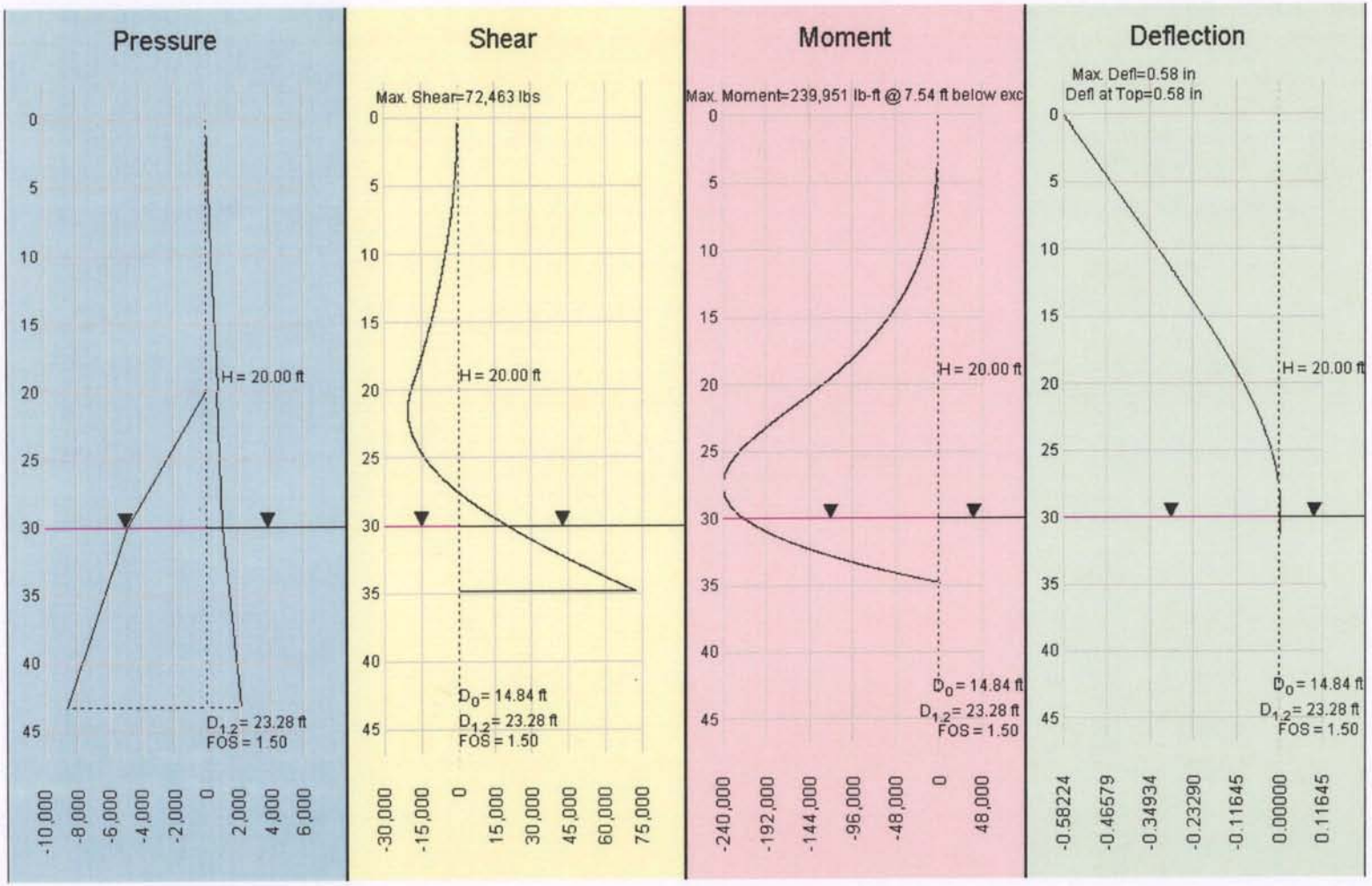


Figure 14: Static Analysis for Tangent Pile Wall, Segment 2 - RW 8 - Sta. 68+00 to 71+70 LOL (H = 20 ft)

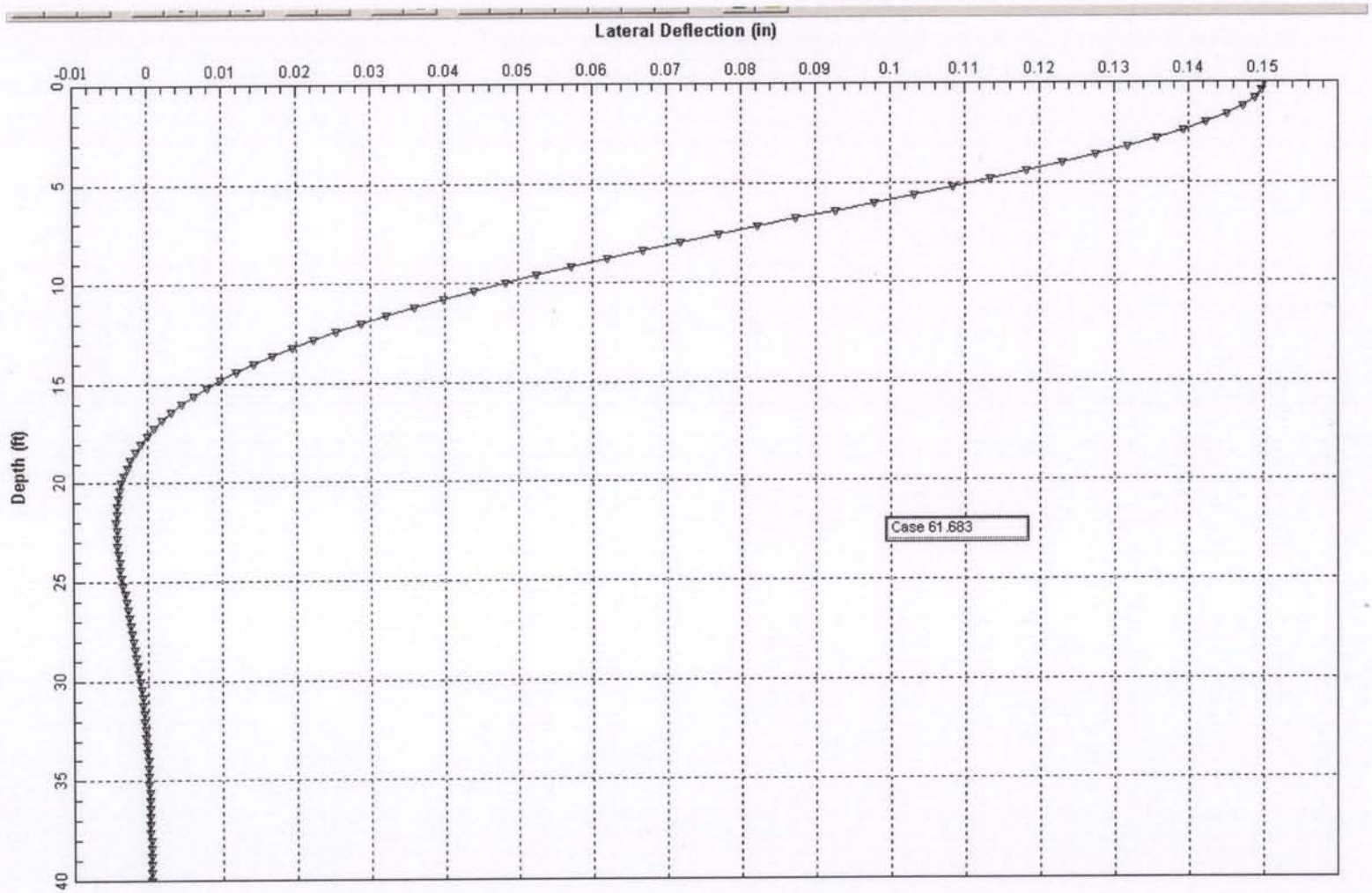


Figure 15: 30" CIDH Pile Deflection – Seismic Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

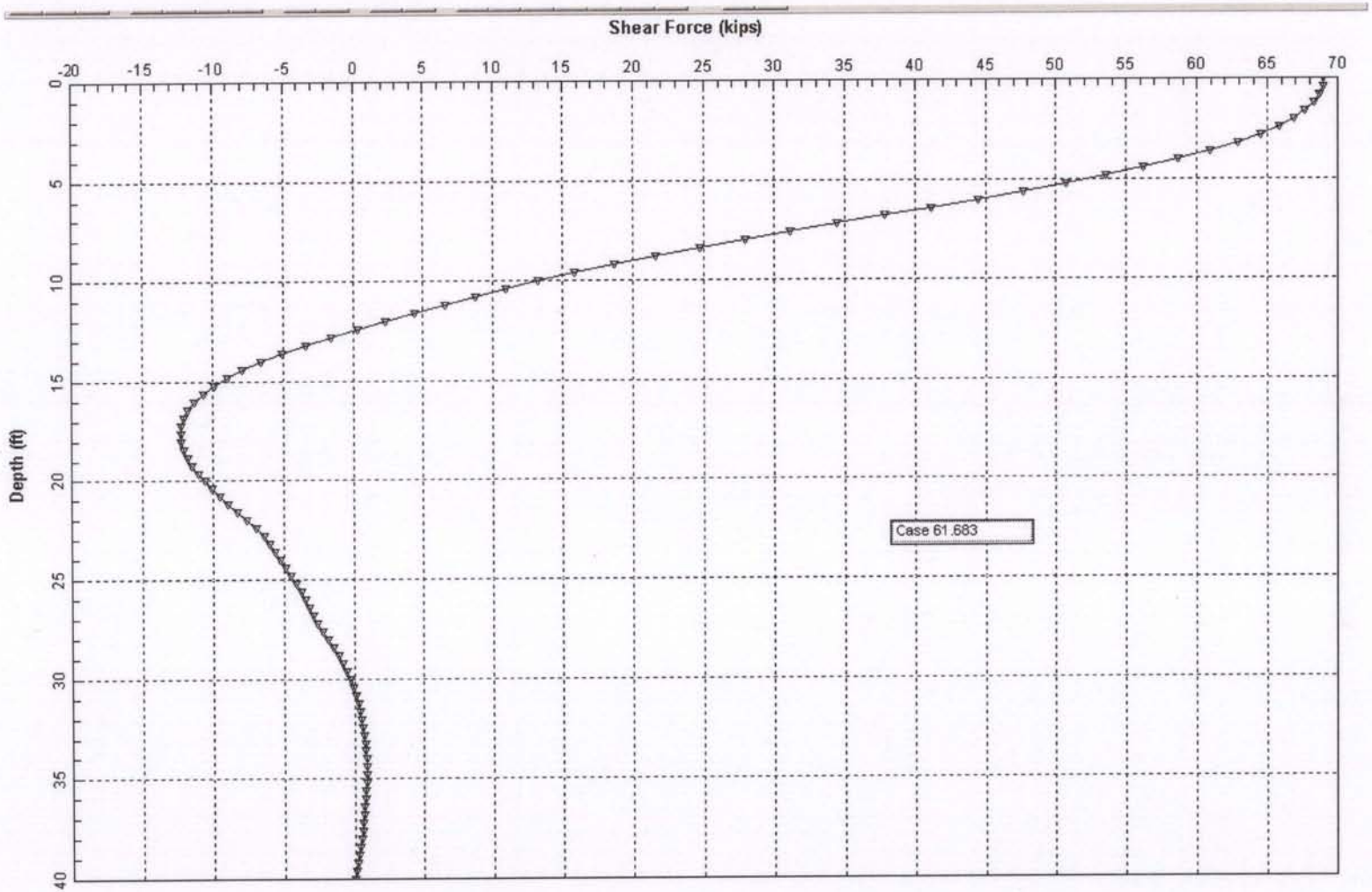


Figure 16: 30" CIDH Pile Shear Force – Seismic Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

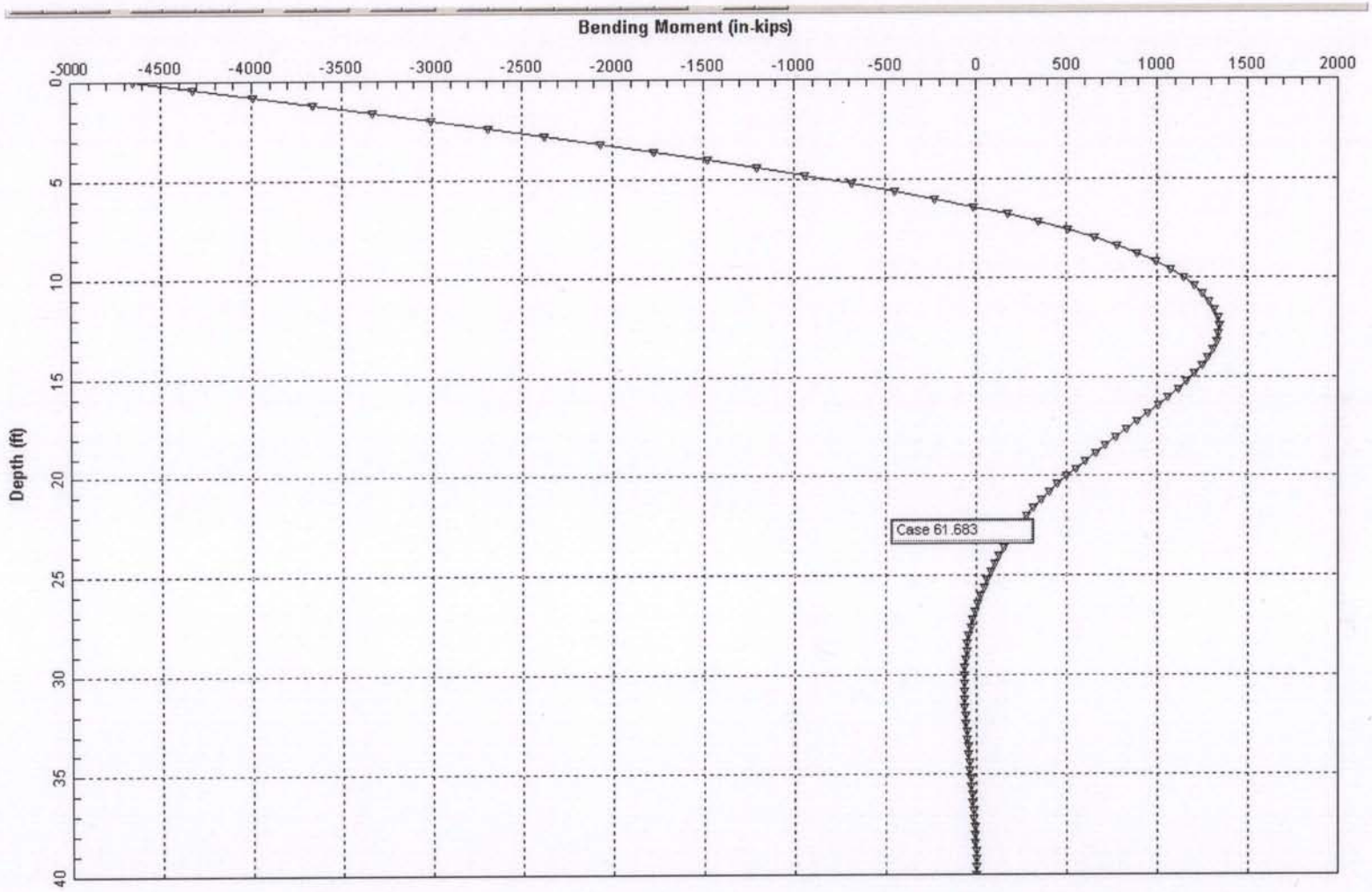


Figure 17: 30" CIDH Pile Bending Moment – Seismic Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

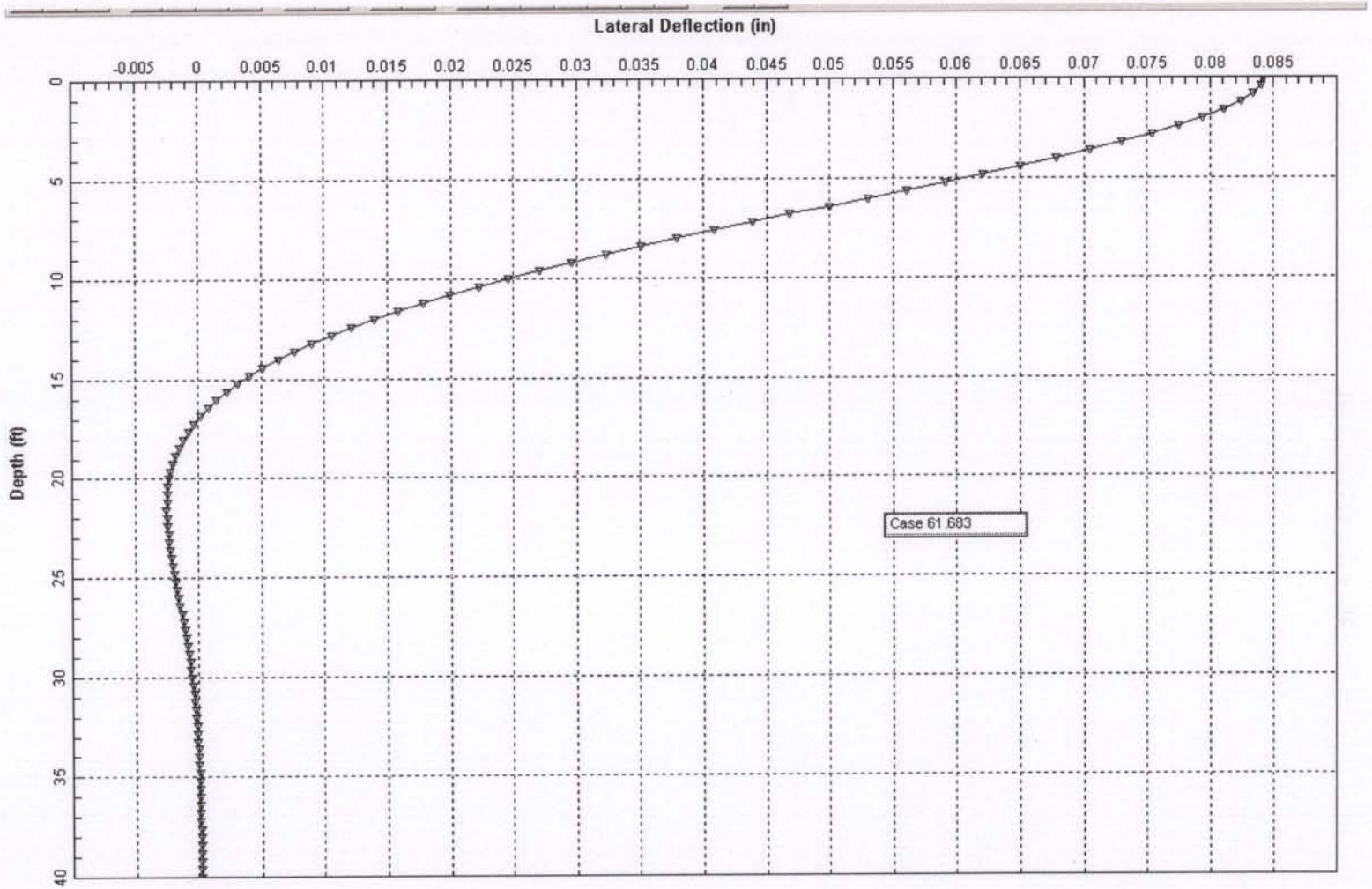


Figure 18: 30" CIDH Pile Deflection – Static Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

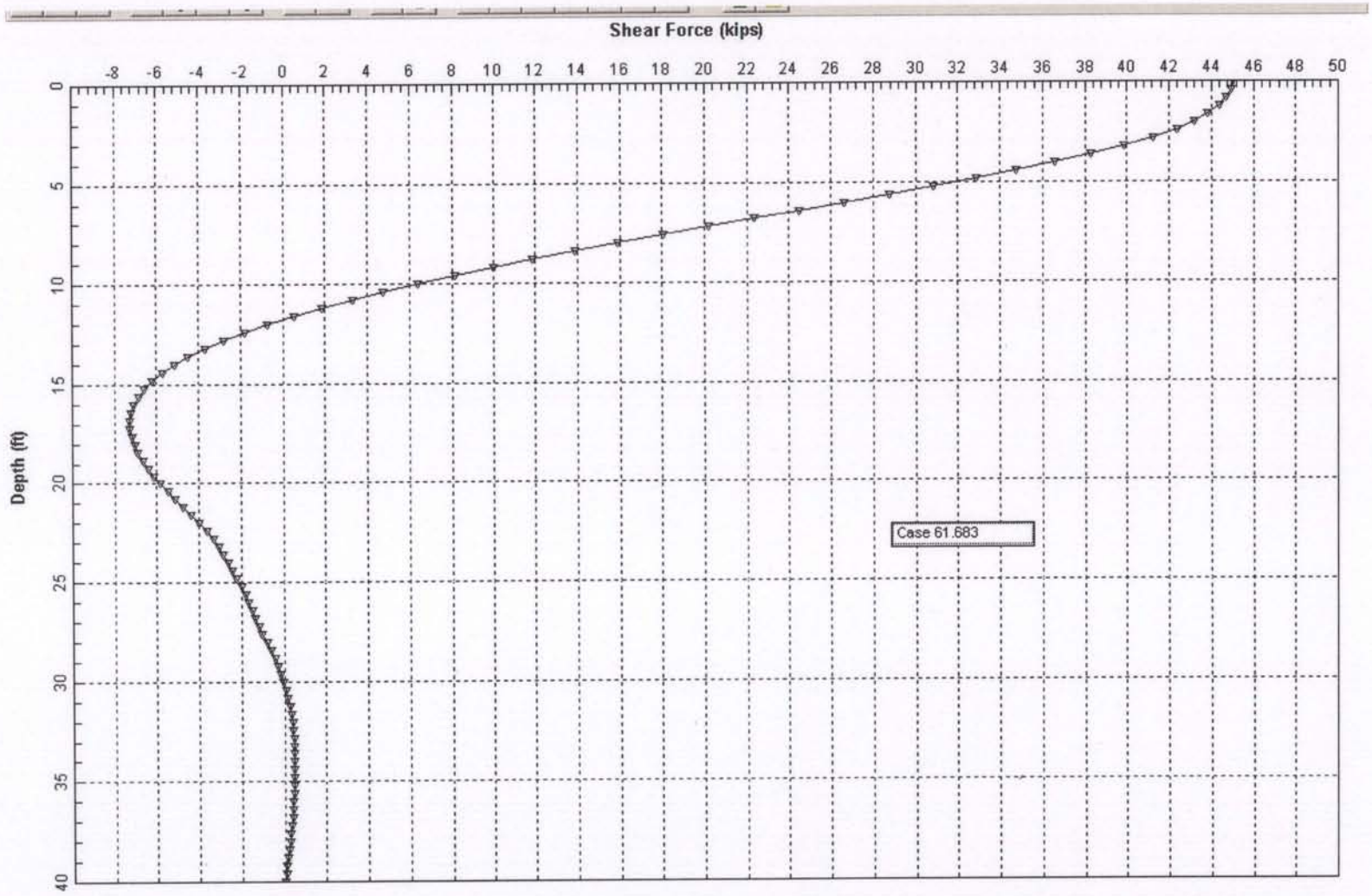


Figure 19: 30" CIDH Pile Shear Force – Static Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

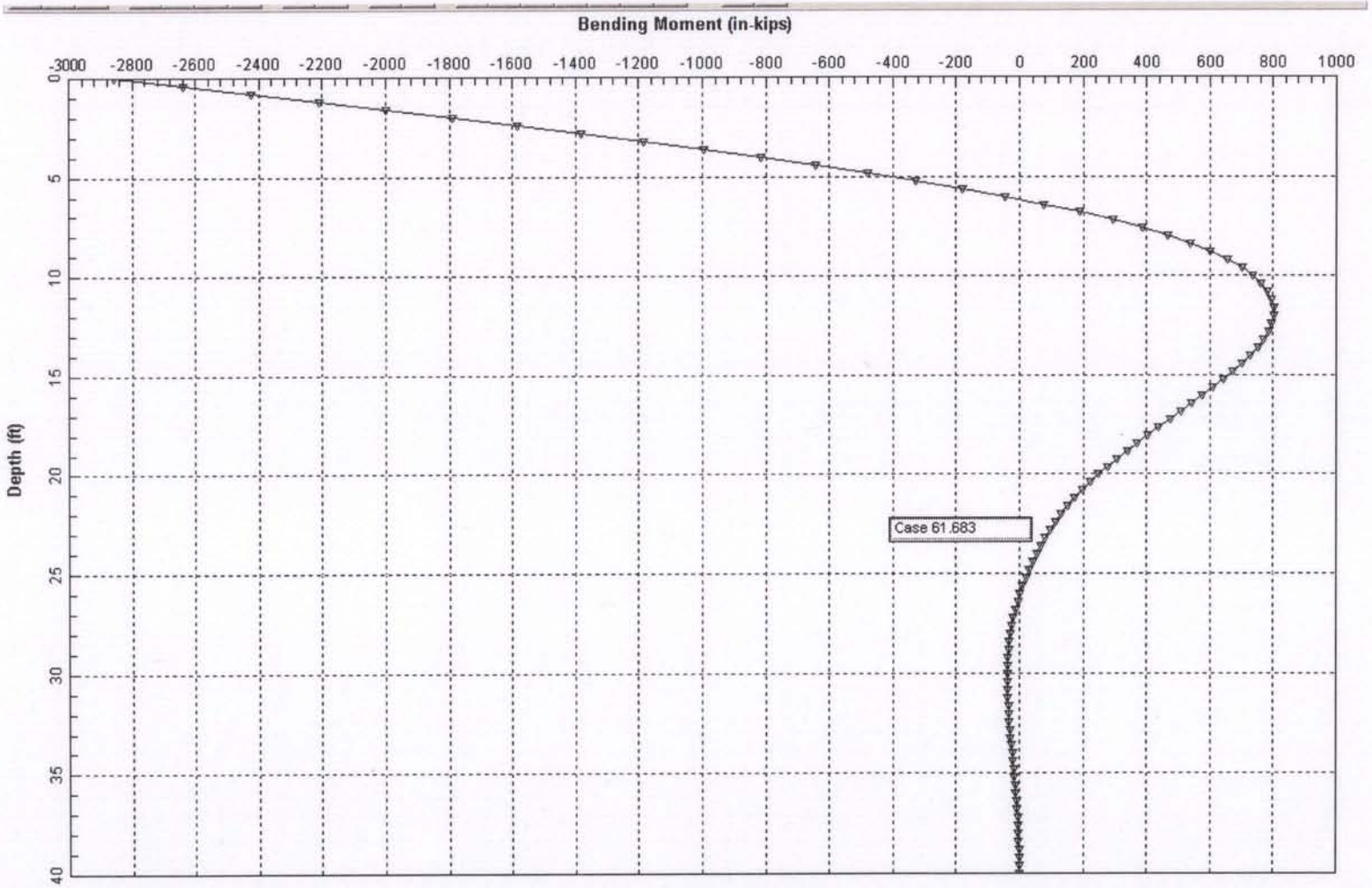


Figure 20: 30" CIDH Pile Bending Moment – Static Lateral Analysis, Section C – RW8 Sta. 70+60 LOL

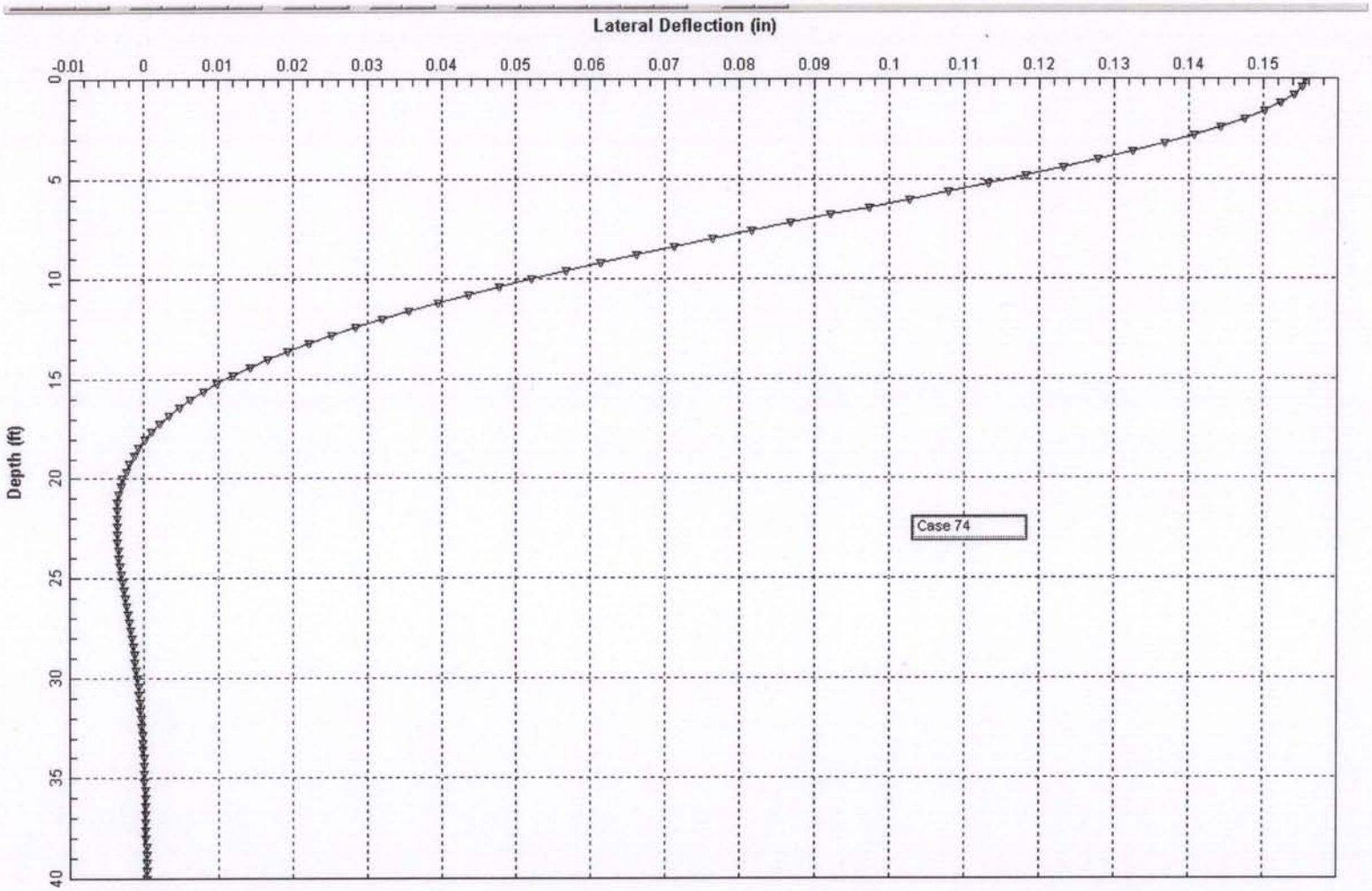


Figure 21: 30" CIDH Pile Deflection – Seismic Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

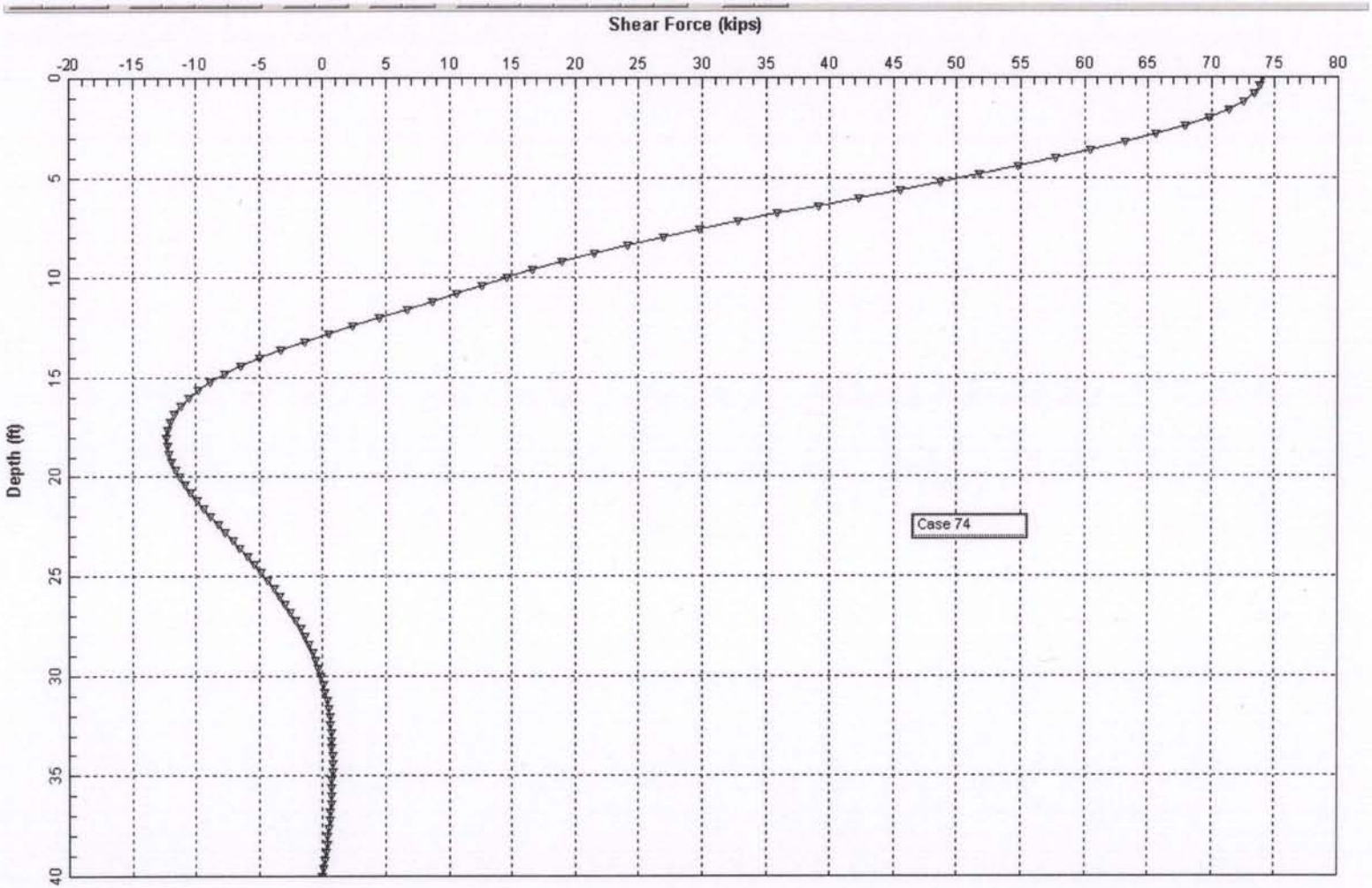


Figure 22: 30" CIDH Pile Shear Force – Seismic Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

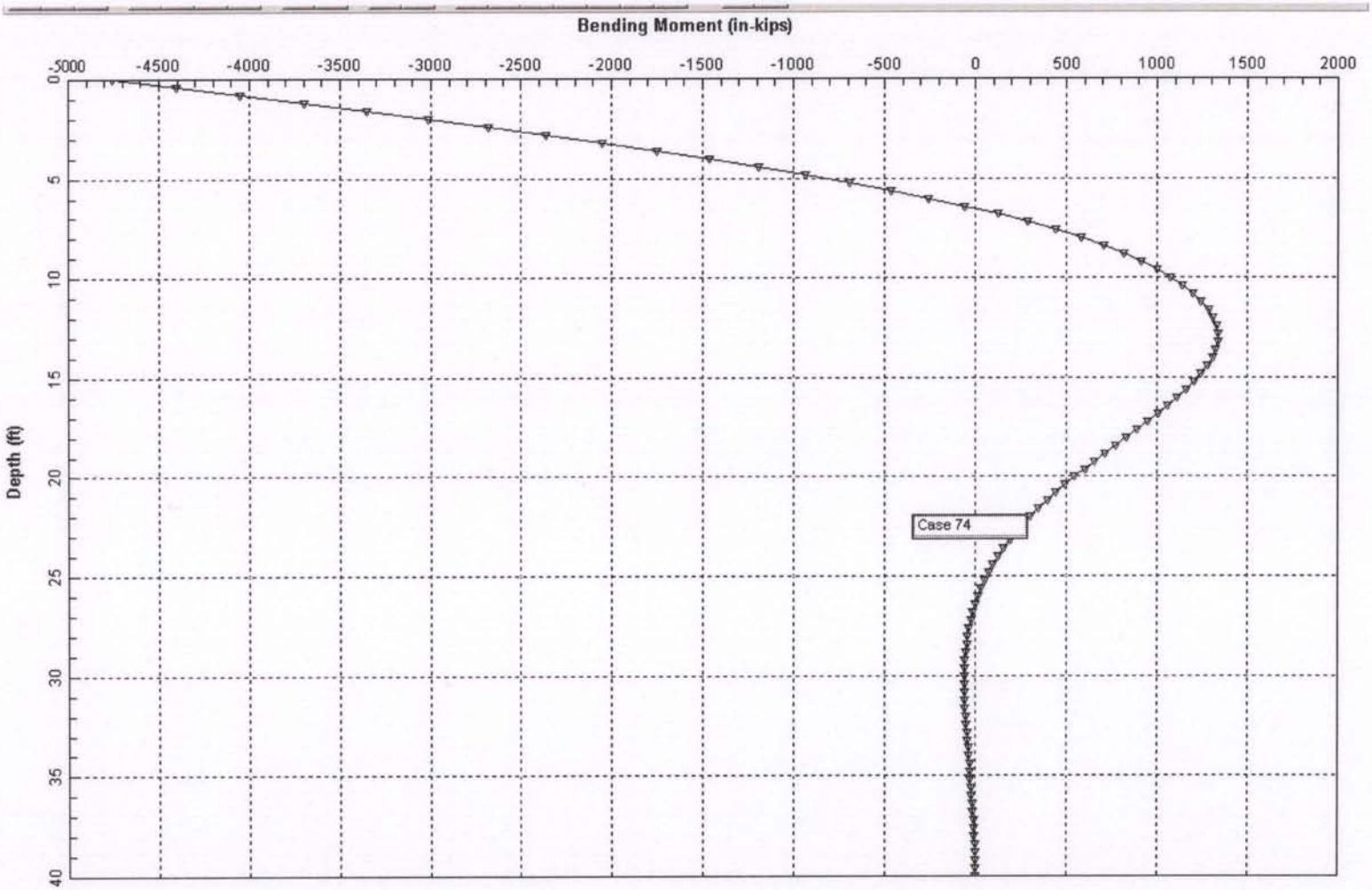


Figure 23: 30" CIDH Pile Bending Moment – Seismic Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

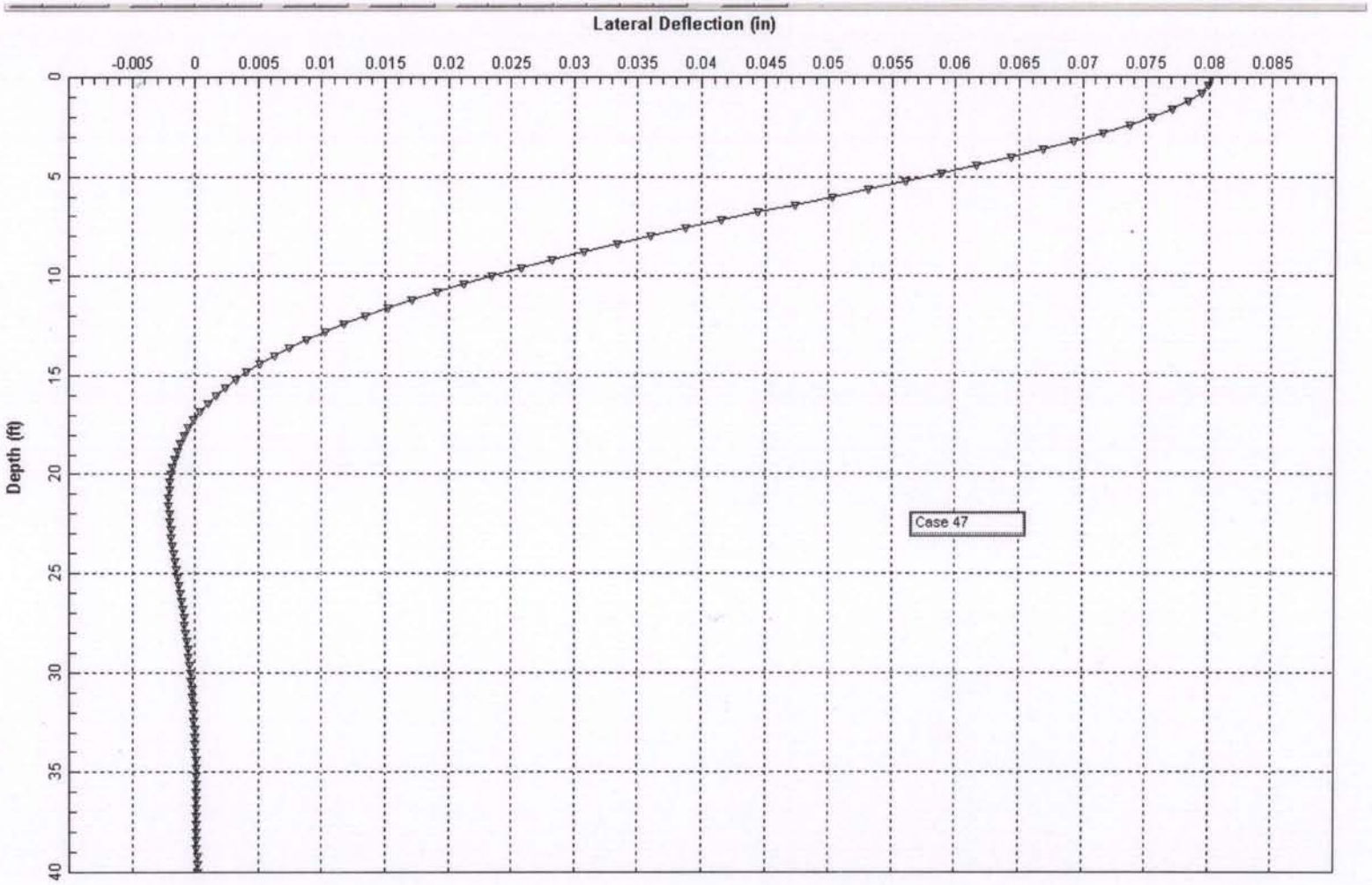


Figure 24: 30" CIDH Pile Deflection – Static Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

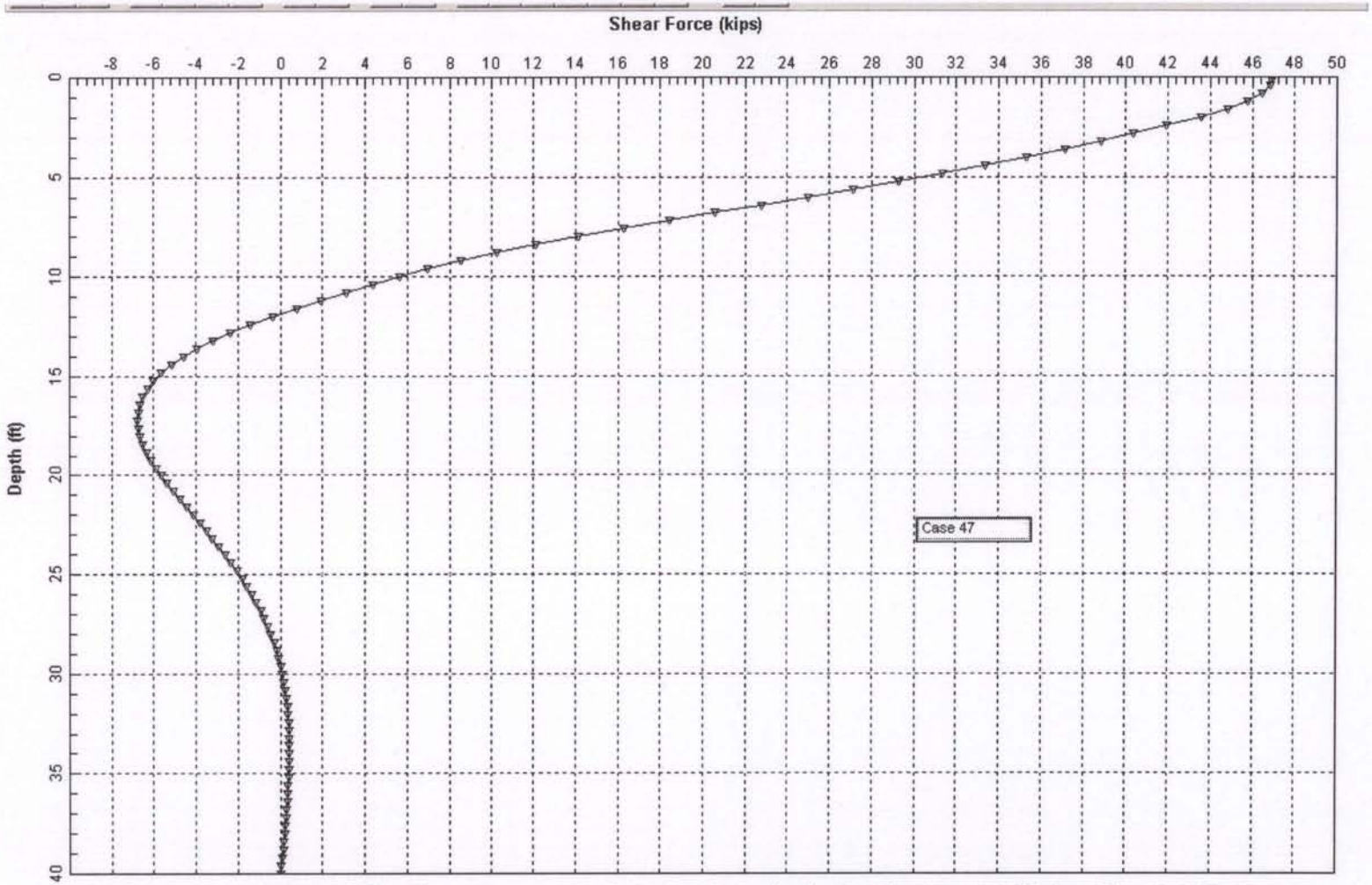


Figure 25: 30" CIDH Pile Shear Force – Static Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

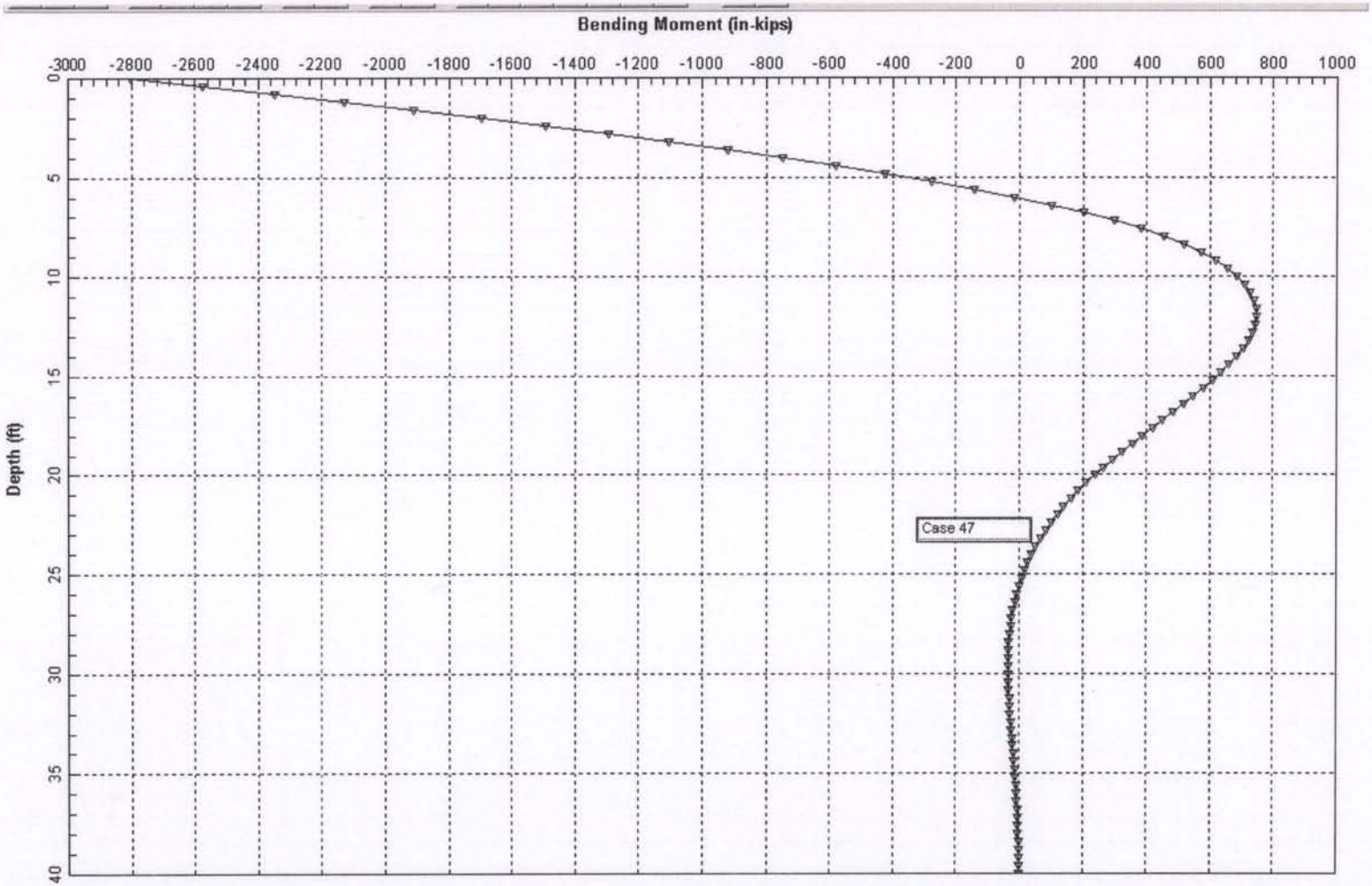


Figure 26: 30" CIDH Pile Bending Moment – Static Lateral Analysis, Section D – RW8 Sta. 71+43.71 LOL

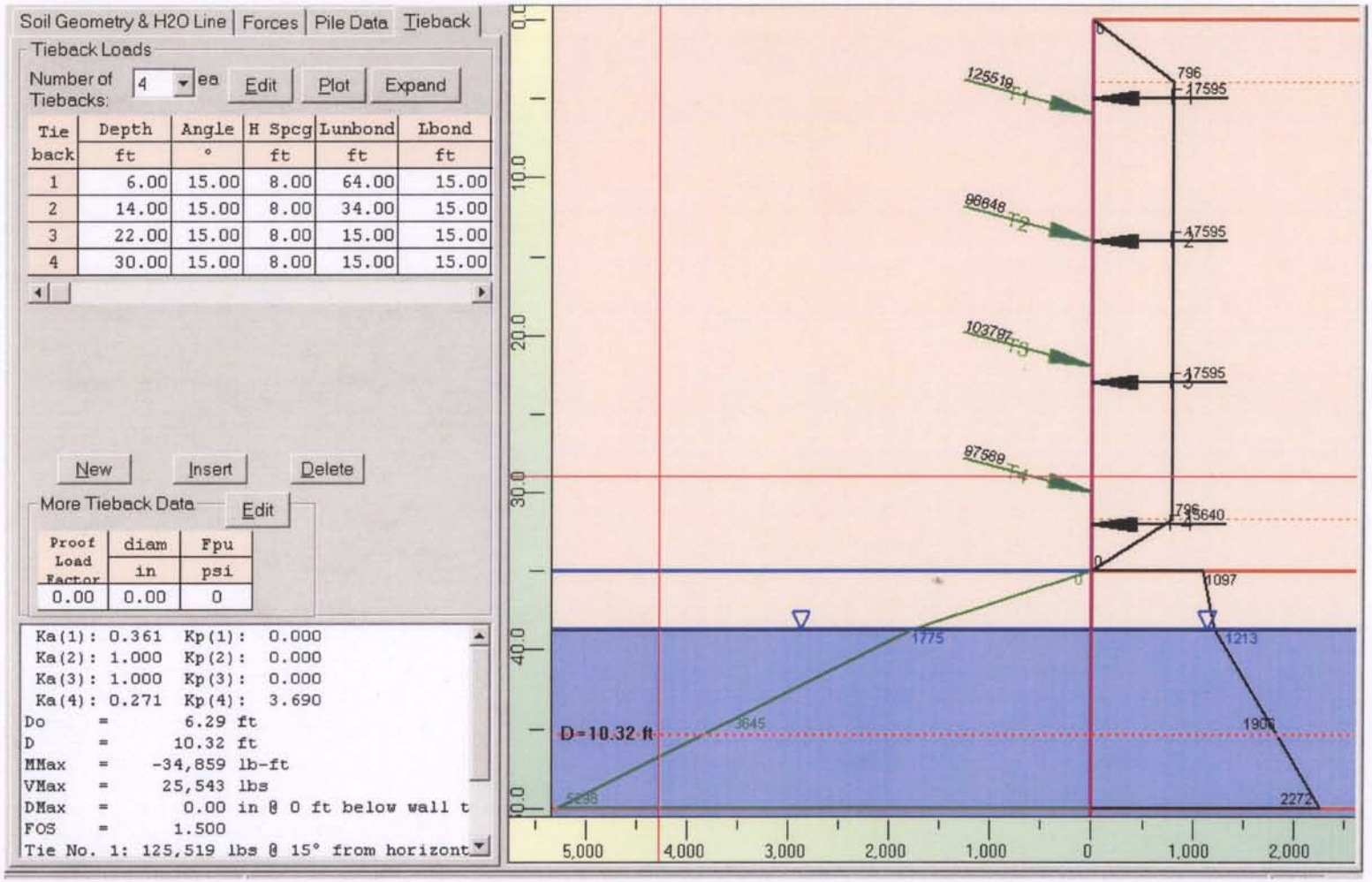


Figure 27: Pressure Diagrams, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL

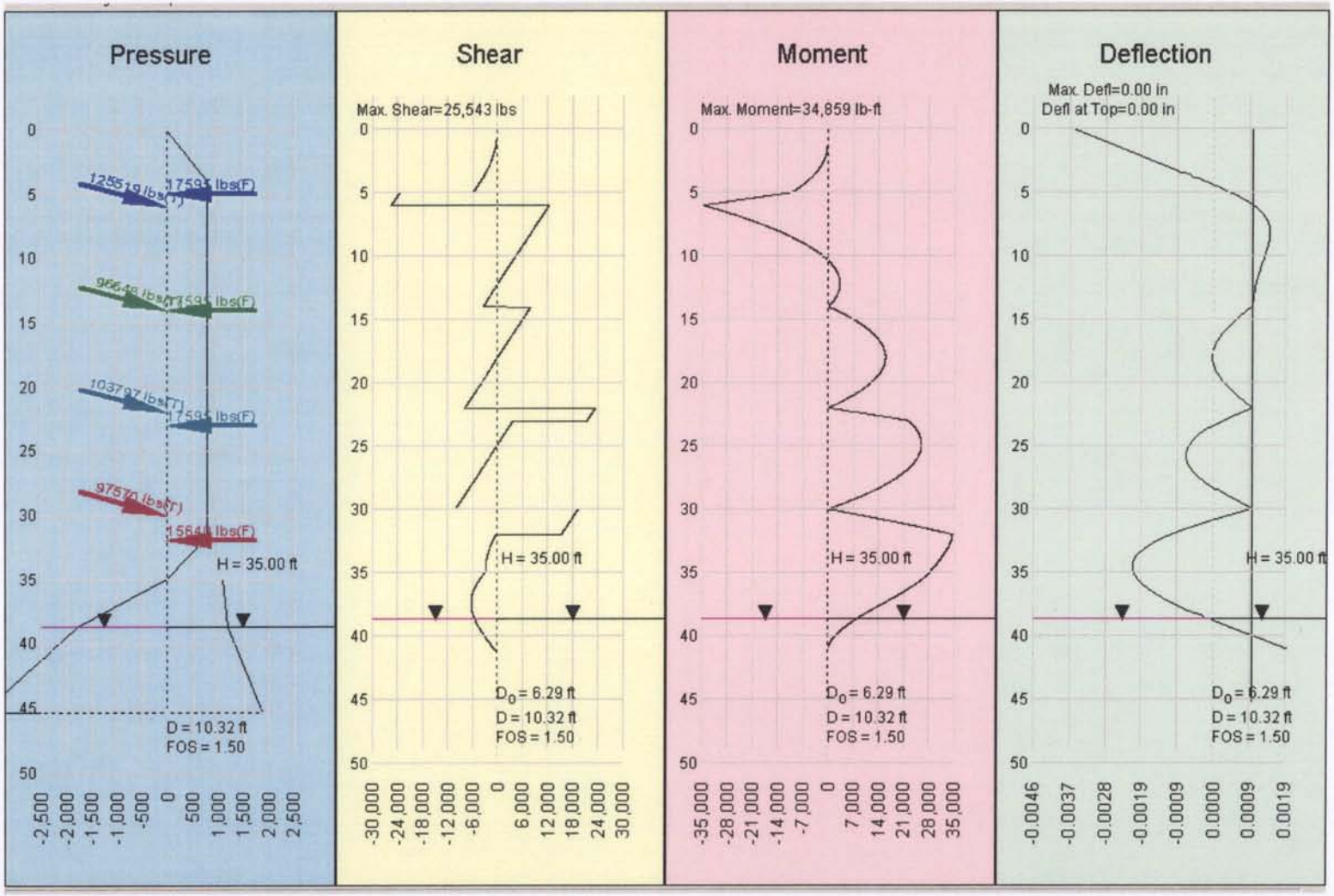


Figure 28: Seismic Analysis for Tangent Pile Wall with Tiebacks, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL (H = 35 ft)

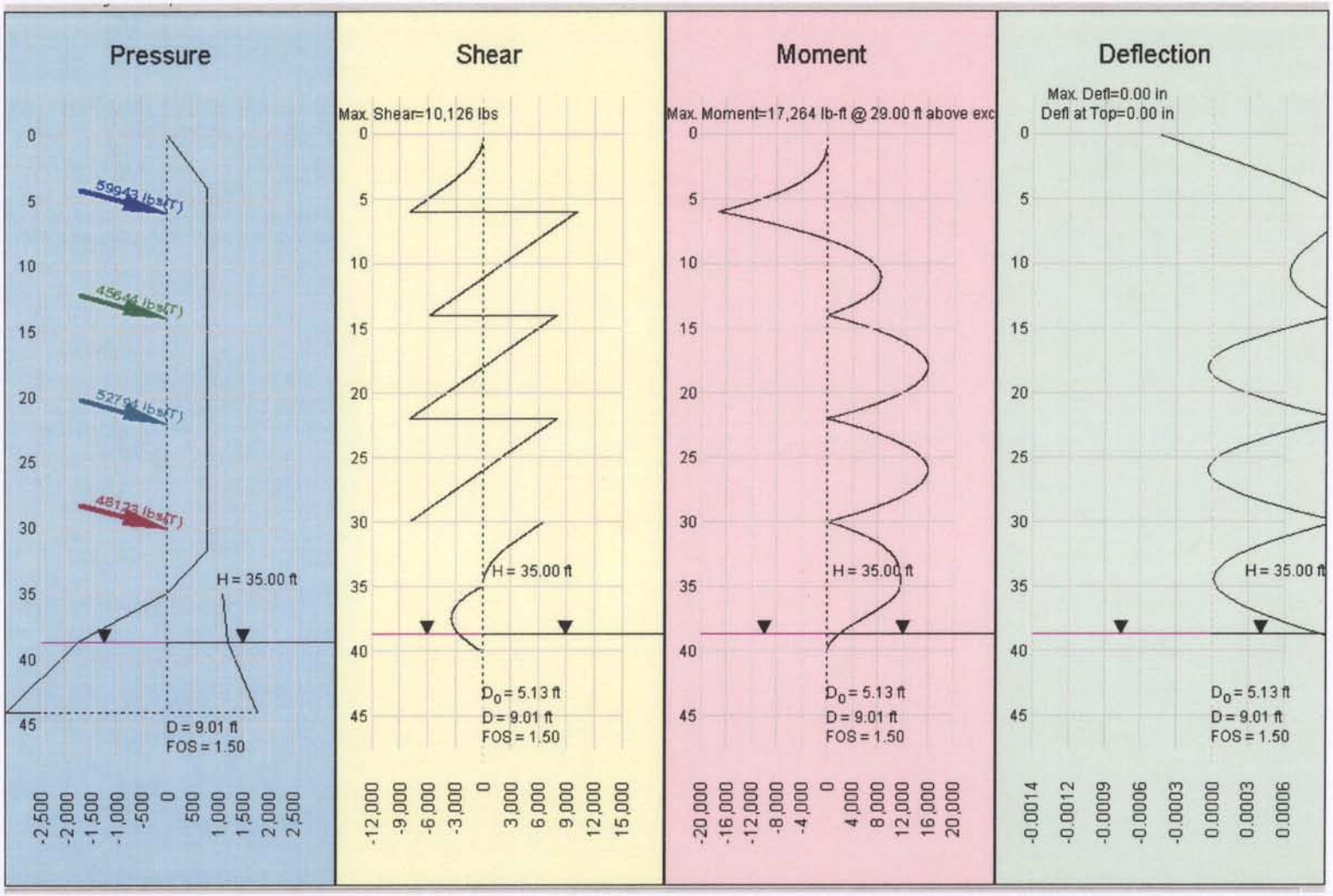


Figure 29: Static Analysis for Tangent Pile Wall with Tiebacks, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL (H = 35 ft)

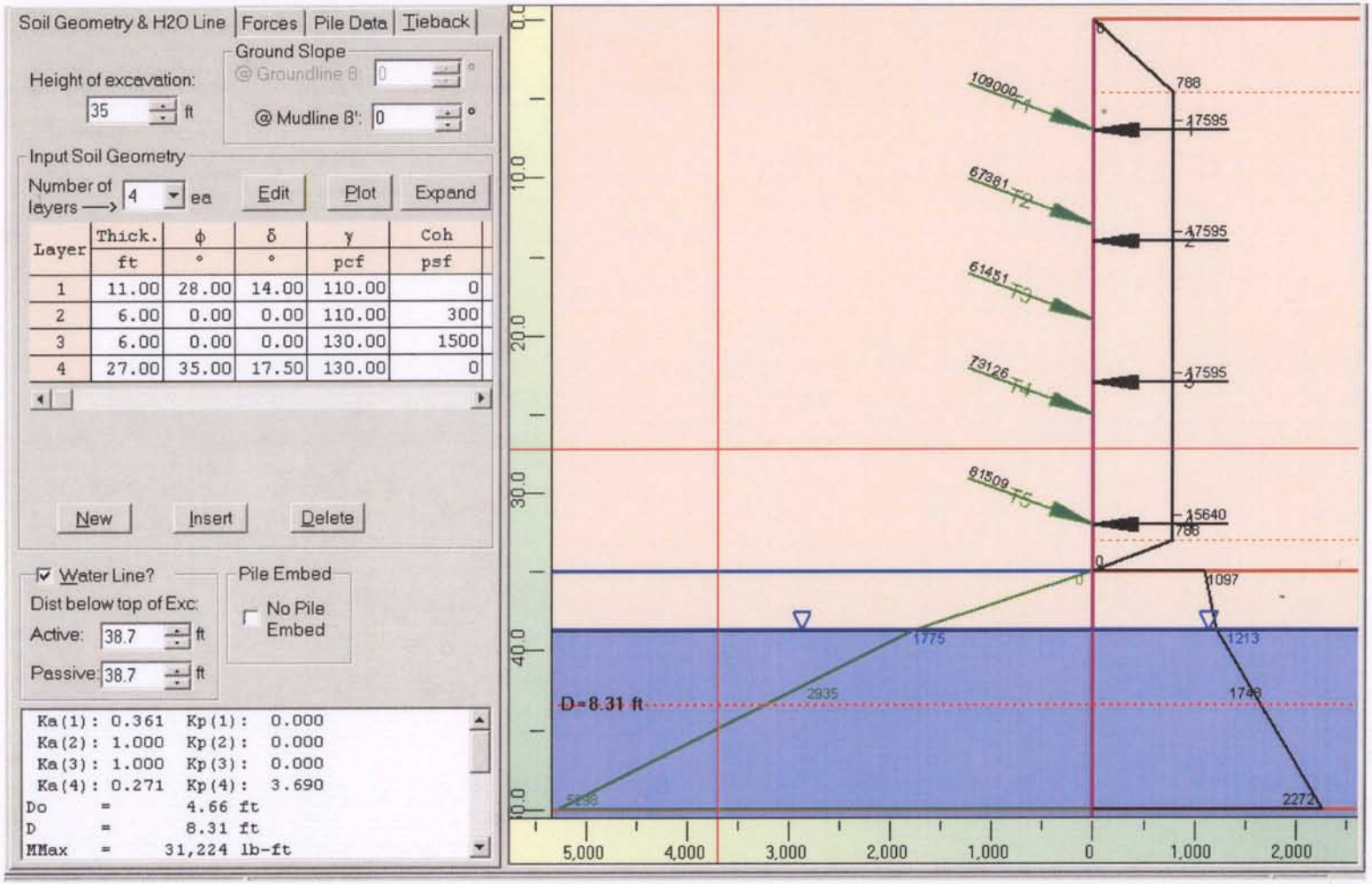


Figure 30: Pressure Diagrams, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL (Alternative Case)

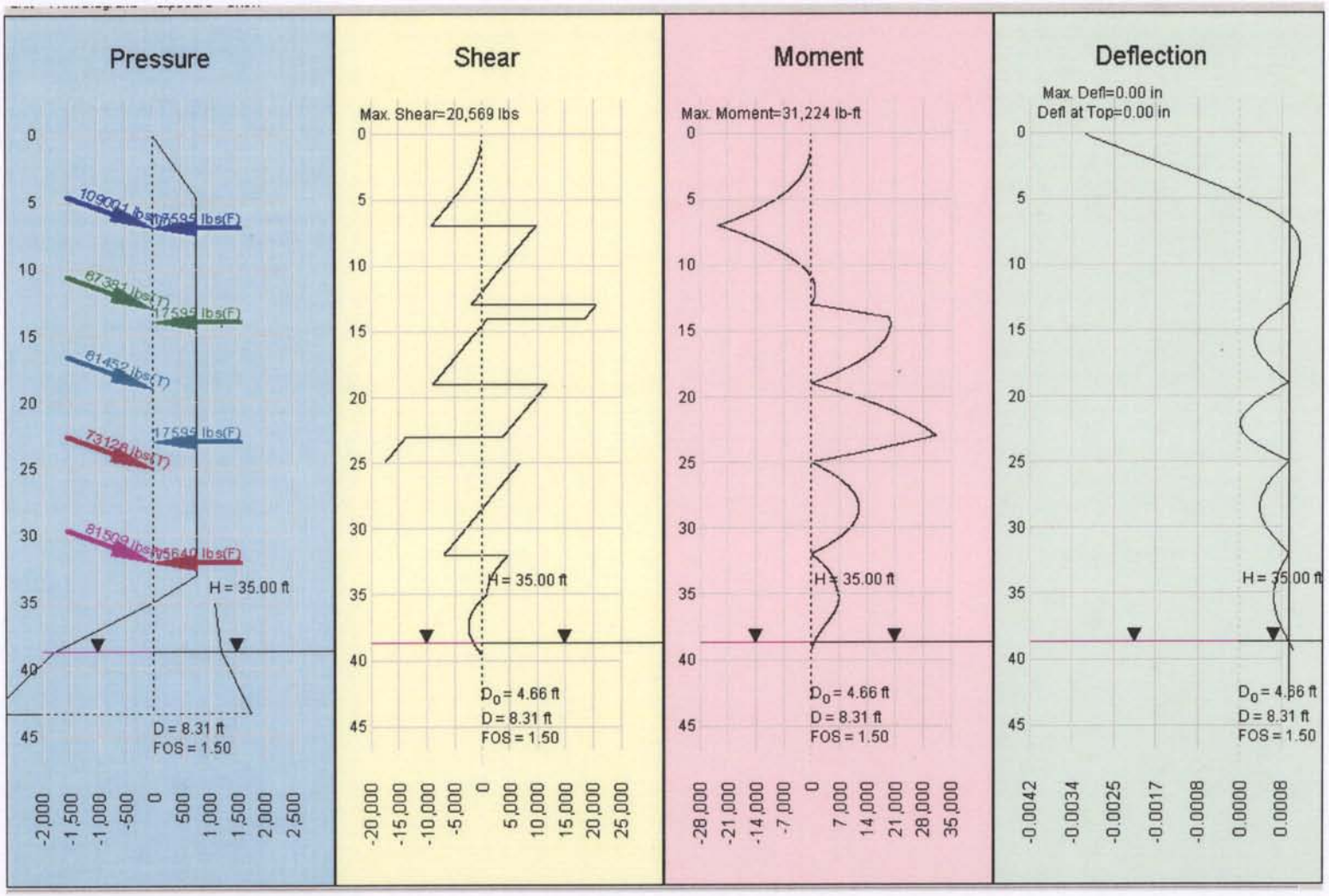


Figure 31: Seismic Analysis for Tangent Pile Wall with Tiebacks, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL
(H = 35 ft, Alternative Case)

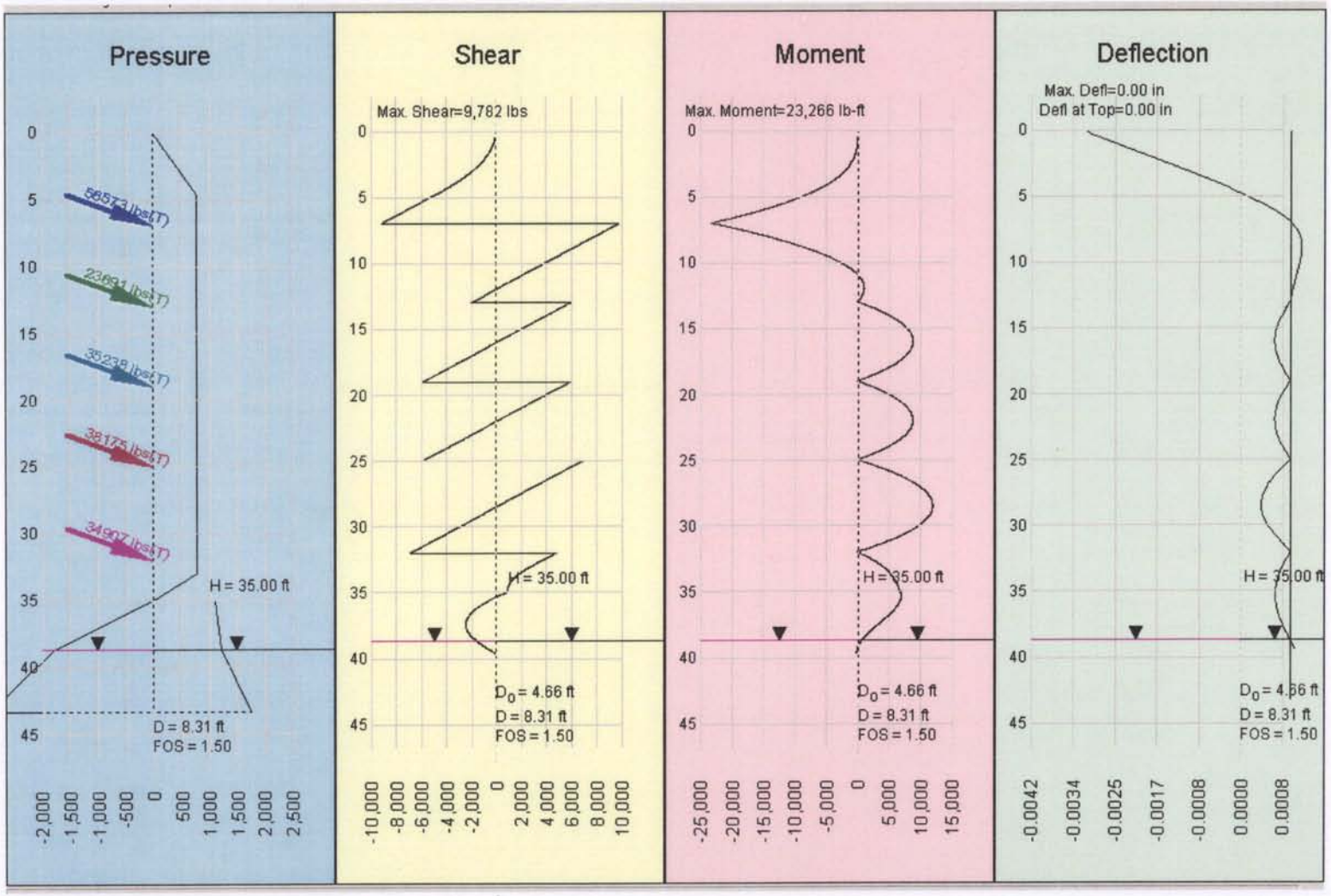
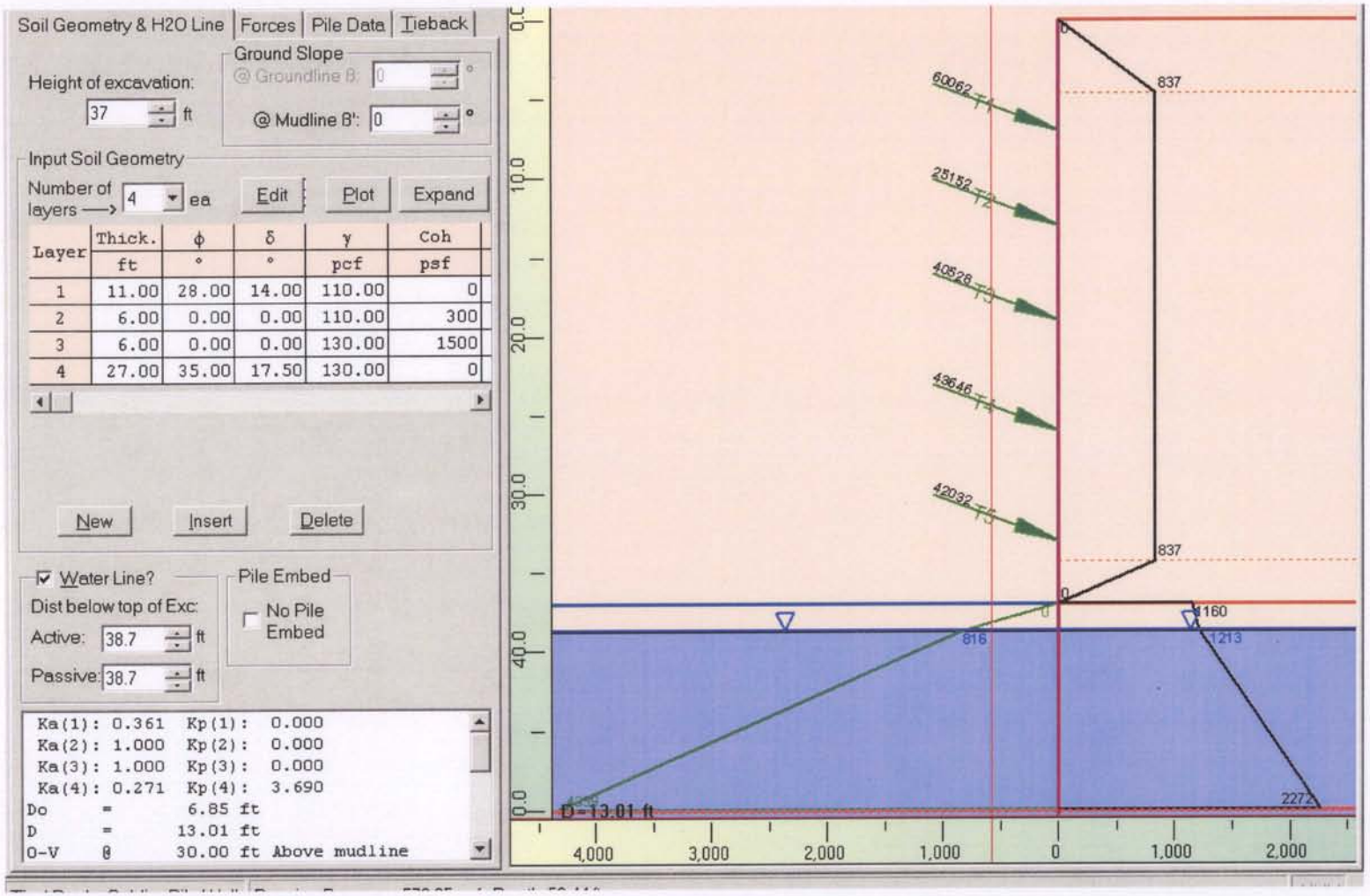


Figure 32: Static Analysis for Tangent Pile Wall With Tiebacks, Segment 3 - RW 8 - Sta. 71+70 to 76+15 LOL
(H = 35 ft, Alternative Case)



Layer	Thick. ft	ϕ °	δ °	γ pcf	Coh psf
1	11.00	28.00	14.00	110.00	0
2	6.00	0.00	0.00	110.00	300
3	6.00	0.00	0.00	130.00	1500
4	27.00	35.00	17.50	130.00	0

Figure 33: Pressure Diagrams, Segment 3 - RW 8 - Sta. 76+14.50 to 76+64.29 LOL

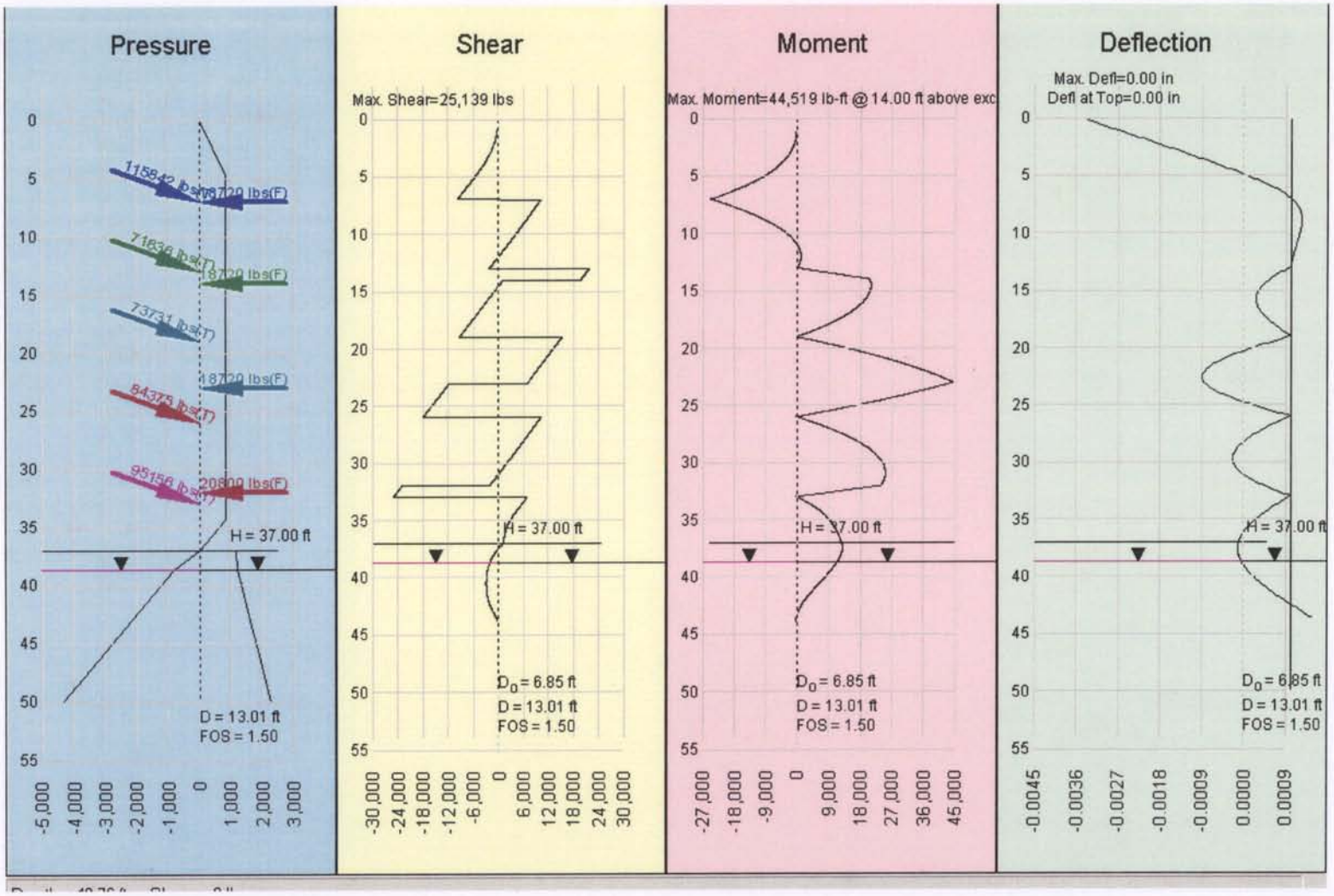


Figure 34: Seismic Analysis for Tangent Pile Wall with Tiebacks,
Segment 3 - RW 8 - Sta. 76+14.50 to 76+64.29 LOL (H = 37 ft)

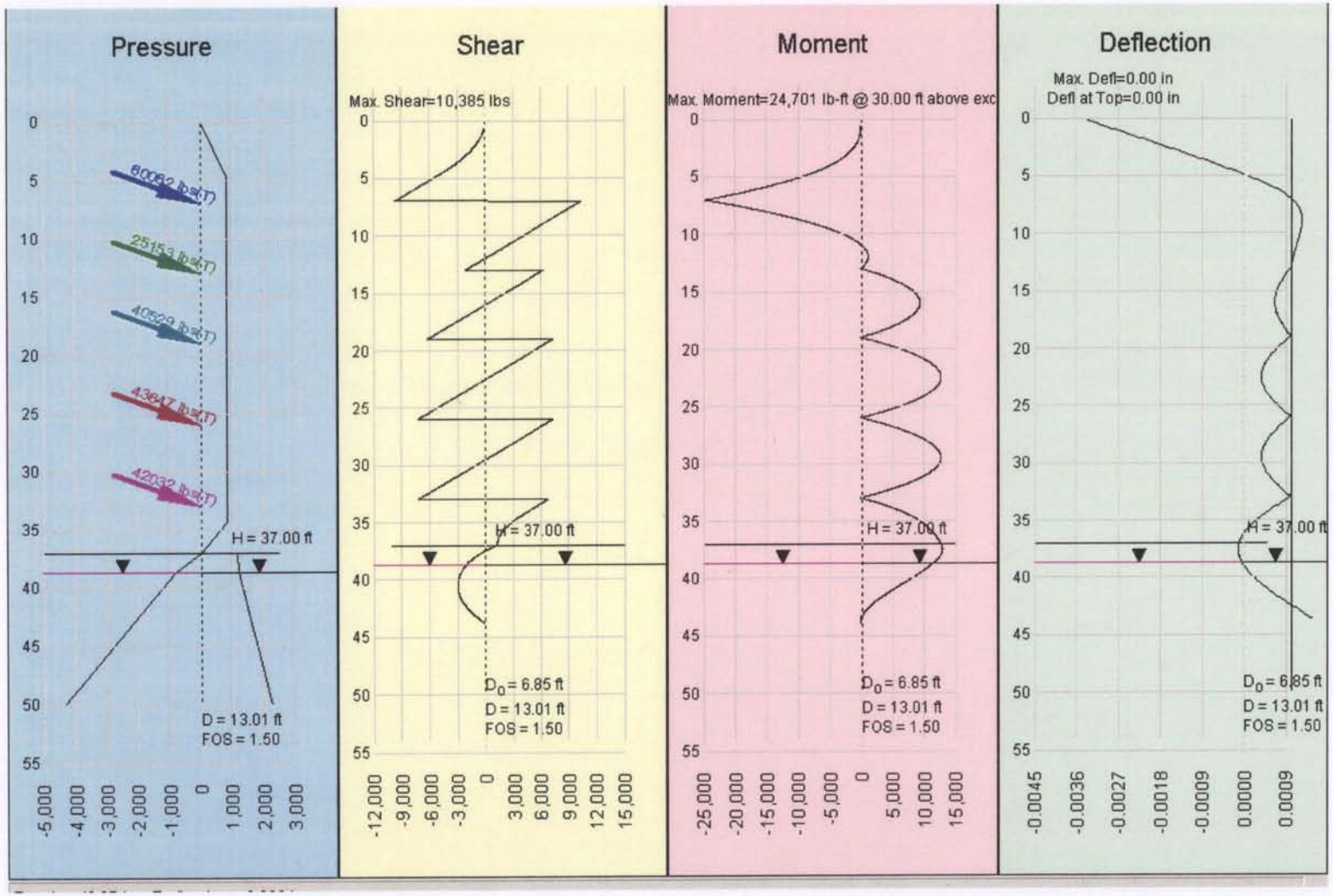


Figure 35: Static Analysis for Tangent Pile Wall with Tiebacks,
Segment 3 - RW 8 - Sta. 76+14.50 to 76+64.29 LOL (H = 37 ft)

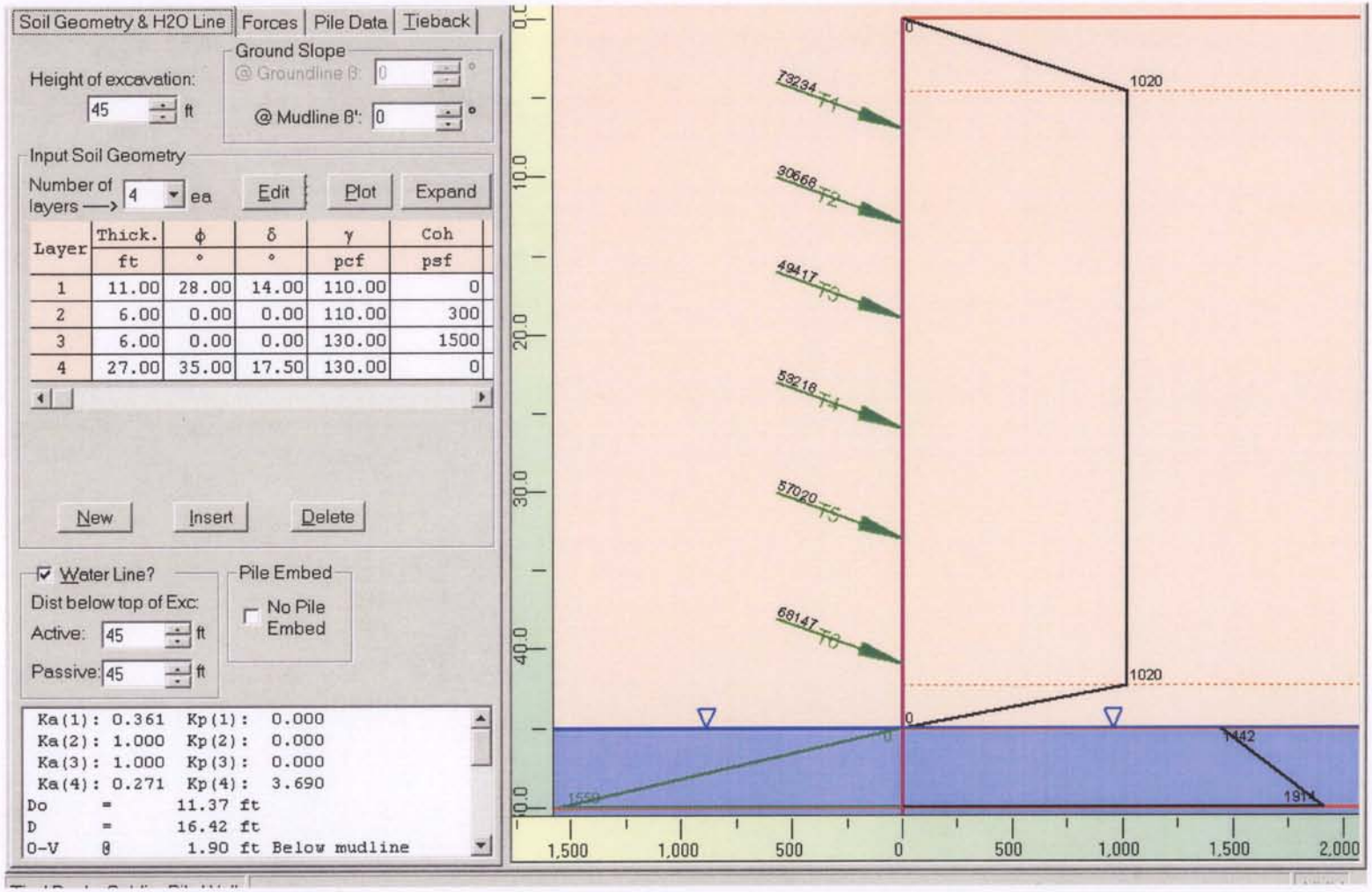


Figure 36: Pressure Diagrams, Segments 3 - RW 8 - Sta. 75+75.00 to 76+64.29 LOL
(Temporary Construction Condition)

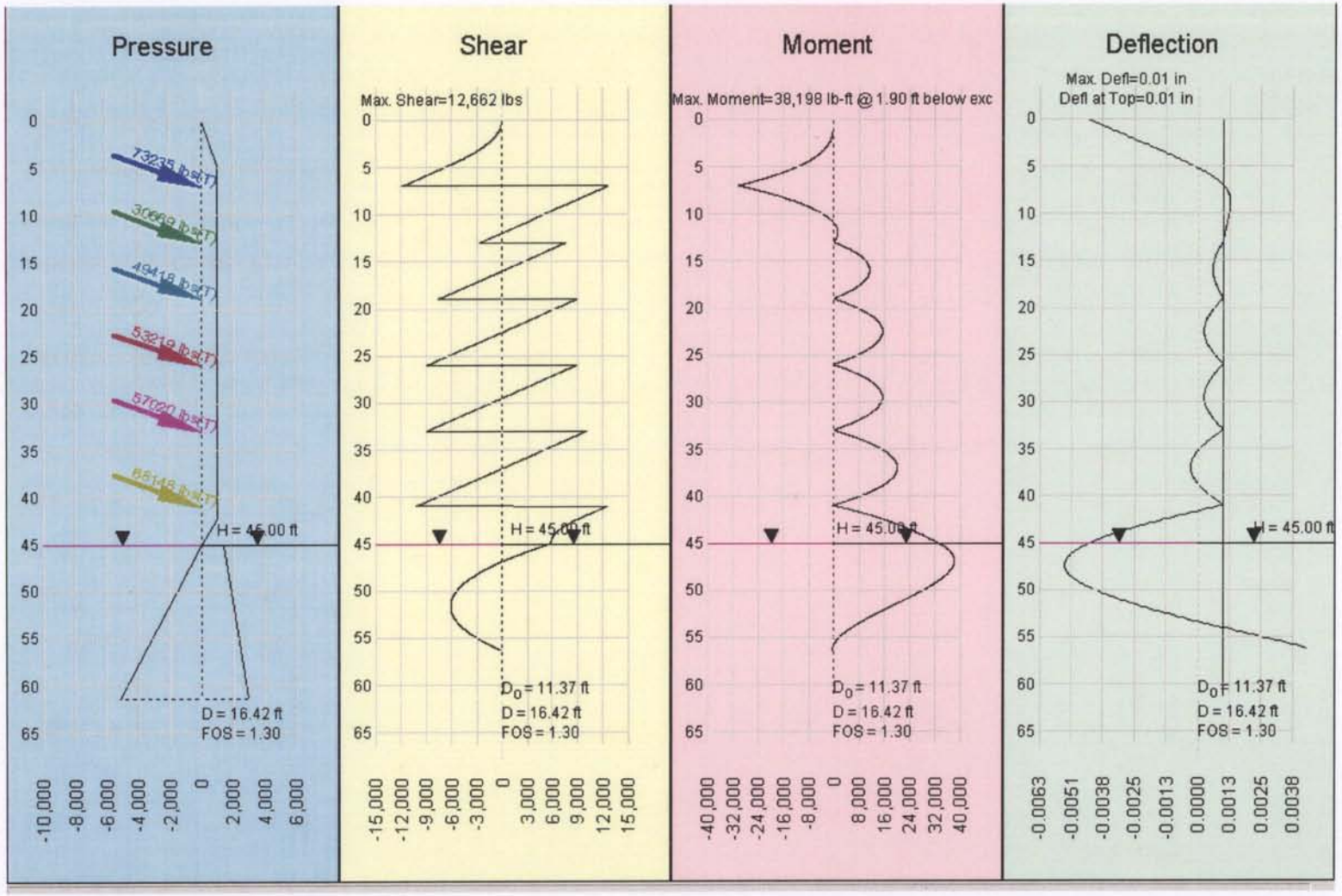


Figure 37: Static Analysis for Tangent Pile Wall with Tiebacks,
Segments 3 - RW 8 - Sta. 75+75.00 to 76+64.29 LOL
(Temporary Construction Condition)

APPENDIX A

LOCATION AND LOG OF TEST BORINGS

NOTE:
The information presented on this drawing was developed and performed by Arup PB JV for the California Department of Transportation (CALTRANS).

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101			

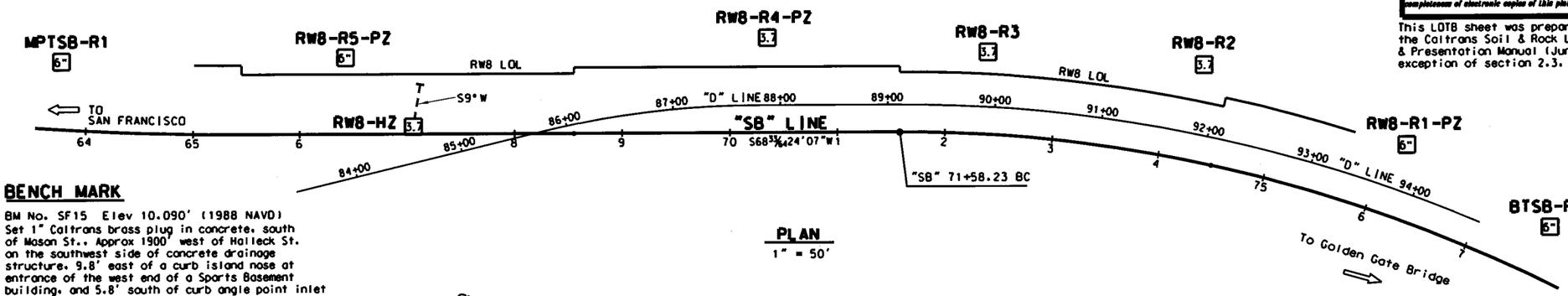
Terrence M Carroll 8-20-09
REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER
Terrence Carroll
No. C80889
Exp. 9-30-09
CIVIL
STATE OF CALIFORNIA

This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock Logging, Classification & Presentation Manual (June 2007), with the exception of section 2.3.

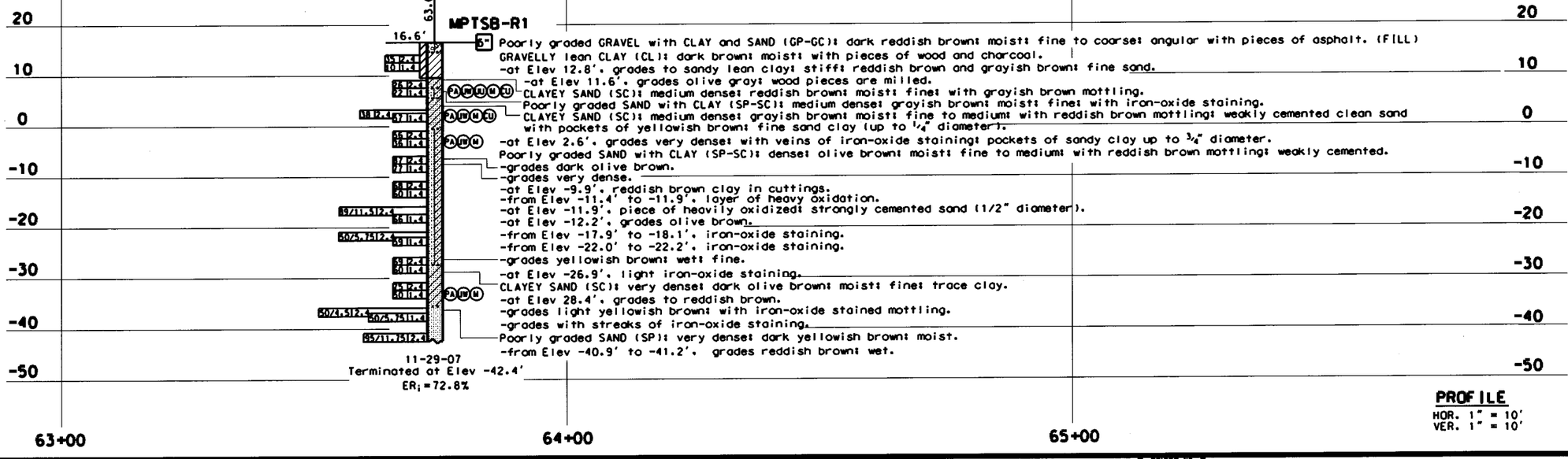


PLAN
1" = 50'

NOTE: Boring RW8-HZ is a horizontal boring with an inclination of 8° down from horizontal, and bearing of S9°W.

BENCH MARK

BM No. SF15 Elev 10.090' (1988 NAVD)
Set 1" Caltrans brass plug in concrete, south of Mason St., Approx 1900' west of Halleck St. on the southwest side of concrete drainage structure, 9.8' east of a curb island nose at entrance of the west end of a Sparts Basement building, and 5.8' south of curb angle point inlet at south edge of Mason St.
N 2120923.973
E 5995469.423



Poorly graded GRAVEL with CLAY and SAND (GP-GC): dark reddish brown; moist; fine to coarse; angular with pieces of asphalt. (FILL)
GRAVELLY lean CLAY (CL): dark brown; moist; with pieces of wood and charcoal.
-at Elev 12.8', grades sandy lean clay; stiff; reddish brown and grayish brown; fine sand.
-at Elev 11.6', grades olive gray; wood pieces are milled.
CLAYEY SAND (SC): medium dense; reddish brown; moist; fine; with grayish brown mottling.
Poorly graded SAND with CLAY (SP-SC): medium dense; grayish brown; moist; fine; with iron-oxide staining.
CLAYEY SAND (SC): medium dense; grayish brown; moist; fine to medium; with reddish brown mottling; weakly cemented clean sand with pockets of yellowish brown; fine sand clay (up to 1/4" diameter).
-at Elev 2.6', grades very dense; with veins of iron-oxide staining; pockets of sandy clay up to 3/4" diameter.
Poorly graded SAND with CLAY (SP-SC): dense; olive brown; moist; fine to medium; with reddish brown mottling; weakly cemented.
-grades dark olive brown.
-grades very dense.
-at Elev -9.9', reddish brown clay in cuttings.
-from Elev -11.4' to -11.9', layer of heavy oxidation.
-at Elev -11.9', piece of heavily oxidized; strongly cemented sand (1/2" diameter).
-at Elev -12.2', grades olive brown.
-from Elev -17.9' to -18.1', iron-oxide staining.
-from Elev -22.0' to -22.2', iron-oxide staining.
-grades yellowish brown; wet; fine.
-at Elev -26.9', light iron-oxide staining.
CLAYEY SAND (SC): very dense; dark olive brown; moist; fine; trace clay.
-at Elev 28.4', grades to reddish brown.
-grades light yellowish brown; with iron-oxide stained mottling.
-grades with streaks of iron-oxide staining.
Poorly graded SAND (SP): very dense; dark yellowish brown; moist.
-from Elev -40.9' to -41.2', grades reddish brown; wet.

11-29-07
Terminated at Elev -42.4'
ER_i = 72.8%

PROFILE
HOR. 1" = 10'
VER. 1" = 10'

ENGINEERING SERVICES	GEOTECHNICAL SERVICES			
FUNCTIONAL SUPERVISOR: NAME: F. Greguras (Arup PB JV)	DRAWN BY: C. Christian, I.C. Remmen, 6/09	CHECKED BY: R. Price	FIELD INVESTIGATION BY: T. Carroll (Arup PB JV)	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN
DESIGN BRANCH

BRIDGE NO. 34-E0014
POST MILES 8.8

RETAINING WALL NO. 8
LOG OF TEST BORINGS 1 OF 9

CU 04
EA 163701

DGN: CIVIL LOG OF TEST BORINGS SHEET
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES
SHEET OF
FILE =) $REQUEST
USERNAME =)USER DATE PLOTTED =)DATE TIME PLOTTED =)TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101			

Terrance McCall 8-20-09
REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER — Terrance Carroll — No. C00000 — Exp. 9-30-09 — CIVIL — STATE OF CALIFORNIA

This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock Logging, Classification & Presentation Manual (June 2007), with the exception of section 2.3.

FOR PLAN VIEW, SEE "LOG OF TEST BORINGS 1 OF 9"

70.0' Lt Sta 66+43.0
"S8" Line

RW8-R5-PZ

42.4'

5"

CLAYEY SAND with GRAVEL (SC): very loose; dark brown; dry; fine to coarse; fine gravel; trace roots with black specks. (FILL)
SANDY SILT (ML): very loose; reddish brown; dry to moist; ash and charcoal; fine gravel; some lenses (1/4" thick) of gravelly sand and rootlets.
Poorly graded SAND with SILT (SP-SM): dense to very dense; reddish brown; moist; slightly cemented, with black specks & iron-oxide mottling.
Poorly graded SAND (SP): dense; light yellowish brown; moist; fine to medium; trace fines.
-grades yellowish brown; iron oxide staining; sand grades fine.
Poorly graded SAND with CLAY (SP-SC): dense; light yellowish brown; moist; fine; 1/4" thick seam of iron-oxide and occasional black specks.
Poorly graded SAND (SP): dense; yellowish brown; moist; fine; trace fines.
Poorly graded SAND with CLAY (SP-SC): dense; yellowish brown; moist; fine.
-grades medium dense with iron-oxide staining.
Poorly graded SAND (SP): very dense; dark yellowish brown; moist; fine.
-thin zones (1" to 2") of poorly graded sand with clay; with iron-oxide staining.
-grades very dense; reddish brown; trace fines.
-grades dark yellowish brown.
Poorly graded SAND (SP): dense; dark yellowish brown moist; fine.
Poorly graded SAND with CLAY (SP-SC): dense; dark yellowish brown; moist; fine; with iron-oxide mottling.
Poorly graded SAND (SP): very dense; dark yellowish brown; moist; fine; trace fines; with iron-oxide staining.
-grades with iron-oxide mottling; sand grades very fine to fine.
Poorly graded SAND (SP): very dense; dark yellowish brown; moist; fine; trace fines; with iron-oxide staining.
Poorly grade SAND with SILT (SP-SM): very dense; yellowish brown; moist; fine; with iron-oxide mottling.
SILTY SAND (SM): very dense; olive brown; wet; fine to very fine; with iron-oxide staining.
-grades bluish gray; moist; with pockets of clay.
SANDY lean CLAY (CL): hard; bluish gray; moist; with white mineral nodules; white veins; and black specks.
-grades olive gray; very stiff.
-grades with shell fragments up to 1".
Lean CLAY with GRAVEL (CL): hard, greenish gray; fine to coarse gravel, angular to subangular; serpentinite fragments, with abundant shells.
Lean CLAY (CL): stiff; dark gray; moist; with black organic specks and pieces of decayed vegetation.
Poorly graded SILT with SAND and GRAVEL (SP-SM): very dense; bluish gray; moist; rounded to angular gravel; fine sand; serpentinite and sandstone fragments.
SILTY SAND (SM): greenish gray; moist; trace gravel; with pieces of decomposed wood; fine sand.

1-9-08
Terminated at Elev -105.1'
ER; = 72.8%

66+00 67+00

40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110

20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110

PROFILE
HOR. 1" = 10'
VER. 1" = 10'

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 34-E0014	RETAINING WALL NO. 8
FUNCTIONAL SUPERVISOR NAME:	DRAWN BY: C. Christian, I.G-Remmen, 8/09		DESIGN BRANCH	POST MILES 8.8	LOG OF TEST BORINGS 2 OF 9
	CHECKED BY: R. Price	FIELD INVESTIGATION BY:			
CGS CIVIL LOG OF TEST BORINGS SHEET	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04 EA 163701	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 07-29-09 07-27-09	SHEET OF

USERNAME = USER DATE PLOTTED = DATE TIME PLOTTED = TIME

FILE = REQUEST

DIST	COUNTY	ROUTE	KILOMETER POST/SHEET TOTAL PROJECT	No	TOTAL SHEETS
04	SF	1.101			

8-20-08
CERTIFIED ENGINEERING GEOLOGIST

PROFESSIONAL GEOLOGIST — Grant Wilcox — No. 2300 — Exp. 4-30-10 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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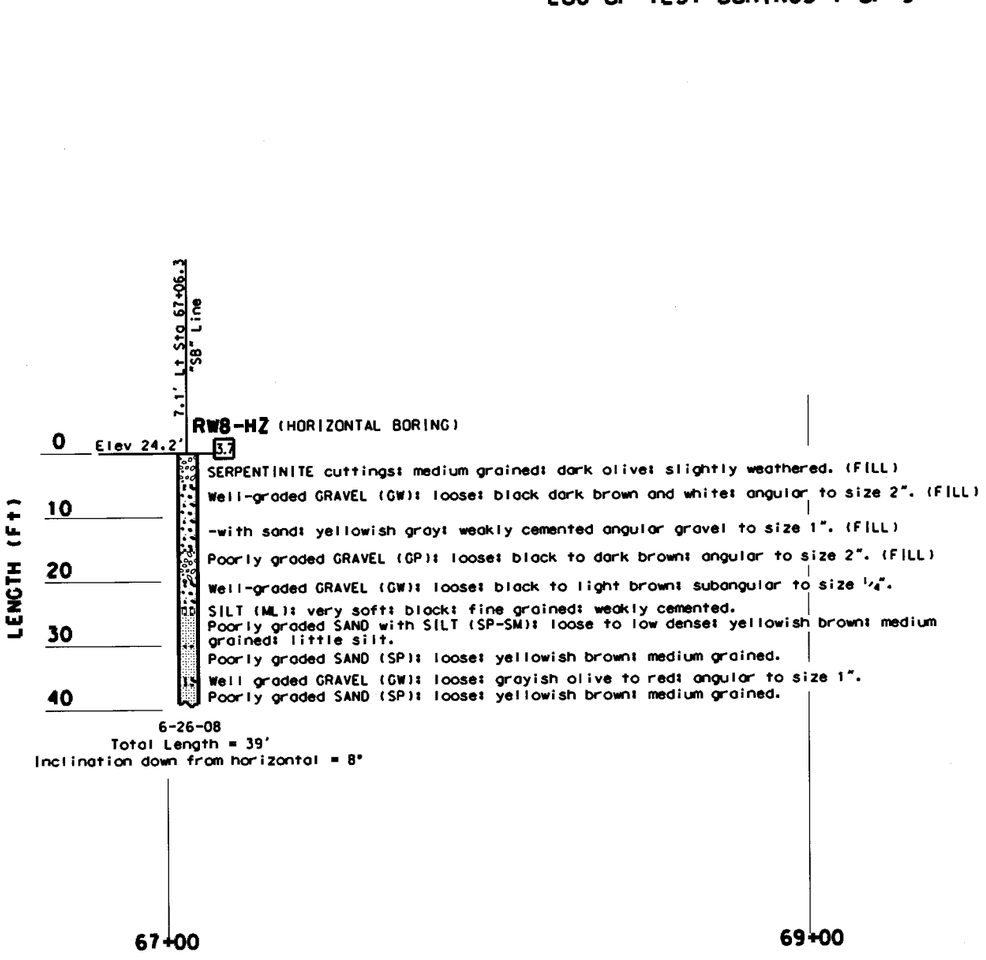
This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock Logging, Classification & Presentation Manual (June 2007), with the exception of section 2.3.

FOR PLAN VIEW, SEE
"LOG OF TEST BORINGS 1 OF 9"



ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	RETAINING WALL NO. 8
FUNCTIONAL SUPERVISOR: T. Pokrywka	DRAWN BY: C. Christian, I.O-Remmen, 6/09	CALIFORNIA	DESIGN BRANCH	34-E0014	LOG OF TEST BORINGS 3 OF 9
	CHECKED BY: R. Price	DEPARTMENT OF TRANSPORTATION		POST MILES 8.8	
	FIELD INVESTIGATION BY: R. Nashed				

CU 04 EA 163701

DGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: 07-29-08 | 07-27-08 | 08-18-08

SHEET OF

FILE •) $REQUEST

USERNAME = $USER DATE PLOTTED = $DATE TIME PLOTTED = $TIME

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	POST/BRIDGE No	TOTAL SHEETS
04	SF	1.101			

CERTIFIED ENGINEERING GEOLOGIST — 8-20-09

PROFESSIONAL GEOLOGIST — Grant Wilcox — No. 2300 — Exp. 4-30-10 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

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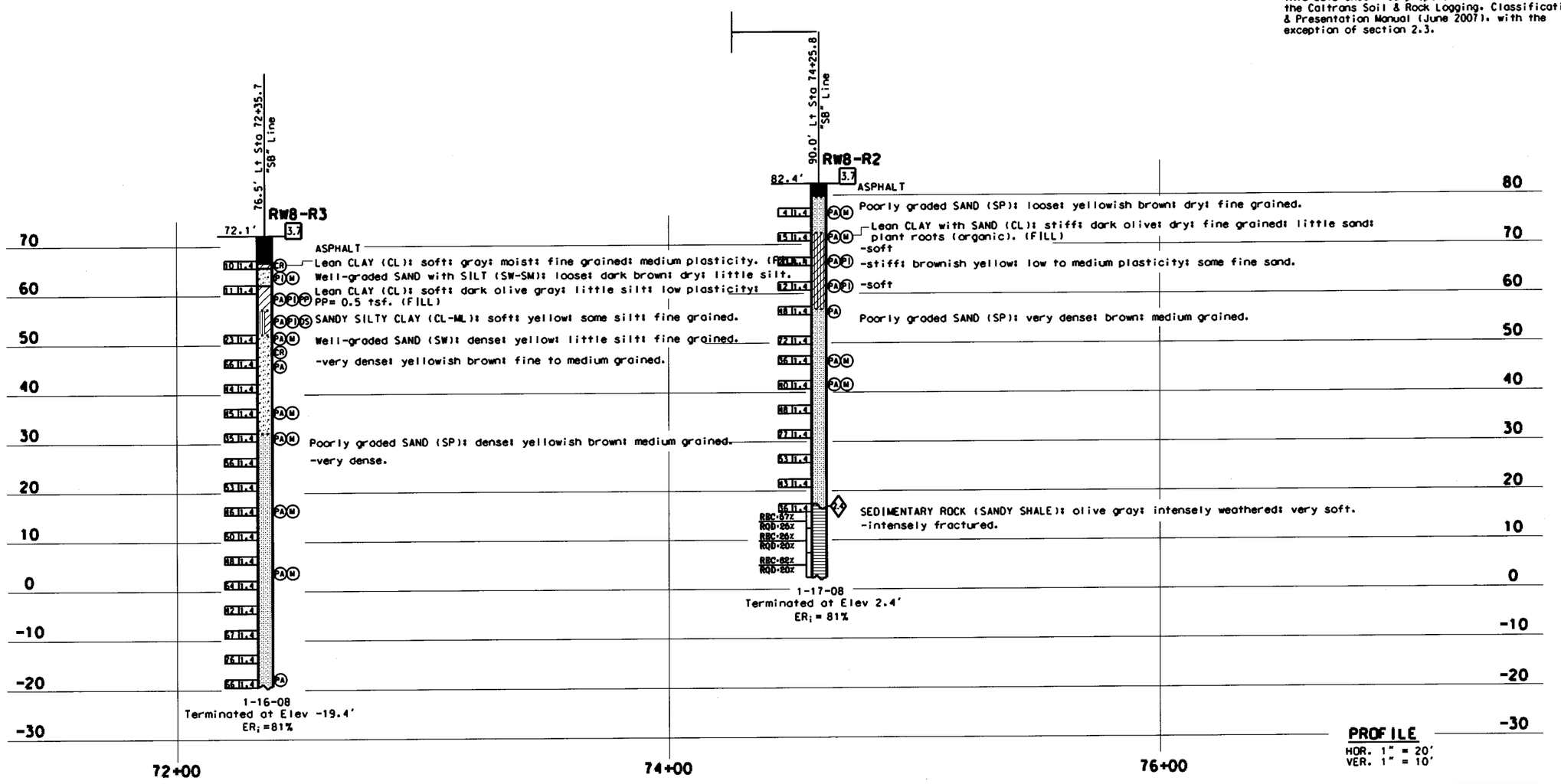
"LOG OF TEST BORINGS 1 OF 9"



ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 34-E0014	RETAINING WALL NO. 8
FUNCTIONAL SUPERVISOR NAME: T. Pokrywka	DRAWN BY: C. Christian, I.G-Remmen, 6/09	FIELD INVESTIGATION BY: R. Nashed	DESIGN BRANCH	POST MILES 8.8	LOG OF TEST BORINGS 4 OF 9
	CHECKED BY: R. Price				
DOS CIVIL LOG OF TEST BORINGS SHEET	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04 EA 163701		DISREGARD PRINTS BEARING EARLIER REVISION DATES: 07-29-08 07-29-08 08-11-08	REVISION DATES

FILE ·) $REQUEST

USERNAME ·)USER DATE PLOTTED ·)DATE TIME PLOTTED ·)TIME

NOTE:
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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101			

Terrence M Carroll 5-20-09
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER Terrence Carroll No. C60082 Exp. 9-30-09 CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

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FOR PLAN VIEW, SEE
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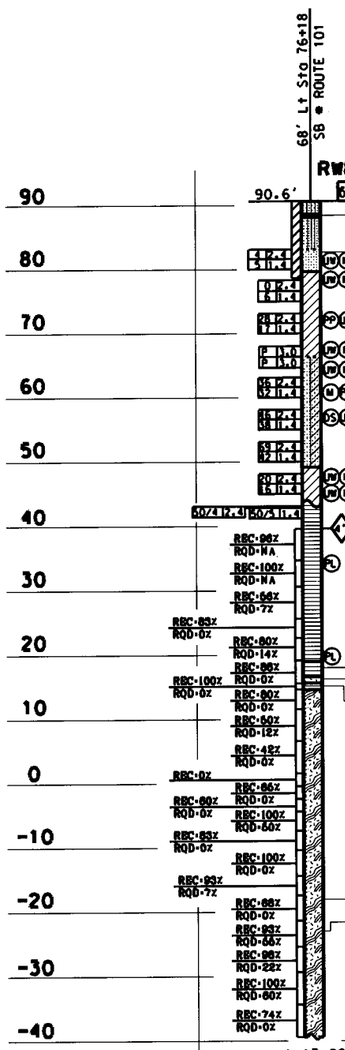

90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40

SILTY SAND (SM): dark brown; moist; fine sand; with fine angular gravel; with roots and plan debris; earth odor detected; (FILL).
-2.0' to 2.5': remnant brick structure.
Poorly graded SAND with SILT (SP-SM): loose; fine; yellowish brown; moist; with wood pieces; earthy odor detected; (FILL).
-grades to brown.
Poorly graded SAND (SP): loose; yellowish brown; moist; very fine sand; trace fines.
-grades dark brown with slight increase in fines content.
Lean CLAY (CL): medium stiff; dark brown; moist; trace fine sand; earthy odor detected.
-yellowish brown; with black specks and dark gray mottling; trace very fine sand.
-grades to very stiff.
-increase in sand content; sand is fine.
-grades with trace fine sand.
Poorly graded SAND with CLAY (SP-SC): medium dense; fine to medium; reddish brown; moist; with occasional coarse sand.
-grades dense; with black specks.
-grades yellowish brown with black mottling and iron-oxide staining.
-grades without iron-oxide staining and without black mottling.
Lean CLAY (CL): stiff to very stiff; reddish brown; moist; trace sand; with frequent black specks and crushable nodules.
-reddish brown; with crushed nodules; with white veins; slight rock structure; decomposed rock.
SEDIMENTARY ROCK (SANDSTONE): fine to medium; reddish brown; decomposed; very soft (poorly graded SAND (SP): very dense; fine to medium sand; moist).
-Grades to yellowish brown, moderately weathered, moderately soft to soft, moderately fractured, numerous incipient fractures, fractures are filled with white precipitate (soft).
-from Elev 39.3' to 38.4', brecciated zone.
-from Elev 31.4' to 30.6', interbedded siltstone lenses (0.1' to 0.3' thick) worth soft sediment deformation.
-from Elev 29.2' to 27.8', very intensely fractured (fragments of sandstone and siltstone mylonized).
-fractures are variably oriented; heavy iron-oxide staining on fracture surfaces.
-from Elev 20.8' to 20', interbedded siltstone lenses (soft sediment deformation?).
SEDIMENTARY ROCK (SANDSTONE BRECCIA): fine grained dark brown and yellowish brown; moderately weathered; soft with harder inclusions; moderately fractured.
METAMORPHIC ROCK (SERPENTINITE): dark greenish gray; intensely weathered; very soft; very intensely fractured; pervasively sheared.
SEDIMENTARY ROCK (SANDSTONE BRECCIA): fine to medium grained; dark yellowish brown; moderately weathered; soft (with 0.05' to 0.1' thick fragments of siltstone and sandstone).
METAMORPHIC ROCK (SERPENTINITE): light greenish gray and dark greenish gray; slightly weathered to fresh; very soft to moderately hard; moderately to slightly fractured; common white secondary mineral veins; commonly intensely sheared.
-from Elev 11.1' to 10.8' and from 10.3' to 10', white apparent decomposition to talc?
-at Elev -2.4', white secondary mineral "blocks" and vein fillings common throughout interval (up to 0.05' thick).
-intensely fractured.
-healed white anatomized fractures.
-from Elev -26.3' to -29.3', polished surfaces on fractures; from -27.2' to -29.4', brecciated zone.
-at Elev -28.7'; fibrous texture noted; from -30' to -32.5', very dark gray; gabbroic; dense; moderately hard; moderately fractured.
-at Elev -30.9', fibrous secondary mineral deposit on fracture. From Elev -31.6' to -32.4', white mineral vein infilling.
-at Elev -32.5', light greenish gray; soft; intensely fractured (non-gabbroic). From -33.8', 0.01' thick fibrous secondary mineral deposit on fracture-oriented perpendicular to fracture.
-at Elev -35.7', gabbroic.

PROFILE
HOR. 1" = 10'
VER. 1" = 10'

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 34-E0014	RETAINING WALL NO. 8
FUNCTIONAL SUPERVISOR: NAME: F. Greguras (Arup PB JV)	DRAWN BY: C. Christian, I.G-Remmen, 7/09	FIELD INVESTIGATION BY: T. Carroll (Arup PB JV)	DESIGN BRANCH	POST MILES 8.8	LOG OF TEST BORINGS 5 OF 9
	CHECKED BY: R. Price				

ORIGINAL SCALE IN INCHES FOR ENGLISH PLANS: 0 1 2 3
CU 04
EA 163701
FILE -> $REQUEST
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES: 07-22-09 07-27-09 08-18-09
SHEET OF

DGS CIVIL LOG OF TEST BORINGS SHEET

USERNAME -> $USER DATE PLOTTED -> $DATE TIME PLOTTED -> $TIME

NOTE:
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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101			

Terrence McCarroll 8-20-09
REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C60000 — Exp. 9-30-09 — CIVIL — STATE OF CALIFORNIA

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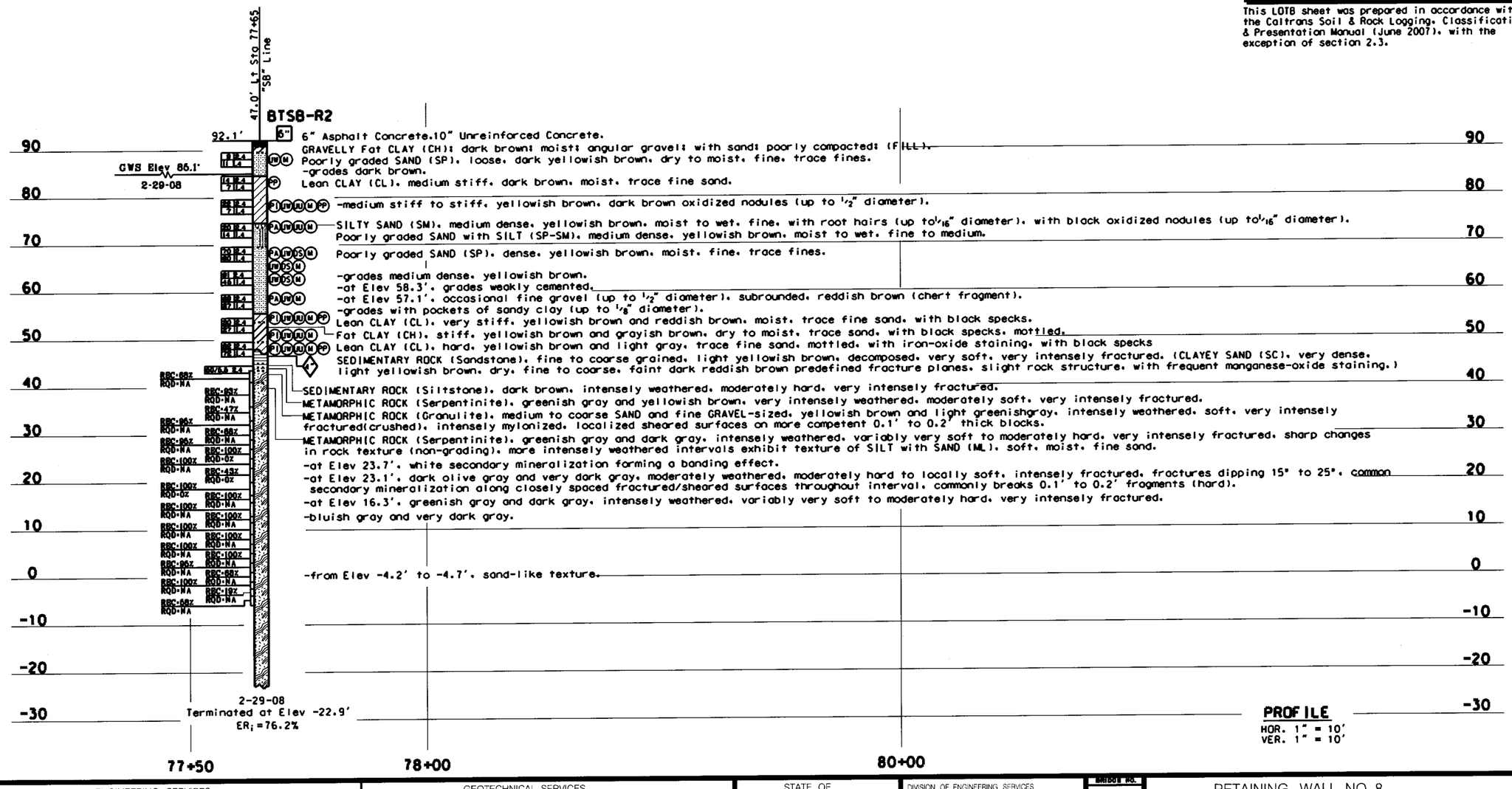
FOR PLAN VIEW, SEE
"LOG OF TEST BORINGS 1 OF 9"



ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 34-E0014	RETAINING WALL NO. 8
FUNCTIONAL SUPERVISOR NAME: F. Greguras (Arup PB JV)	DRAWN BY: J.G-Remmen, 7/09 CHECKED BY: R. Price	FIELD INVESTIGATION BY: T. Carroll (Arup PB JV)	DESIGN BRANCH	POST MILES 8.8	LOG OF TEST BORINGS 6 OF 9
DGN: CIVIL LOG OF TEST BORINGS SHEET	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04 EA 163701 FILE =) $REQUEST	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 07-28-09 07-29-09 08-18-09	SHEET OF

USERNAME =)USER DATE PLOTTED =)DATE TIME PLOTTED =)TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	KILOMETER POST/REV TOTAL PROJECT	No	TOTAL SHEETS
04	SF	1, 101			

CERTIFIED ENGINEERING GEOLOGIST 8-20-09

PROFESSIONAL GEOLOGIST Grant Wilcox No. 2300 Exp. 4-30-10 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

PLANS APPROVAL DATE

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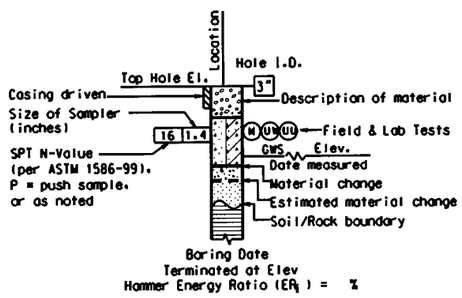
CEMENTATION	
Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

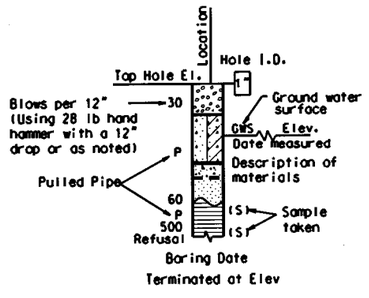
BOREHOLE IDENTIFICATION		
Symbol	Hole Type	Description
	A	Auger Boring
	R P	Rotary drilled boring Rotary percussion boring (air)
	R	Rotary drilled diamond core
	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778-95)
	O	Other
Note: Size in inches.		

CONSISTENCY OF COHESIVE SOILS				
Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	≤ 0.25	≤ 0.25	≤ 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	¢ 4.0	¢ 4.0	¢ 2.0	Indented by thumbnail with difficulty

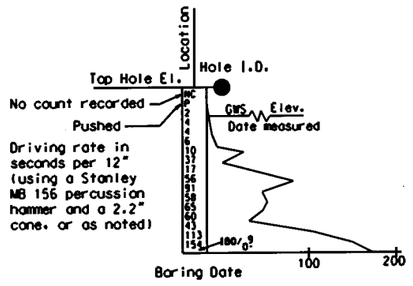
PLASTICITY OF FINE-GRAINED SOILS	
Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.



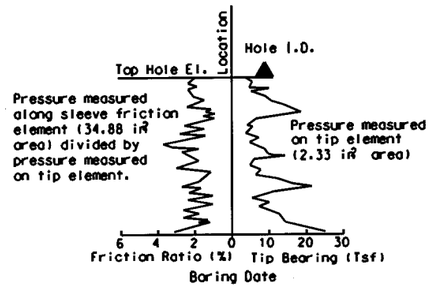
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH	BRIDGE NO. 34-E0014 POST MILE 8.8	RETAINING WALL NO. 8 LOG OF TEST BORINGS 7 OF 9
	PREPARED BY: I.G-Remmen, 7/09				

08 LOTB SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04 EA 163701

FILE =i $REQUEST

BORDER AND PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES

SHEET OF

USERNAME = $USER DATE PLOTTED = $DATE TIME PLOTTED = $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (PP) Pocket Penetrometer
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (TV) Pocket Torvane
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)
- (VS) Vane Shear (AASHTO T 223)

DIST	COUNTY	ROUTE	KILOMETER POST/MISC TOTAL PROJECT	No	TOTAL SHEETS
04	SF	1, 101			

CERTIFIED ENGINEERING GEOLOGIST — 8-20-09

PLANS APPROVAL DATE

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PROFESSIONAL GEOLOGIST — Grant Wilcox — No. 2200 — Exp. 4-30-10 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	¢ 50

MOISTURE

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		¢ 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

ENGINEERING SERVICES

GEOTECHNICAL SERVICES

PREPARED BY: I.O-Remmen, 7/09

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN — DESIGN BRANCH

BRIDGE NO. 34-E0014

POST MILE 8.6

RETAINING WALL NO. 8

LOG OF TEST BORINGS — 8 OF 9

CE LOTS SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04 BA 163701

FILE -) $REQUEST

HARDCARD PRINTS DRAWING EARLIER REVISION DATES →

REVISION DATES

SHEET OF

USERNAME =$USER DATE PLOTTED =$DATE TIME PLOTTED =$TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	KILOMETER POST/REF TOTAL PROJECT	No	TOTAL SHEETS
04	SF	1.101			

CERTIFIED ENGINEERING GEOLOGIST — 8-20-09

PLANS APPROVAL DATE

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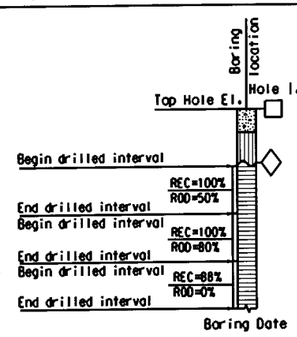
PROFESSIONAL GEOLOGIST — Grant Wilcox — No. 2300 — Exp. 4-30-10 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PERCENT CORE RECOVERY (REC) & ROCK QUALITY DESIGNATION (RQD)

$$REC = \frac{\sum \text{Length of the recovered core pieces (inches)}}{\text{Total length of core run (inches)}} \times 100\%$$

$$RQD = \frac{\sum \text{Length of intact core pieces} \geq 4"}{\text{Total length of core run (inches)}} \times 100\%$$



RELATIVE STRENGTH OF INTACT ROCK

Term	Uniaxial Compressive Strength (PSI)
Extremely Strong	¢ 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	≤ 150

BEDDING SPACING

Description	Thickness / Spacing
Massive	Greater than 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8" to 1 ft
Thinly bedded	1-1/4" to 3-5/8"
Very thinly bedded	3/8" to 1-1/4"
Laminated	Less than 3/8"

LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

ROCK HARDNESS

Description	Criteria
Extremely Hard	Specimen cannot be scratched with a pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows.
Very Hard	Specimen cannot be scratched with a pocket knife or sharp pick. Breaks with repeated heavy hammer blows.
Hard	Specimen can be scratched with a pocket knife or sharp pick with difficulty (heavy pressure). Heavy hammer blows required to break specimen.
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure. Core breaks with moderate hammer blows.
Moderately Soft	Specimen can be grooved 1/6" deep with a pocket knife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Specimen can be grooved or gauged easily by a pocket knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very Soft	Specimen can be readily indented, grooved or gauged with fingernail, or carved with a pocket knife. Breaks with light manual pressure.

FRACTURE DENSITY

Description	Observed Fracture Density
Unfractured	No fractures.
Very slightly fractured	Lengths greater than 3 feet.
Slightly fractured	Lengths from 1 to 3 feet with few lengths less than 1 foot or greater than 3 feet.
Moderately fractured	Lengths mostly in 4" to 1 foot range with most lengths about 8"
Intensely fractured	Lengths average from 1 to 4" with scattered fragmented intervals with lengths less than 4"
Very intensely fractured	Mostly chips and fragments with a few scattered short core lengths.

Combination descriptors (such as "Very intensely to intensely fractured") are used where equal distribution of both fracture density characteristics is present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions. Only two adjacent descriptors may be combined.

WEATHERING DESCRIPTORS FOR INTACT ROCK

Description	Diagnostic features: Chemical Weathering-Discoloration and/or oxidation — Body of Rock	Diagnostic features: Chemical Weathering-Discoloration and/or oxidation — Fracture Surfaces	Diagnostic features: Mechanical Weathering-Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Diagnostic features: Texture and Solutioning — Texture	Diagnostic features: Texture and Solutioning — Solutioning	General Characteristics
Fresh	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change.	No solutioning.	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fracturest some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in-situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Combination descriptors (such as "slightly weathered to fresh") are permissible where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant, identifiable zones can be delineated. Only two adjacent descriptors may be combined. "Very intensely weathered" is the combination descriptor for "intensely weathered to decomposed."

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA — DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES — STRUCTURE DESIGN — DESIGN BRANCH	BRIDGE NO. 34-E0014 — POST MILE 8.8	RETAINING WALL NO. 8 — LOG OF TEST BORINGS — 9 OF 9
	PREPARED BY: I.G-Remmen, 7/09	CU 04 EA 163701			

GB LOTB ROCK LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

FILE =) $REQUEST

DGN/CLARD PRINTS DRAWING EARLIEST REVISION DATES →

REVISION DATES | SHEET OF

USERNAME =$USER DATE PLOTTED =$DATE TIME PLOTTED =$TIME

APPENDIX B

GROUNDWATER MONITORING AND LABORATORY TEST DATA

GROUNDWATER MONITORING DATA

	RESULTS OF GROUNDWATER MONITORING												
Borehole ID	RW18-A1-PZ-D	RW18-A1A-PZ-S	RW19-A1-PZ-D	RW19-A1A-PZ-S	RW6-R1-PZ	RW6-R2-PZ-D	RW6-R2A-PZ-S	RW8-R1A-PZ	RW8-R4-PZ	RW8-R5-PZ	TS-R1-PZ-D	TS-R1A-PZ-I	TS-R1B-PZ-S
Piezometer ID	Deep	Shallow	Deep	Shallow		Deep	Shallow				Deep	Intermediate	Shallow
Elevation, NAVD88 (ft)	10.35	10.326	15.379	15.375	108.507	108.659	108.315	90.616	61.569	42.437	12.301	12.379	12.284
Screen Depth Inverval (ft)	20.0 to 30.0	4.0 to 9.0	20.0 to 30.0	4.5 to 9.5	12.0 to 22.0	76.0 to 98.0	12.0 to 29.0	25.0 to 45.0	85.0 to 95.0	15.0 to 35.0	40.0 to 50.0	15.0 to 20.0	2.0 to 7.0
Screened Material	Marine Sand, Colma Sand	Sandy Bay Mud, Bay Mud, Marine Sand	Marine Sand, Bay Mud, Colma Sand	Fill, Marine Sand	Colma Sand, Sandstone	Sandstone, Shale	Colma Sand, Sandstone	Colma Sand, Clay within Colma Formation, Residual Soil	Information Not Available to Arup	Colma Sand	Colma Sand	Marine Sand	Fill, Bay Mud
Pipe Inside Diameter (in)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.5	2.0	2.0	2.0	2.0
Date Installed	1/3/2008	1/3/2008	1/4/2008	1/4/2008	2/28/2008	4/17/2008	4/17/2008	1/17/2008	1/17/2008	1/9/2008	12/20/2007	12/18/2007	12/17/2007
Date Developed	3/26/2008	3/26/2008	3/24/2008	3/24/2008	6/9/2008	6/9/2008	6/9/2008	6/11/2008	6/11/2008	6/11/2008	3/27/2008	3/27/2008	3/26/2008
Date Read													
08/02/02													
08/05/02													
12/04/07													
12/20/07													
02/11/08													
03/04/08													
03/05/08													
03/21/08													
03/24/08			1.6	7.2									
03/25/08													
03/26/08	-1.6	2.1											4.8
03/27/08											2.0	4.5	
03/28/08									45.5				
06/09/08					19.87	41.7	Dry						
06/10/08													
06/11/08								39.5	49.0	28.0			
06/12/08													
06/13/08													
06/16/08													
07/18/08	-1.5	3.2	3.2	7.6	20.2	50.4	28.2	38.7	45.9	28.1	1.9	5.1	4.9
08/29/08					20.6	52.2	28.6	38.8					
09/22/08													
10/03/08													
11/18/08	-1.55		3.17	7.47							1.81	4.36	4.34
Average	-1.5	3.2	3.2	7.5	20.4	51.3	28.4	38.8	45.9	28.1	1.8	4.7	4.6

ARUP PB
joint venture

LABORATORY TEST DATA

Boring BTSB-R2

MOISTURE & DENSITY TEST

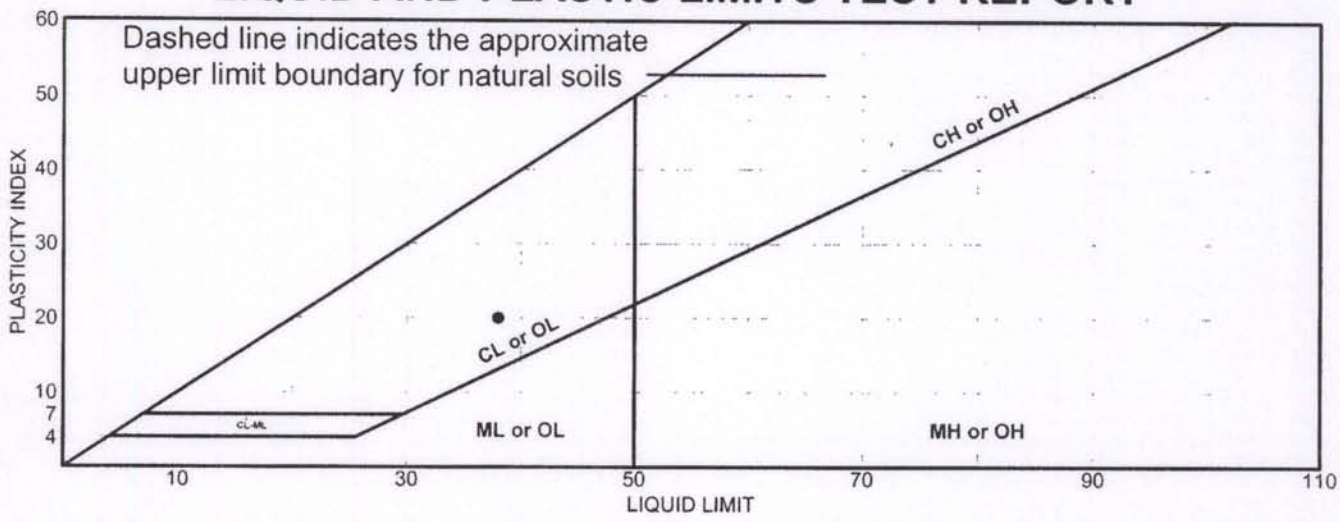
Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

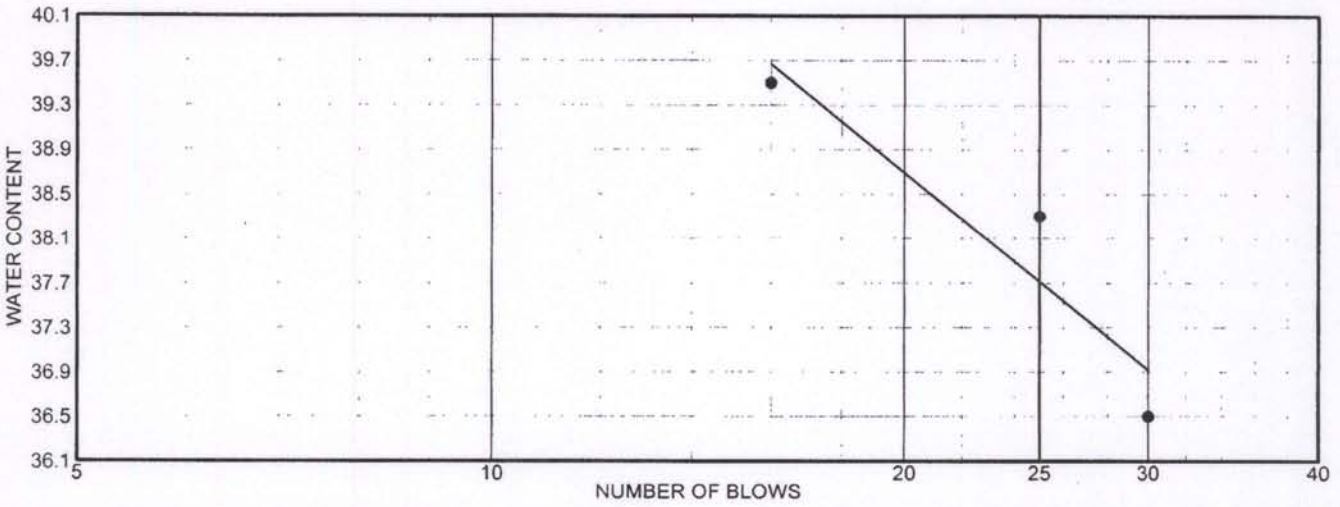
	Boring #	BTSB-R1	BTSB-R2	BTSB-R3A	BTNB-R4	BTNB-R4	BTNB-R4	BTNB-R4	BTNB-R6	
	Sample #	5B	1B	3A	3A	5B	13A	19A	3B	
	Depth (ft.)	13-13.5	3-3.5	2.8-3.3	8-8.5	13.1-13.6	32.8-33.3	47.8-48.3	7.9-8.4	
	Soil type: (visual)	Brown poorly graded sand	Brown sand	Brown poorly graded sand	Brown lean clay with sand	Brown sandy silt	Brown poorly graded sand with clay	Brown sand	Reddish brown poorly graded sand with silt	
1.	Date tested:	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/22/08	05/22/08	1.
2.	Tested by:	CN	CN	CN	CN	CN	CN	KA	KA	2.
3.	Specimen height (in.)	5.81	6.00	6.00	4.93	5.88	5.85	5.80	6.00	3.
4.	Wt. of specimen + tare (gm)	1060.5	1074.3	1085.5	778.7	971.8	1152.9	933.0	901.0	4.
5.	Tare wt. (gm)	206.40	213.11	261.30	0.00	0.00	213.41	0.00	0.00	5.
6.	Diameter (in.)	2.42	2.42	2.40	2.42	2.42	2.42	2.41	2.42	6.
7.	Wet wt. of soil + dish wt. (gm)	1137.90	225.09	281.36	277.11	322.07	333.81	690.09	276.28	7.
8.	Dry wt. of soil + dish wt. (gm)	1026.90	216.59	266.41	248.89	287.17	286.65	622.49	246.32	8.
9.	Wt. of dish (gm)	284.85	54.75	42.33	43.19	40.42	51.73	303.12	42.87	9.
10.	Dish ID									10.
	Wet Density (pcf)	121.7	118.8	115.6	130.7	136.8	132.9	134.2	124.3	
	Dry Density (pcf)	105.8	112.9	108.4	114.9	119.8	110.7	110.8	108.3	
	Moisture Content (%)	15.0	5.3	6.7	13.7	14.1	20.1	21.2	14.7	
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.592	0.493	0.555	0.466	0.406	0.522	0.521	0.555	
	Saturation (%)	68.2	28.8	32.5	79.5	94.0	103.8	109.7	71.6	

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay	38	18	20			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 5A **Elev./Depth:** 12.8-13.3

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

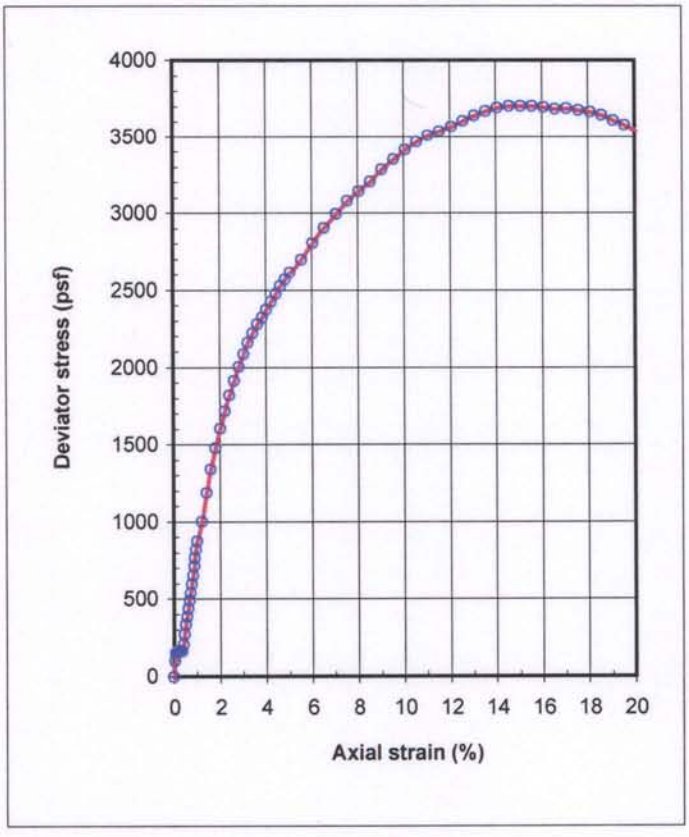
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 5A
Depth (ft) : 12.8
Date tested : 05/30/08
Soil : Reddish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

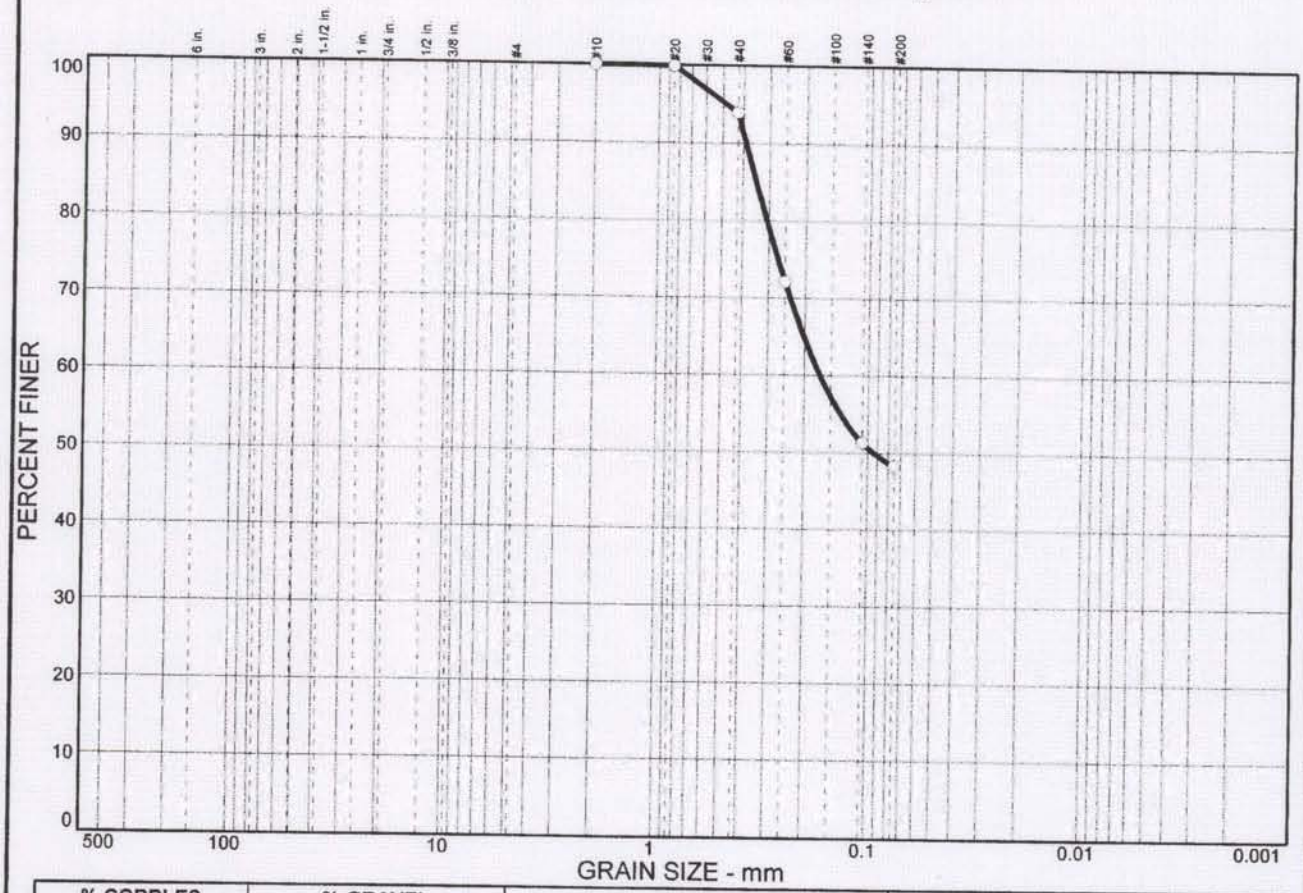
Specimen:
Total wt. = 929.4 gms
Ht. = 6.000 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 452.4 c.c.
Shearing rate = 0.05 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.610
Ht/Dia ratio = 2.48
Moisture = 22.5 %
Total density = 128.2 pcf
Dry density = 104.6 pcf
Saturation = 99.6 %
Chamber pressure = 2250 psf
Max. deviator stress = 3707 psf
Strain @ failure = 15.08 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	3.2	0.05	100.5
0.003	4.9	0.07	154.1
0.004	4.8	0.10	151.5
0.007	4.8	0.15	151.1
0.010	5.0	0.20	155.3
0.013	5.2	0.25	161.5
0.016	5.4	0.30	167.3
0.018	5.3	0.33	165.7
0.021	5.1	0.37	159.8
0.024	6.6	0.43	205.9
0.027	8.9	0.47	275.7
0.030	10.8	0.52	337.5
0.033	12.5	0.57	387.5
0.036	14.1	0.62	437.9
0.039	15.8	0.67	492.5
0.042	17.4	0.72	540.5
0.045	19.3	0.77	599.3
0.048	21.1	0.82	655.2
0.051	23.1	0.88	716.5
0.054	24.8	0.92	768.1
0.057	26.5	0.97	821.6
0.060	28.3	1.02	876.4
0.072	32.5	1.23	1004.3
0.084	38.6	1.43	1190.3
0.096	43.7	1.63	1344.2
0.108	48.2	1.83	1482.2
0.120	52.4	2.03	1605.6
0.133	56.2	2.24	1719.5
0.145	59.7	2.44	1823.1
0.156	62.9	2.63	1917.0
0.169	65.9	2.84	2004.8
0.181	68.9	3.05	2089.4
0.193	71.4	3.24	2162.8
0.205	73.7	3.44	2226.5
0.217	75.7	3.65	2282.2
0.230	77.4	3.85	2328.7
0.241	79.2	4.05	2379.2
0.253	81.1	4.25	2430.6
0.266	83.0	4.46	2481.2
0.278	84.8	4.66	2529.7
0.290	86.5	4.86	2574.5
0.302	88.1	5.06	2618.3
0.332	91.3	5.56	2698.0
0.362	95.6	6.06	2810.0
0.392	99.4	6.56	2906.1
0.422	103.1	7.07	2998.1
0.452	106.6	7.57	3085.0
0.482	109.4	8.07	3146.9

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	51.7	48.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	93.9		
#60	72.1		
#140	51.3		
#200	48.3		

* (no specification provided)

Soil Description

Reddish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.346 D_{60}= 0.169 D_{50}= 0.0936
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Sample No.: 7A **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 17.8-18.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

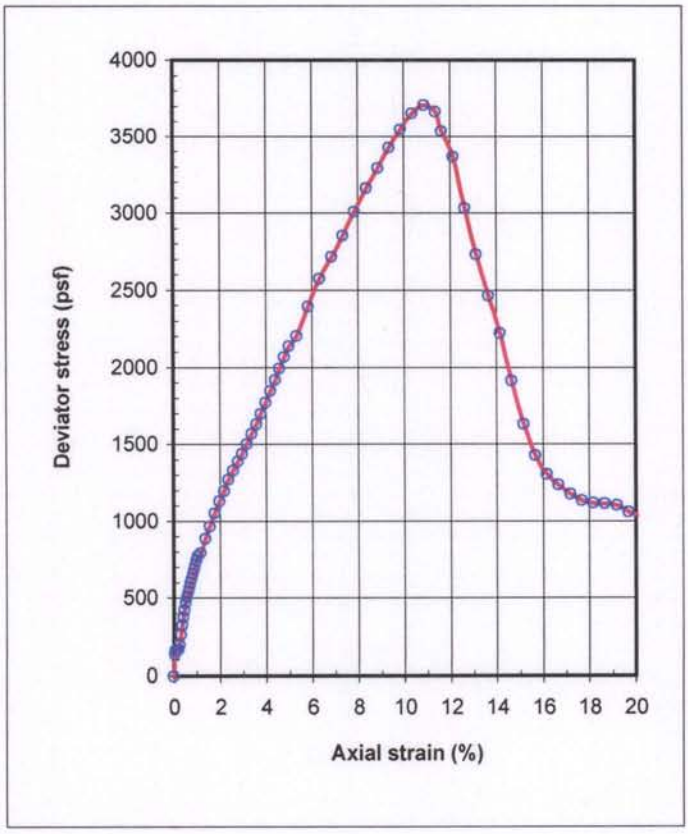
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 7A
Depth (ft) : 17.8
Date tested : 05/30/08
Soil : Reddish brown clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

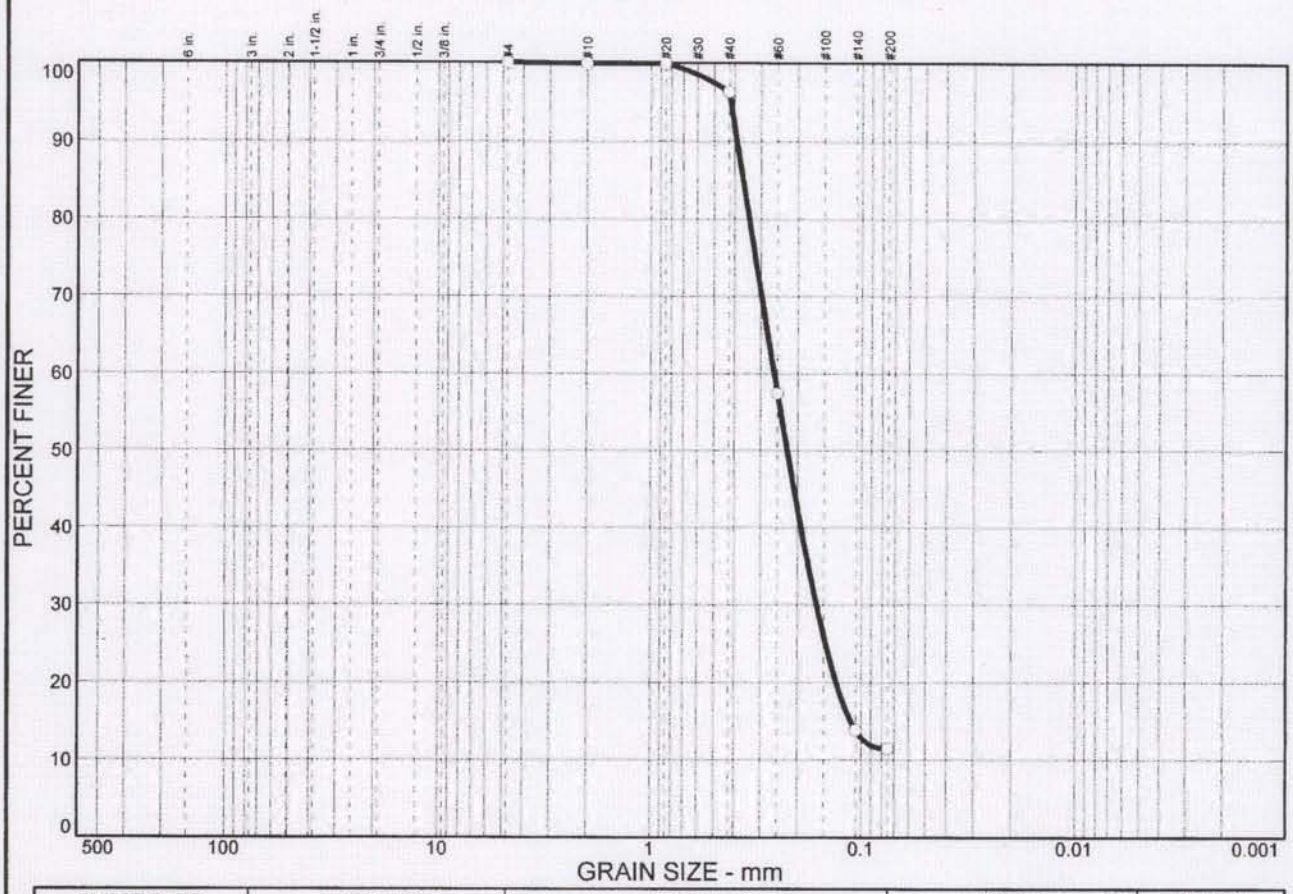
Specimen:
Total wt. = 976.6 gms
Ht. = 5.950 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 448.7 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.478
Ht/Dia ratio = 2.46
Moisture = 19.1 %
Total density = 135.8 pcf
Dry density = 114.0 pcf
Saturation = 108.2 %
Chamber pressure = 3100 psf
Max. deviator stress = 3708 psf
Strain @ failure = 10.88 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	4.4	0.05	136.6
0.003	5.3	0.07	166.3
0.005	5.3	0.10	165.7
0.007	5.4	0.14	167.9
0.011	5.4	0.20	169.1
0.014	6.4	0.25	201.2
0.017	8.6	0.31	268.3
0.020	10.6	0.36	329.1
0.023	12.2	0.41	379.2
0.026	13.7	0.47	426.1
0.029	15.1	0.52	469.8
0.033	16.3	0.57	508.1
0.036	17.4	0.62	542.1
0.039	18.4	0.68	573.0
0.042	19.5	0.73	604.7
0.045	20.3	0.79	631.5
0.049	21.4	0.84	663.2
0.052	22.3	0.89	692.1
0.054	23.3	0.93	721.5
0.058	24.1	0.99	748.1
0.061	25.0	1.05	774.0
0.068	25.7	1.17	794.0
0.080	28.8	1.37	890.2
0.092	31.5	1.58	968.8
0.104	34.3	1.78	1055.1
0.116	36.9	1.98	1133.1
0.128	39.2	2.18	1199.9
0.140	41.7	2.38	1272.8
0.152	43.6	2.58	1330.3
0.164	45.7	2.79	1391.0
0.176	47.5	2.99	1443.1
0.188	49.6	3.19	1502.6
0.200	52.0	3.39	1572.9
0.212	54.2	3.59	1635.6
0.224	56.5	3.79	1700.9
0.236	59.0	4.00	1773.0
0.248	61.7	4.20	1850.0
0.260	64.1	4.40	1919.2
0.272	66.7	4.60	1992.3
0.284	69.4	4.80	2066.6
0.296	72.0	5.00	2139.6
0.317	74.4	5.35	2204.5
0.347	81.4	5.86	2399.6
0.377	87.9	6.35	2576.7
0.407	93.3	6.86	2719.3
0.437	98.5	7.37	2855.5
0.466	104.4	7.86	3011.3
0.497	110.4	8.37	3164.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	88.6	11.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	96.3		
#60	57.4		
#140	13.8		
#200	11.4		

* (no specification provided)

Soil Description

Reddish brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.365 D_{60}= 0.259 D_{50}= 0.225
D_{30}= 0.163 D_{15}= 0.112 D_{10}=
C_u= C_c=

Classification

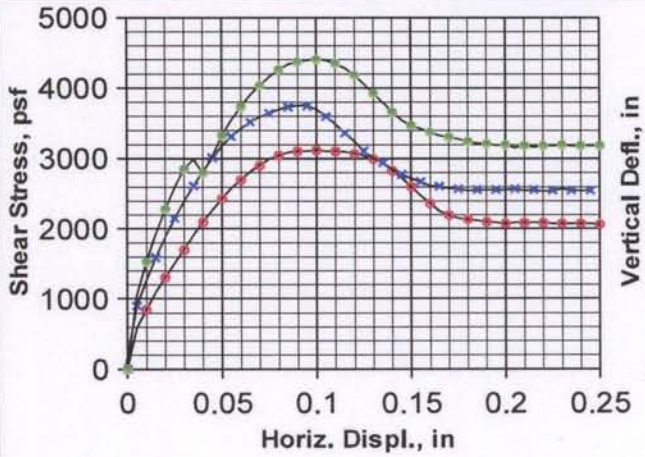
USCS= SP-SM AASHTO=

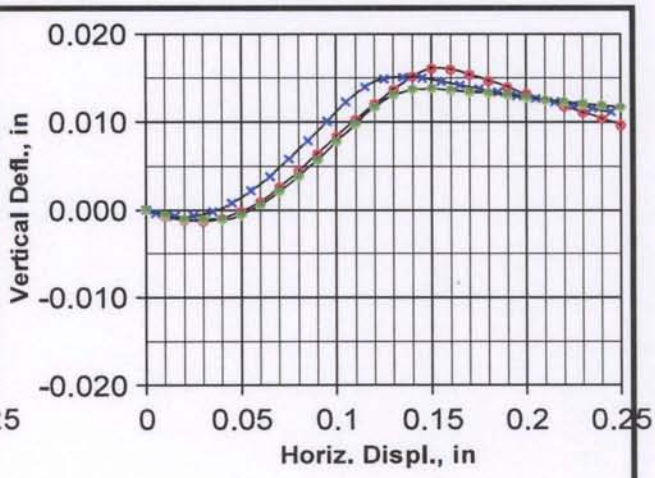
Remarks

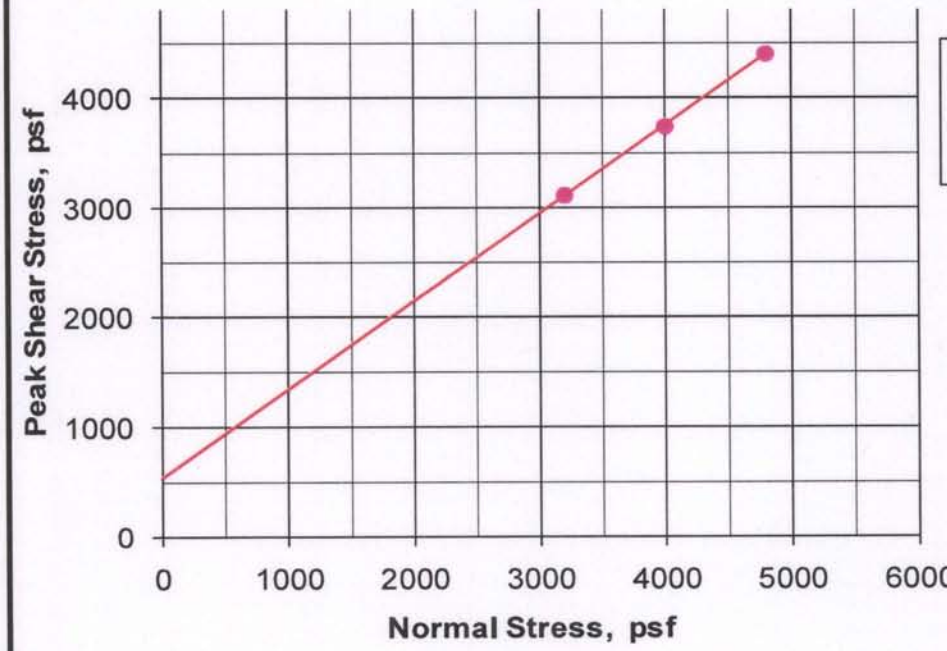
Sample No.: 11B **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 28.1-28.4

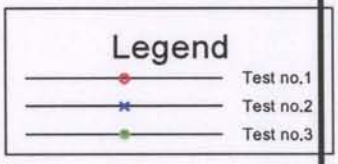
SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**









Results

C = 550 psf
phi = 39 deg.

Gs = 2.70
Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	3200	3120	0.100	0.18	21.8	106.8	102	0.578	1.00	2.416	20.7	103.6	89	0.627	1.031
2	4000	3744	0.090	0.18	20.7	107.6	99	0.567	1.00	2.416	20.2	103.2	86	0.633	1.042
3	4800	4404	0.100	0.18	20.6	107.8	99	0.564	1.00	2.416	20.2	103.9	88	0.622	1.037

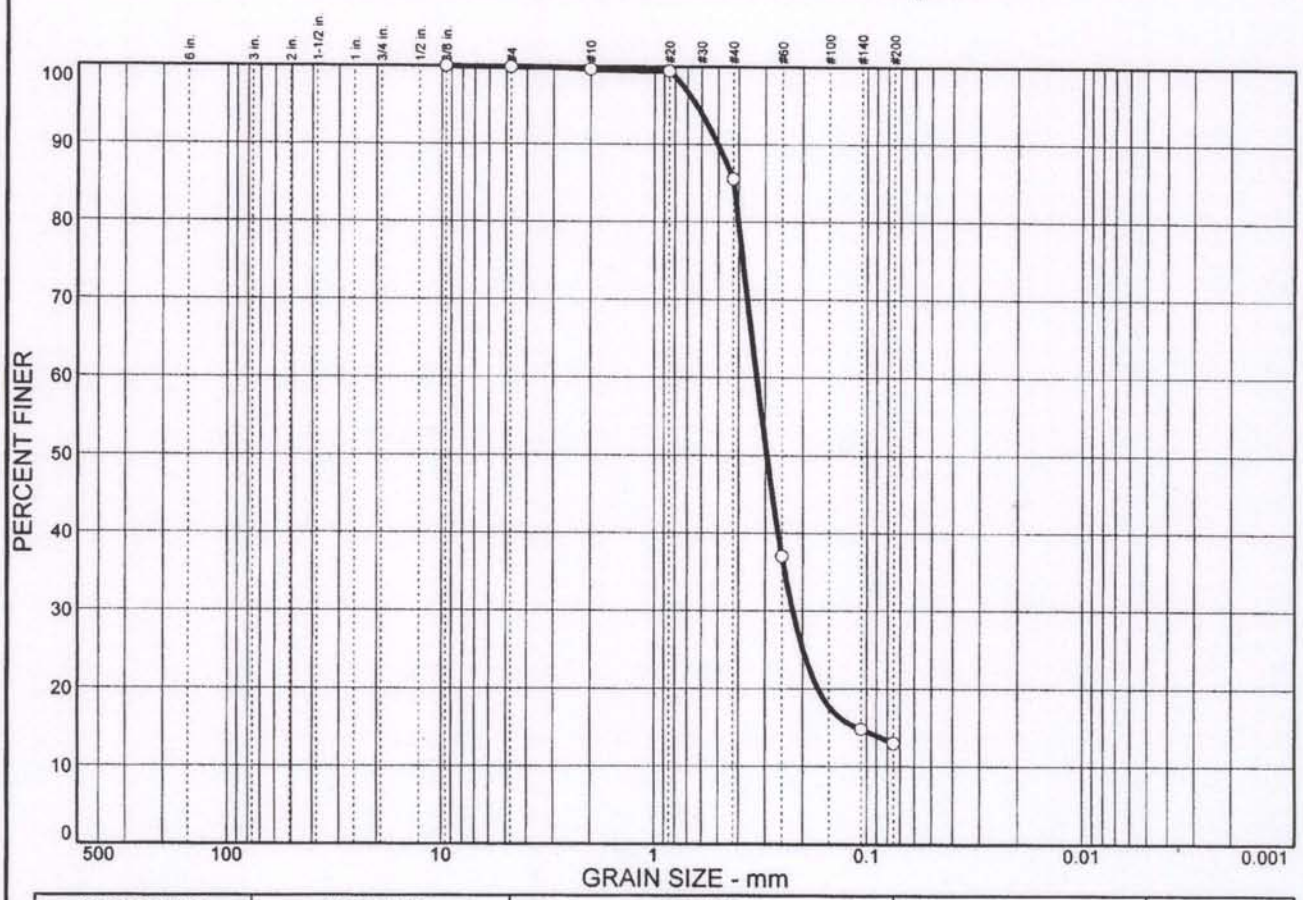
Client:	**ARUP**	Boring #: **BTSB-R2**	Sample #: **11B**
Project:	**Doyle Drive Replacement Project**	Depth (ft):	**28.1-28.4**
Project #:	**131558**	Soil:	**Undisturbed reddish brown poorly graded sand with silt**

TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	86.9	13.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.6		
#20	99.4		
#40	85.5		
#60	37.0		
#140	14.8		
#200	13.0		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.423 D_{60}= 0.329 D_{50}= 0.295
D_{30}= 0.222 D_{15}= 0.110 D_{10}=
C_u= C_c=

Classification

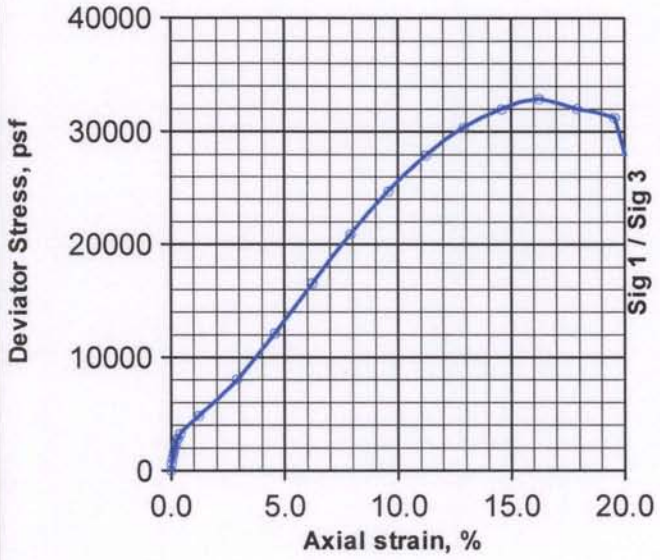
USCS= SM AASHTO=

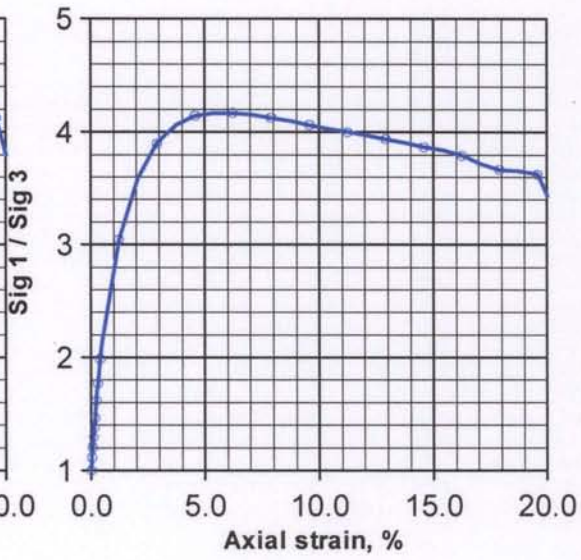
Remarks

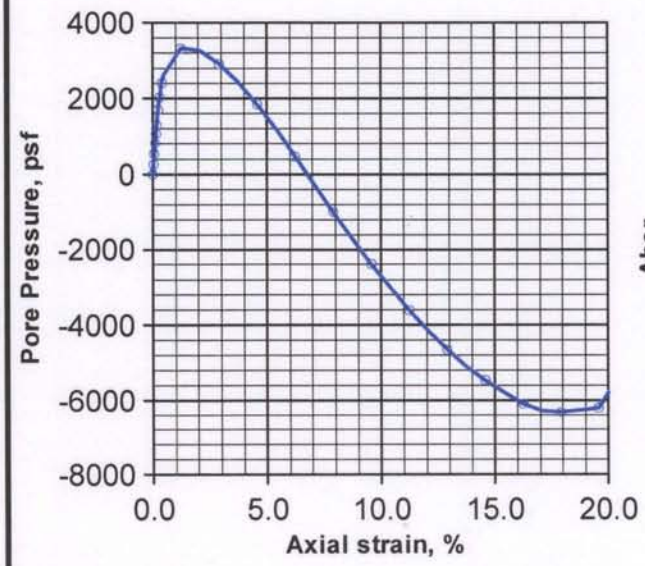
Sample No.: 13B **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 33.3-33.8

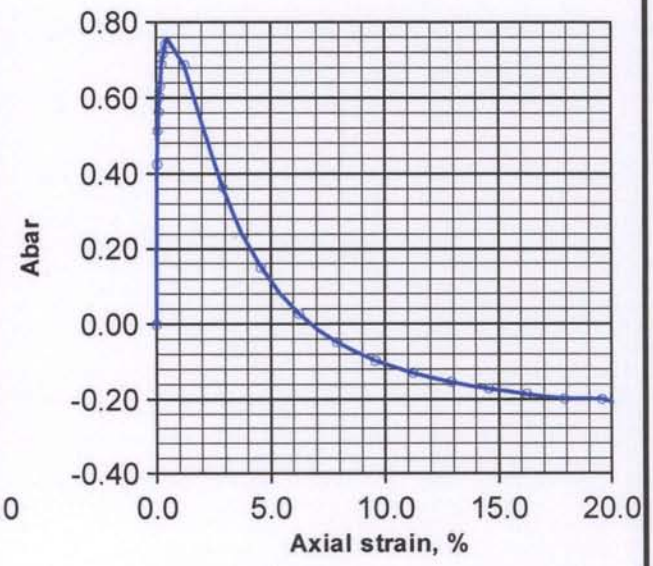
Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**









Line type	SigC psf	Peak Deviator str., psf	Strain @ fail. %	PWP psf	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio			Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Strain Rate %/hr.
solid	5700	14315	5.4	1183	21.2	106.0	97	0.589			20.2	108.3	98	0.555	1.0
dash															
dot															

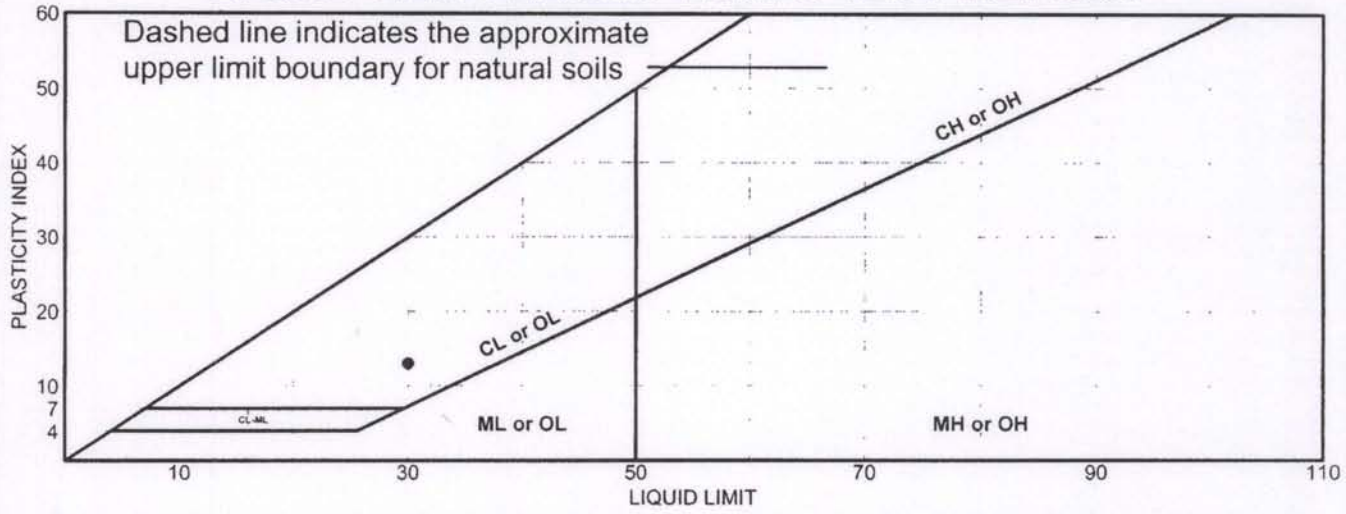
Client: **Arup**	Boring #: **BTSB-R2** Sample #: **13B**
Project: **Doyle Drive Replacement Project**	Depth (ft): **33.3-33.8**
Project #: **131558**	Soil: **Brown silty sand**

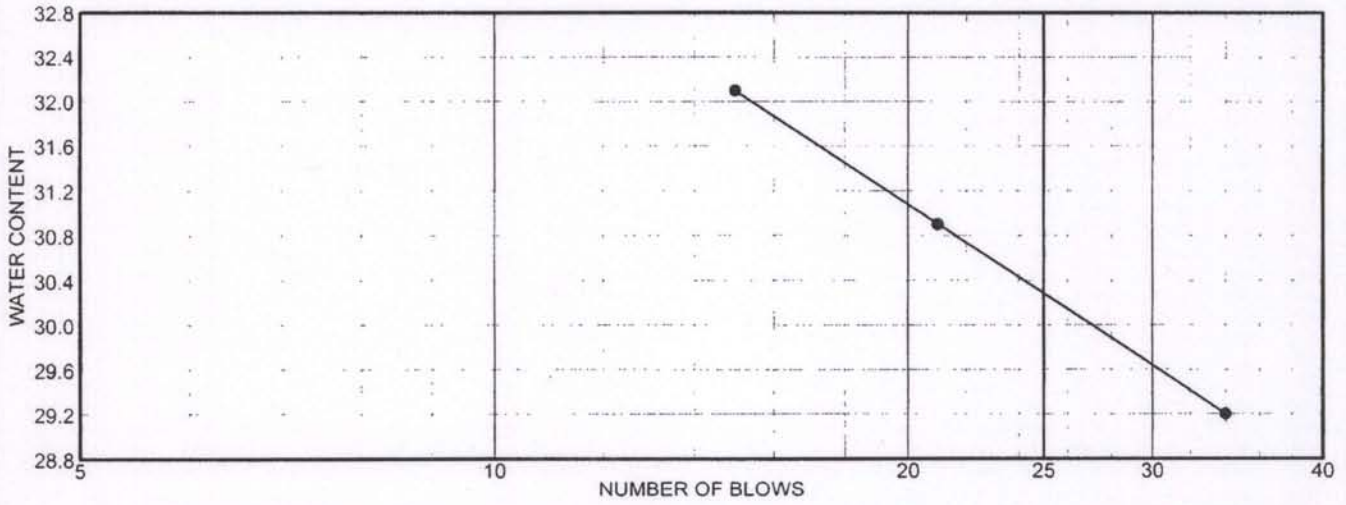
TEST REPORT: **Consolidated Undrained Triaxial Compression Test**

Signet Testing Labs, Inc.

Plate no: _____

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay	30	17	13			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 15A **Elev./Depth:** 37.8-38.3

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

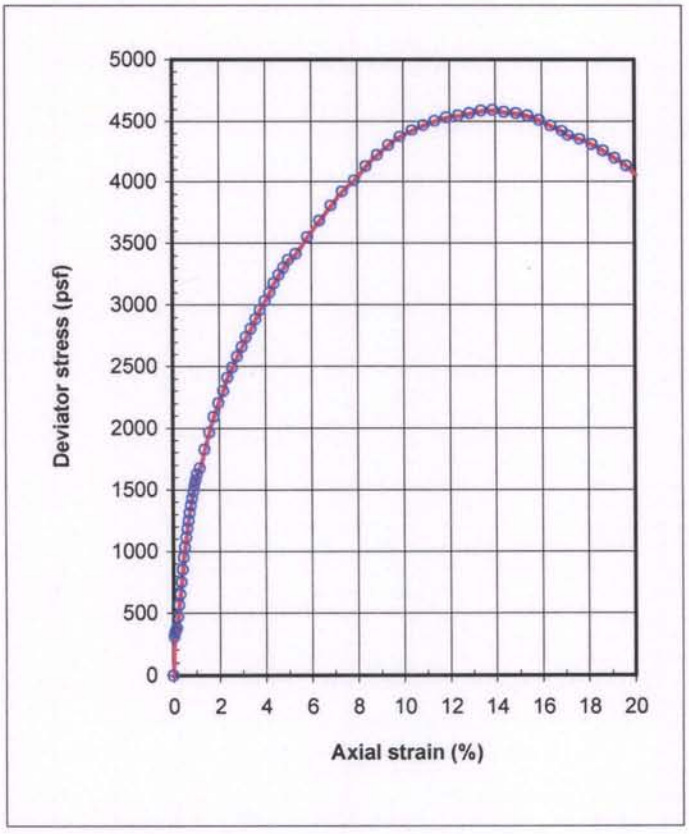
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 15A
Depth (ft) : 37.8
Date tested : 05/30/08
Soil : Reddish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 944.1 gms
Ht. = 5.990 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 451.7 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

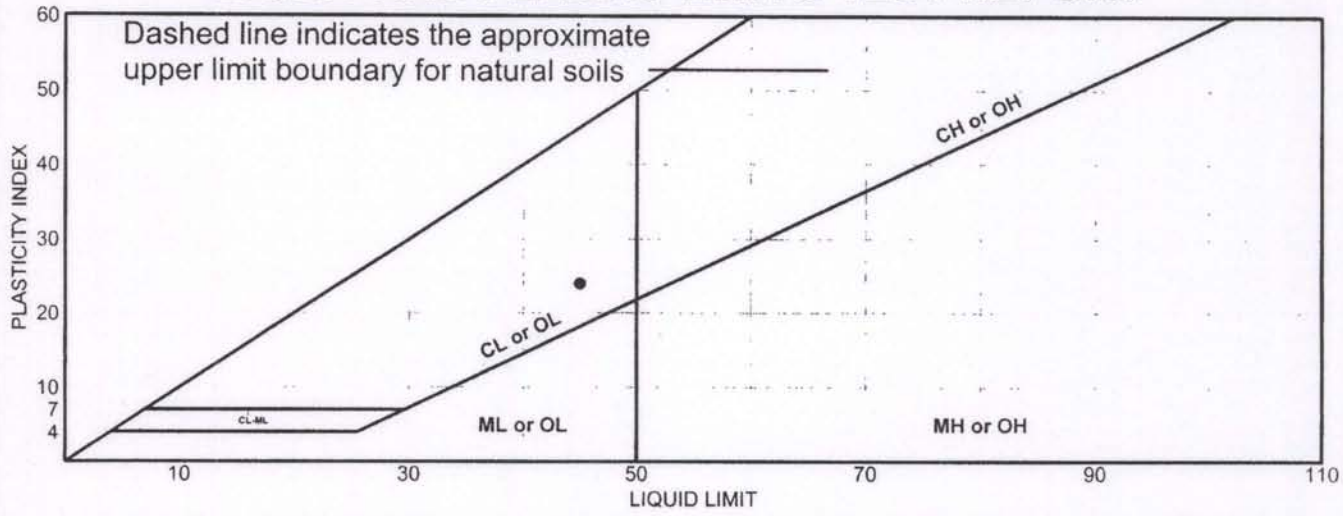
Test Report:
Void ratio = 0.559
Ht/Dia ratio = 2.48
Moisture = 20.7 %
Total density = 130.4 pcf
Dry density = 108.1 pcf
Saturation = 99.9 %
Chamber pressure = 6550 psf
Max. deviator stress = 4591 psf
Strain @ failure = 13.89 %

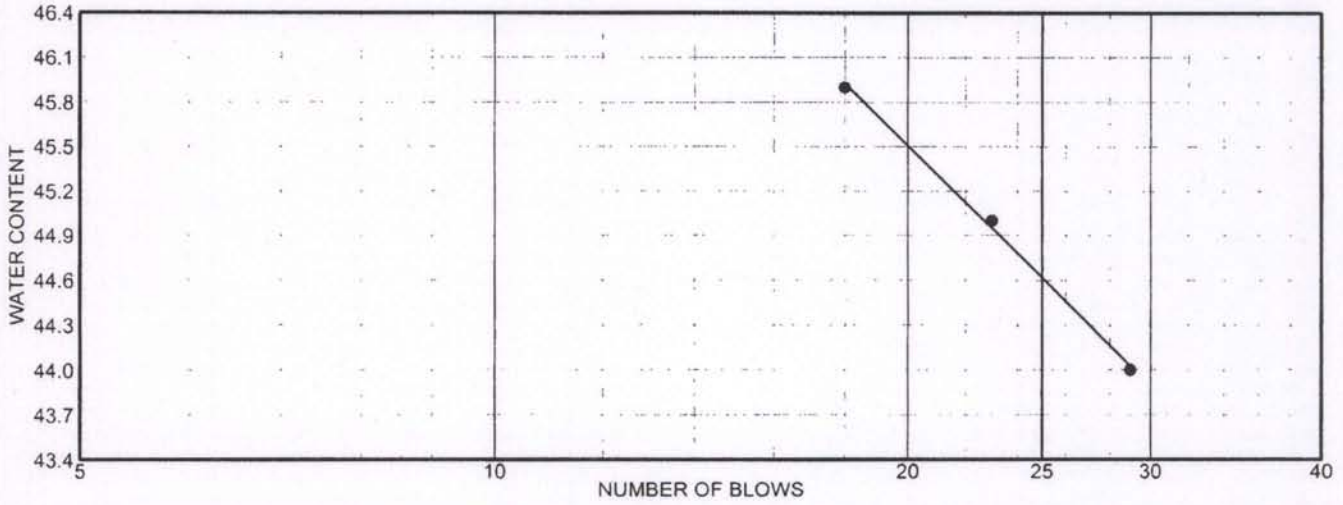


Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	9.9	0.05	310.8
0.003	11.0	0.07	343.1
0.004	11.3	0.09	351.9
0.007	12.1	0.15	379.0
0.011	15.1	0.20	471.4
0.014	18.0	0.25	561.7
0.017	20.8	0.31	649.1
0.020	24.0	0.36	748.9
0.023	27.3	0.41	851.5
0.027	30.4	0.47	948.4
0.030	33.2	0.52	1033.0
0.033	35.8	0.57	1112.4
0.036	38.0	0.63	1183.2
0.039	40.2	0.68	1248.8
0.042	42.3	0.73	1314.0
0.046	44.2	0.78	1371.3
0.049	46.0	0.84	1428.0
0.052	47.8	0.89	1482.8
0.055	49.4	0.94	1532.1
0.058	51.0	1.00	1579.2
0.062	52.6	1.05	1627.5
0.069	54.1	1.18	1672.8
0.081	59.2	1.38	1827.7
0.093	63.7	1.58	1961.9
0.105	68.0	1.78	2088.9
0.118	71.8	1.99	2202.5
0.129	75.2	2.19	2302.0
0.142	78.8	2.39	2407.6
0.154	81.8	2.59	2494.7
0.166	84.8	2.79	2579.7
0.178	87.6	2.99	2658.0
0.190	90.3	3.19	2736.4
0.202	92.9	3.39	2807.2
0.214	95.6	3.59	2884.2
0.226	98.2	3.79	2957.2
0.238	100.9	4.00	3032.9
0.250	103.5	4.20	3101.8
0.262	106.0	4.40	3171.6
0.274	108.6	4.60	3240.9
0.286	110.7	4.80	3299.4
0.298	113.1	5.00	3362.4
0.319	115.3	5.35	3415.7
0.350	120.5	5.86	3551.2
0.380	125.7	6.36	3682.4
0.410	130.5	6.87	3804.4
0.440	135.1	7.37	3915.8
0.470	139.2	7.88	4012.1
0.501	143.8	8.38	4123.6

Signet Testing Labs

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	45	21	24			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 15B **Elev./Depth:** 38.3-38.8

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

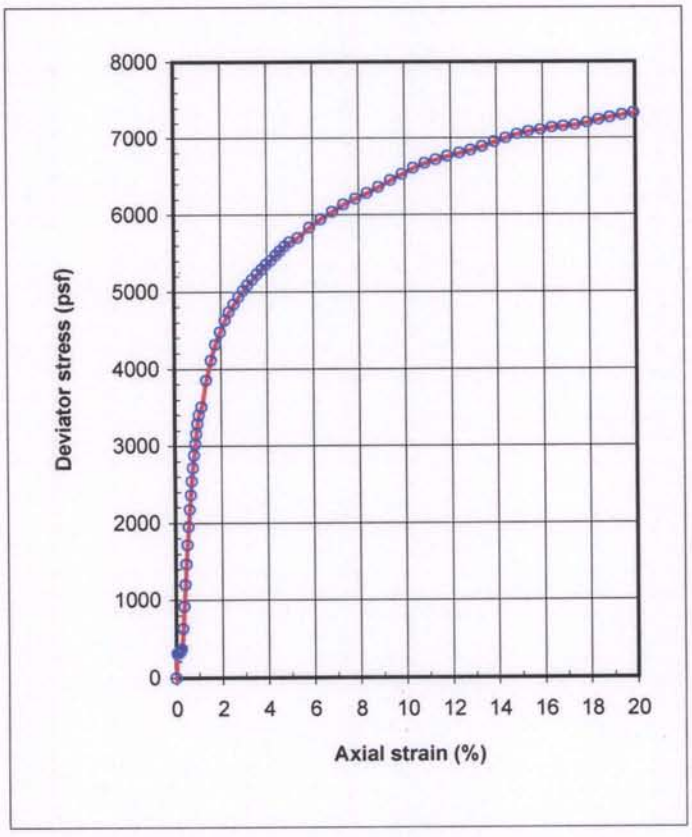
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 15B
Depth (ft) : 38.3
Date tested : 05/30/08
Soil : Yellowish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

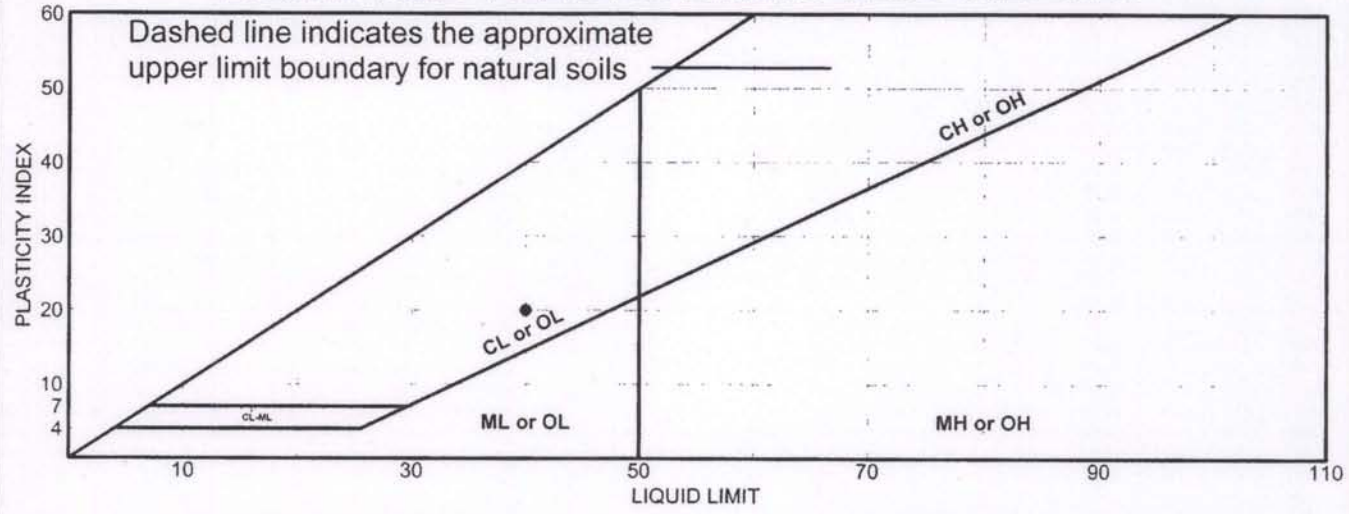
Specimen:
Total wt. = 845.2 gms
Ht. = 5.510 in
Ave dia. = 2.413 in
Area = 4.576 sq.in
Volume = 413.2 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

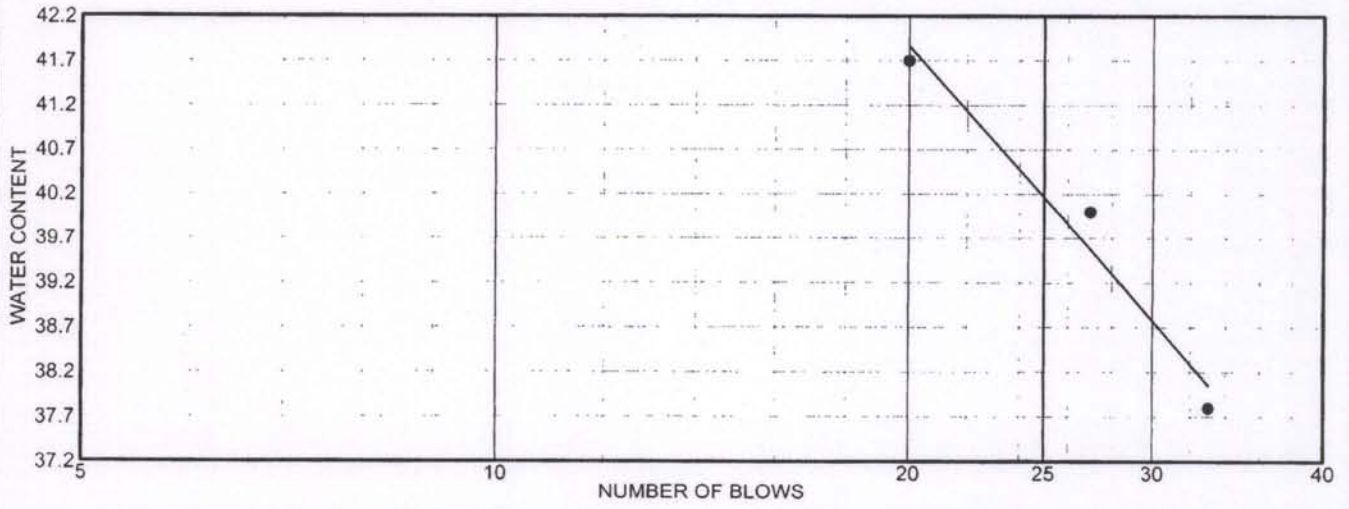
Test Report:
Void ratio = 0.615
Ht/Dia ratio = 2.28
Moisture = 22.3 %
Total density = 127.6 pcf
Dry density = 104.3 pcf
Saturation = 98.1 %
Chamber pressure = 6550 psf
Max. deviator stress = 7350 psf
Strain @ failure = 20.04 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	9.6	0.05	302.6
0.003	9.8	0.08	308.9
0.004	9.9	0.11	309.8
0.007	10.1	0.16	316.8
0.010	10.7	0.21	334.5
0.013	11.7	0.27	366.7
0.016	20.2	0.31	634.6
0.019	29.5	0.37	926.1
0.022	38.5	0.42	1206.7
0.025	47.0	0.47	1473.2
0.027	55.0	0.53	1722.2
0.030	62.6	0.58	1958.8
0.033	69.6	0.63	2176.6
0.036	75.8	0.69	2369.1
0.039	81.6	0.74	2547.5
0.042	87.2	0.79	2722.7
0.045	92.5	0.85	2887.1
0.047	97.1	0.89	3026.9
0.051	101.3	0.94	3159.0
0.053	105.5	1.00	3287.5
0.056	109.3	1.05	3404.2
0.063	113.0	1.18	3513.7
0.075	124.2	1.38	3855.0
0.086	132.9	1.58	4117.4
0.097	139.8	1.78	4319.3
0.108	145.4	1.98	4484.1
0.119	150.3	2.19	4627.3
0.130	154.5	2.39	4744.3
0.141	158.0	2.59	4844.7
0.152	161.4	2.79	4938.0
0.163	164.5	2.99	5022.3
0.174	167.2	3.19	5092.7
0.186	169.9	3.40	5165.4
0.197	172.6	3.60	5234.8
0.208	174.9	3.80	5293.6
0.219	177.5	4.00	5361.0
0.230	179.7	4.20	5417.4
0.241	182.0	4.40	5474.3
0.252	184.3	4.61	5533.2
0.263	186.8	4.81	5594.4
0.274	189.1	5.01	5652.1
0.294	191.5	5.37	5702.1
0.322	197.1	5.87	5837.4
0.350	201.8	6.37	5946.4
0.377	206.2	6.87	6043.7
0.404	210.5	7.37	6136.9
0.432	214.3	7.88	6213.7
0.460	217.9	8.38	6283.2

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	40	20	20			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 17 **Elev./Depth:** 42.8-43.3

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

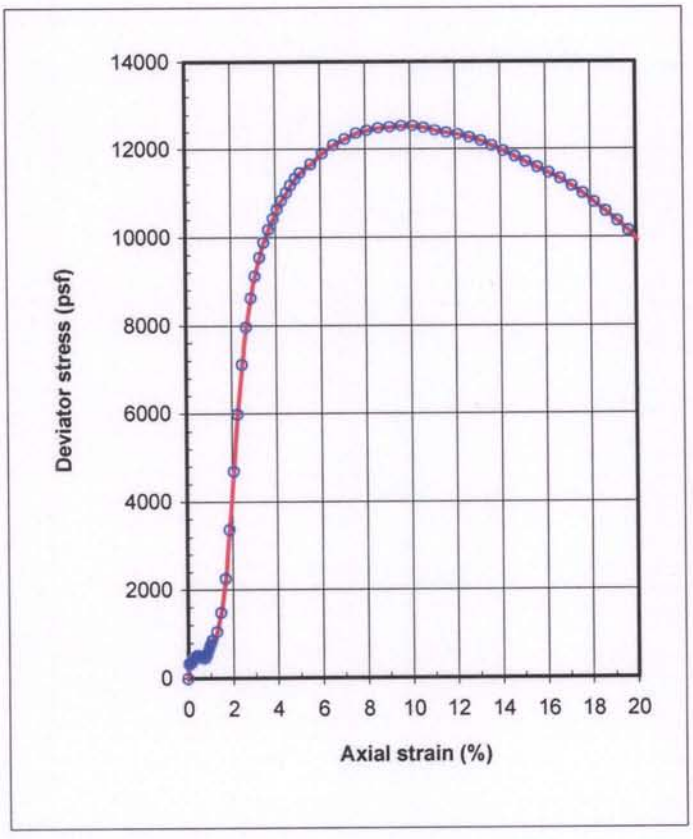
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 17
Depth (ft) : 42.8
Date tested : 05/30/08
Soil : Yellowish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 905.4 gms
Ht. = 5.660 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 426.8 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.519
Ht/Dia ratio = 2.34
Moisture = 19.4 %
Total density = 132.4 pcf
Dry density = 110.9 pcf
Saturation = 100.7 %
Chamber pressure = 7400 psf
Max. deviator stress = 12547 psf
Strain @ failure = 9.63 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	10.5	0.05	328.0
0.003	10.5	0.07	327.3
0.004	10.4	0.11	325.9
0.007	11.4	0.16	356.4
0.010	13.1	0.21	409.4
0.014	14.0	0.27	436.5
0.017	14.7	0.32	457.6
0.019	15.7	0.37	488.1
0.022	16.1	0.42	500.7
0.024	16.8	0.44	524.1
0.027	16.1	0.50	500.4
0.030	16.3	0.56	506.0
0.033	15.2	0.61	472.3
0.036	14.9	0.66	464.6
0.039	14.4	0.71	447.9
0.042	14.5	0.77	448.9
0.044	15.5	0.81	480.2
0.047	17.3	0.86	536.0
0.050	20.1	0.92	623.1
0.053	23.0	0.97	712.0
0.056	25.2	1.02	781.1
0.059	27.7	1.08	858.7
0.071	34.1	1.28	1053.2
0.082	48.4	1.48	1491.3
0.094	73.3	1.68	2256.4
0.105	109.8	1.88	3371.8
0.116	153.6	2.08	4707.6
0.128	195.7	2.28	5985.5
0.139	233.3	2.49	7119.5
0.151	261.5	2.69	7962.3
0.162	283.8	2.89	8623.8
0.173	300.8	3.09	9122.8
0.185	315.1	3.29	9537.5
0.196	327.4	3.49	9886.5
0.208	337.6	3.70	10176.0
0.219	346.7	3.90	10426.0
0.230	354.7	4.10	10645.6
0.242	361.9	4.30	10837.5
0.253	368.3	4.50	11008.1
0.264	374.8	4.70	11177.0
0.276	380.5	4.90	11323.6
0.287	385.9	5.10	11459.6
0.316	394.5	5.61	11653.4
0.344	404.9	6.11	11895.9
0.373	413.7	6.61	12089.9
0.401	420.8	7.11	12232.4
0.430	427.7	7.62	12363.7
0.458	432.7	8.12	12439.8

California State Certified Laboratory No. 2153

Reviewed For Adequacy (RFA)

By: TC

Date: 2/11/2009

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax: 925 462 2775
www.cercoanalytical.com

28 January, 2009

Job No.0901056
Cust. No.11993

RECD FEB 11 2009

Mr. Terrence Carroll
Arup North America, Ltd.
560 Mission St., Suite 700
San Francisco, CA 94103

Subject: Project No.: 131-558
Project Name: Doyle Drive Replacement Project
Corrosivity Analysis – CalTrans Test Methods

Dear Mr. Carroll:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on January 9, 2009. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, the following is the corrosivity classifications:

Severely Corrosive
Sample No.006

Corrosive

Sample No.001	Sample No.007	Sample No.009

Moderately Corrosive

Sample No.002	Sample No.003	Sample No.004
Sample No.005	Sample No.010	Sample No.011

Mildly Corrosive
Sample No.008

All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations range from none detected to 61 mg/kg. Because the chloride ion concentrations are less than 300 mg/kg, they are determined to be insufficient to attack steel embedded in a concrete mortar coating.

The sulfate ion concentrations range from none detected to 4,300 mg/kg and are determined to be sufficient to damage reinforced concrete structures and cement mortar-coated steel at these

locations. Therefore, concrete that comes into contact with this soil should use sulfate resistant cement such as Type II, in accordance with the Uniform Building Code requirements.

The pH of the soils range from 3.3 to 8.2 which does present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures. Any soils with a pH of <6.0 is considered to be corrosive to buried iron, steel, mortar-coated steel and reinforced concrete structures. Therefore, corrosion prevention measures need to be considered for structures to be placed in this acidic soil.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

Cheryl McMullen for
J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

California State Certified Laboratory No. 2153

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Client: ARUP
Client's Project No.: Not Indicated
Client's Project Name: Doyle Drive Replacement Project
Date Sampled: Not Indicated
Date Received: 9-Jan-09
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 28-Jan-2009

Job/Sample No.	Sample I.D.	Moisture (%)	pH	Min.Resistivity (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
0901056-001	34-0164SB-R1 @ 10-15'	-	3.3	540	-	61	3,900 (1)
0901056-002	34-0168-R1 @ 10-15'	-	4.0	2,100	-	21	4,300 (1)
0901056-003	34-01654NB-R2 @ 10-20'	-	8.1	2,800	-	35	570
0901056-004	34-0168-R1 @ 20-25'	-	7.9	4,900	-	23	19
0901056-005	34-0164NB-A5 @ 30-50'	-	8.0	5,600	-	N.D.	20
0901056-006	34-0164NB-R4 @ 10-15'	-	3.6	480	-	42	3,900 (1)
0901056-007	34-0168-R1 @ 5-10'	-	6.2	1,500	-	N.D.	150
0901056-008	A2-R9 @ 15-25'	-	7.3	10,000	-	N.D.	N.D.
0901056-009	34-0165SB-B2 @ 20-30'	-	7.8	1,900	-	N.D.	280
0901056-010	RW8-R4 @ 5-10'	-	6.7	2,500	-	25	51
0901056-011	RW8-R3 @ 5-10'	-	8.2	3,800	-	16	51

Method:	226	CT 532/643	CT 532/643	-	CT 422/ASTM D4327	CT 417/ASTM D4327
Detection Limit:	-	-	-	50	15	15
Date Analyzed:	-	23-Dec-2008	23-Jan-2009 & 26-Jan-2009	-	21-Jan-2009	21-Jan-2009 & 22-Jan-2009

Cheryl McMillen
Laboratory Director

* Results Reported on an "As Received" Basis
N.D. - None Detected
(1) Detection limit is elevated to 75 mg/kg due to dilution

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

LABORATORY TEST DATA

Boring RW8-R1-PZ

MOISTURE & DENSITY TEST

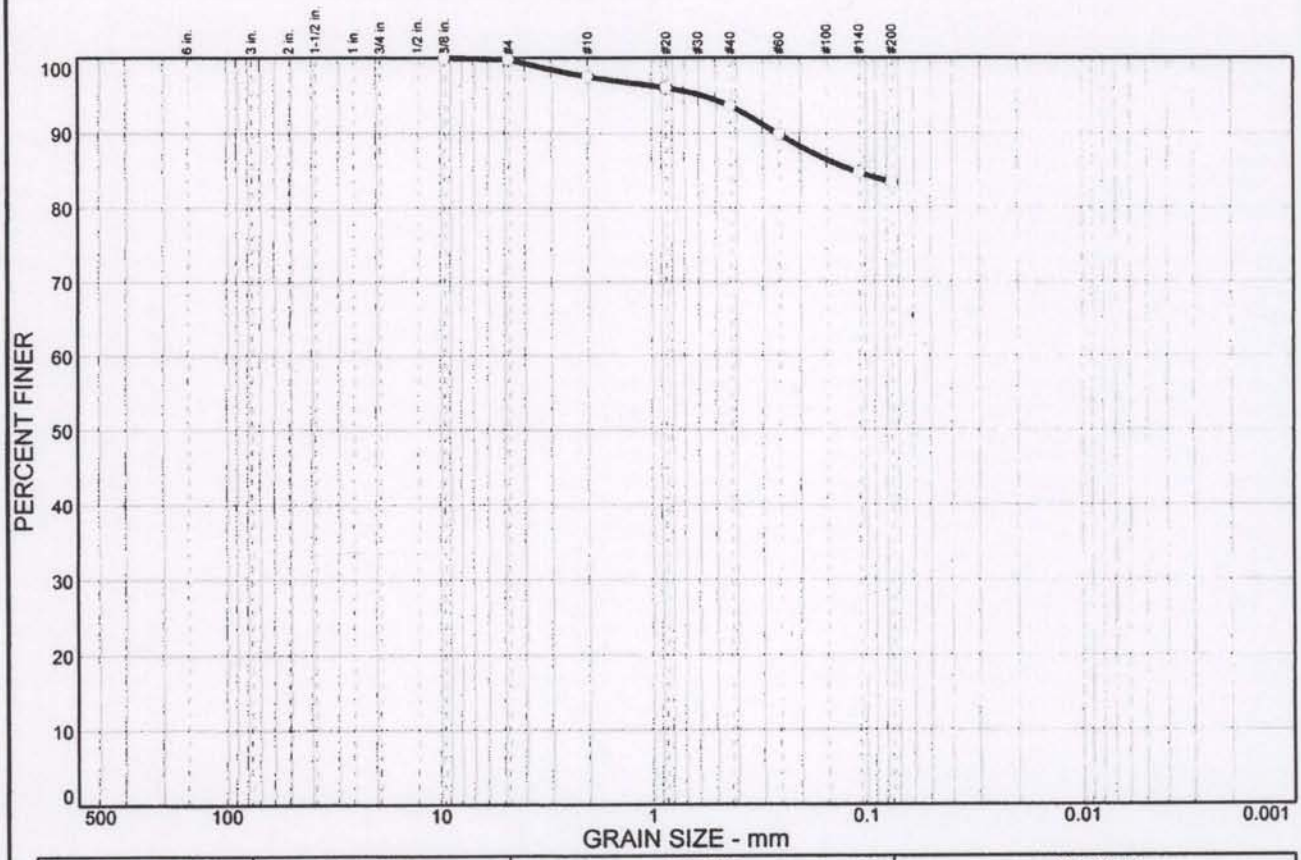
Client : Arup Project : Doyle Drive Replacement Project Retaining Wall Job no : EA04-163701

	Boring #	RW8-R1	RW8-R1	RW8-R1	RW8-R5	RW8-R5	RW8-R5	RW8-R5		
	Sample #	3B	5A	7B	3A	5B	17	24		
	Depth (ft.)	8.5-9	13-13.5	18.5-19	8-8.5	13.5-14	43-43.5	67.5-69		
	Soil type: (visual)	Very dark brown silty sand	Very dark brown silty clay with sand	Yellowish brown clay	Dark yellowish brown clayey sand	Olive brown poorly graded sand with silt	Olive brown poorly graded sand with silt	Olive brown silty sand		
1.	Date tested:	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09		1.
2.	Tested by:	KA	KA	KA	KA	KA	KA	KA		2.
3.	Specimen height (in.)	5.98	5.51	5.84	5.76	5.96	6.00			3.
4.	Wt. of specimen + tare (gm)	787.7	847.3	926.5	896.0	935.7	972.3			4.
5.	Tare wt. (gm)	0.00	0.00	0.00	0.00	0.00	0.00			5.
6.	Diameter (in.)	2.42	2.42	2.42	2.42	2.42	2.42			6.
7.	Wet wt. of soil + dish wt. (gm)	246.59	663.67	224.63	275.43	290.62	202.36	616.50		7.
8.	Dry wt. of soil + dish wt. (gm)	228.70	597.74	195.25	239.90	259.43	175.95	516.91		8.
9.	Wt. of dish (gm)	42.09	303.28	40.26	51.36	52.18	43.17	165.58		9.
10.	Dish ID									10.
	Wet Density (pcf)	109.0	127.3	131.3	128.7	129.9	134.1			
	Dry Density (pcf)	99.5	104.0	110.4	108.3	112.9	111.9			
	Moisture Content (%)	9.6	22.4	19.0	18.8	15.0	19.9	28.3		
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.694	0.620	0.527	0.555	0.492	0.506			
	Saturation (%)	37.3	97.4	97.2	91.6	82.6	106.1			

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	2.3	3.9	10.2	83.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	97.5		
#20	96.0		
#40	93.6		
#60	89.8		
#140	84.7		
#200	83.4		

* (no specification provided)

Soil Description

Very dark brown Silty clay with sand

Atterberg Limits

PL= 17 LL= 24 PI= 7

Coefficients

D_{85}= 0.113 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

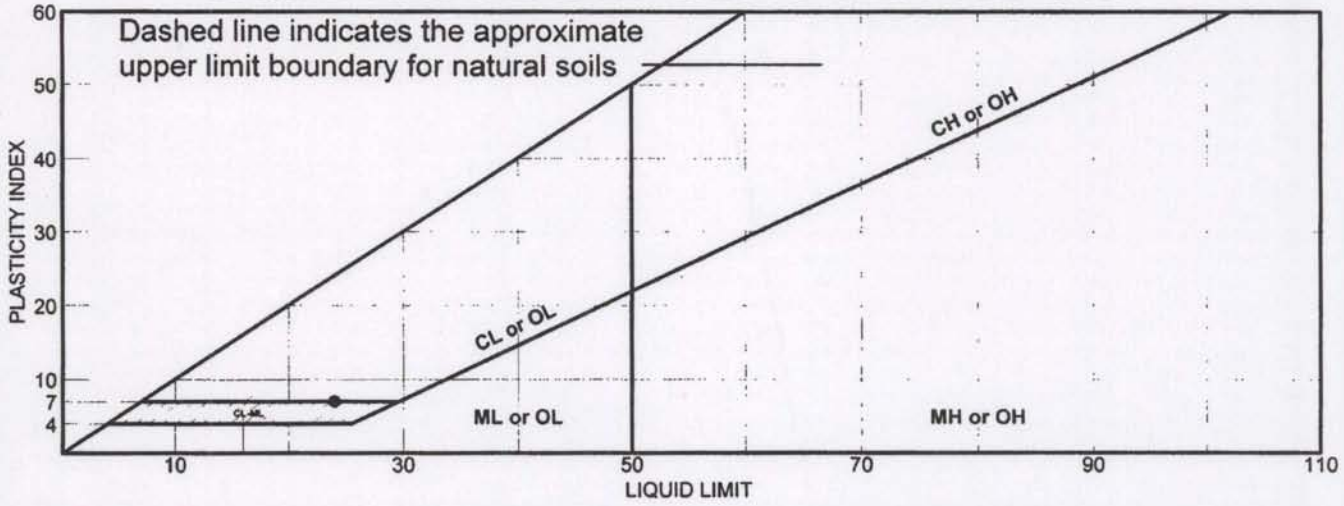
Remarks

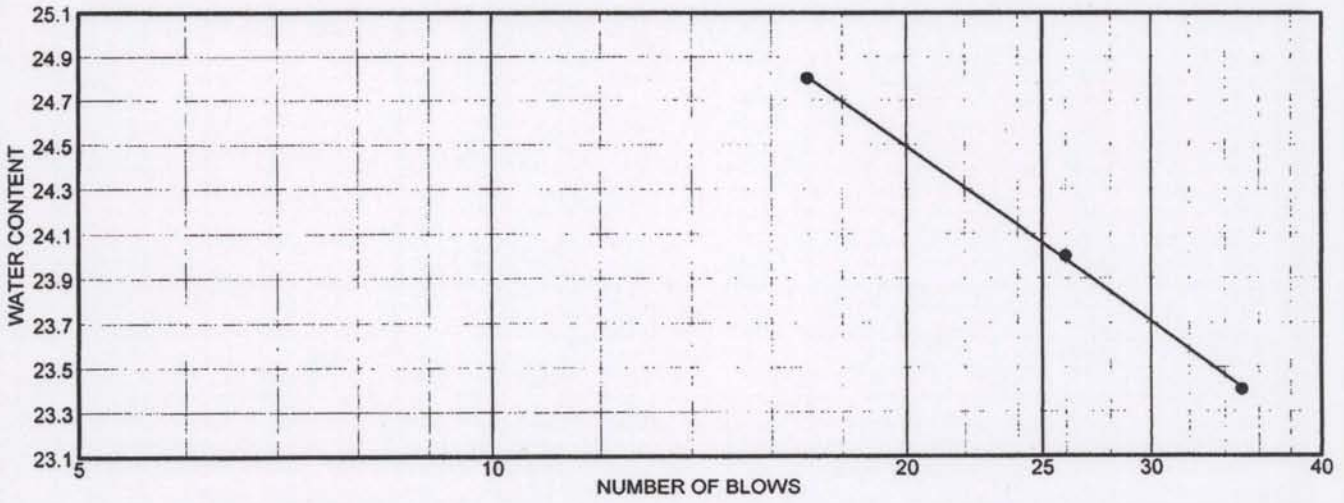
Sample No.: 5A **Source of Sample:** RW8-R1 **Date:** 1-22-09
Location: **Elev./Depth:** 13-13.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Very dark brown Silty clay with sand	24	17	7	93.6	83.4	CL-ML

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 5A **Elev./Depth:** 13-13.5

Remarks:

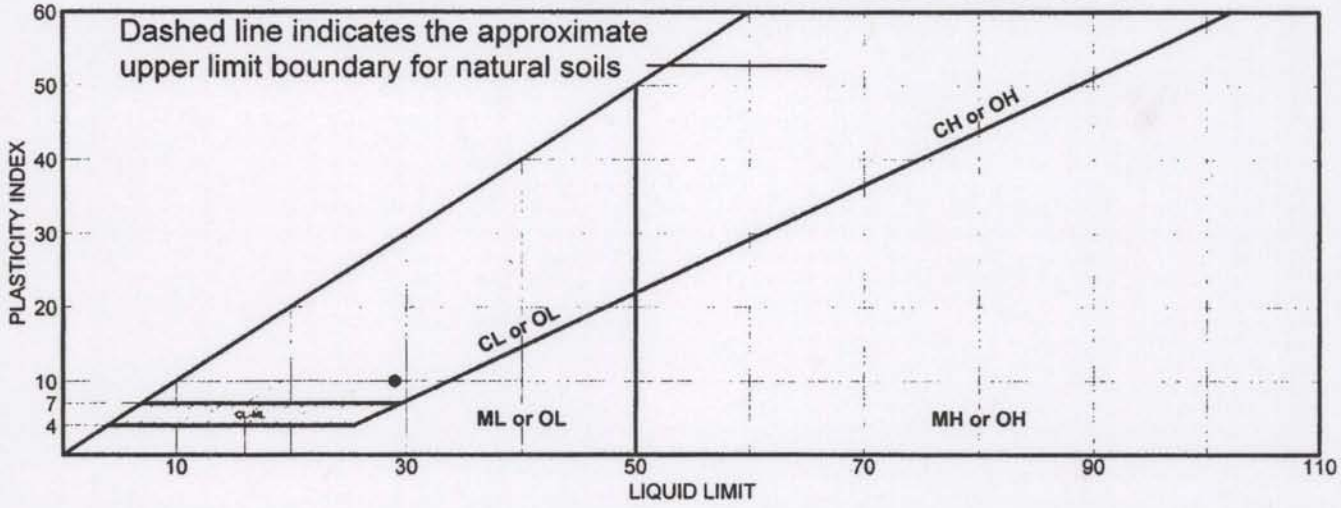
●

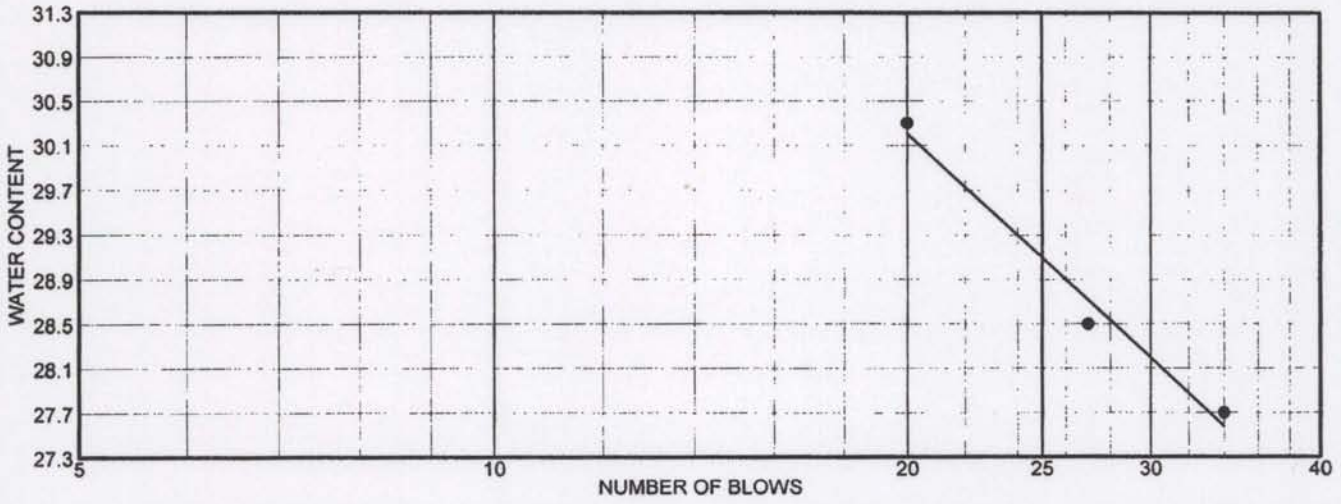
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	29	19	10			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 7B **Elev./Depth:** 18.5-19

Remarks:

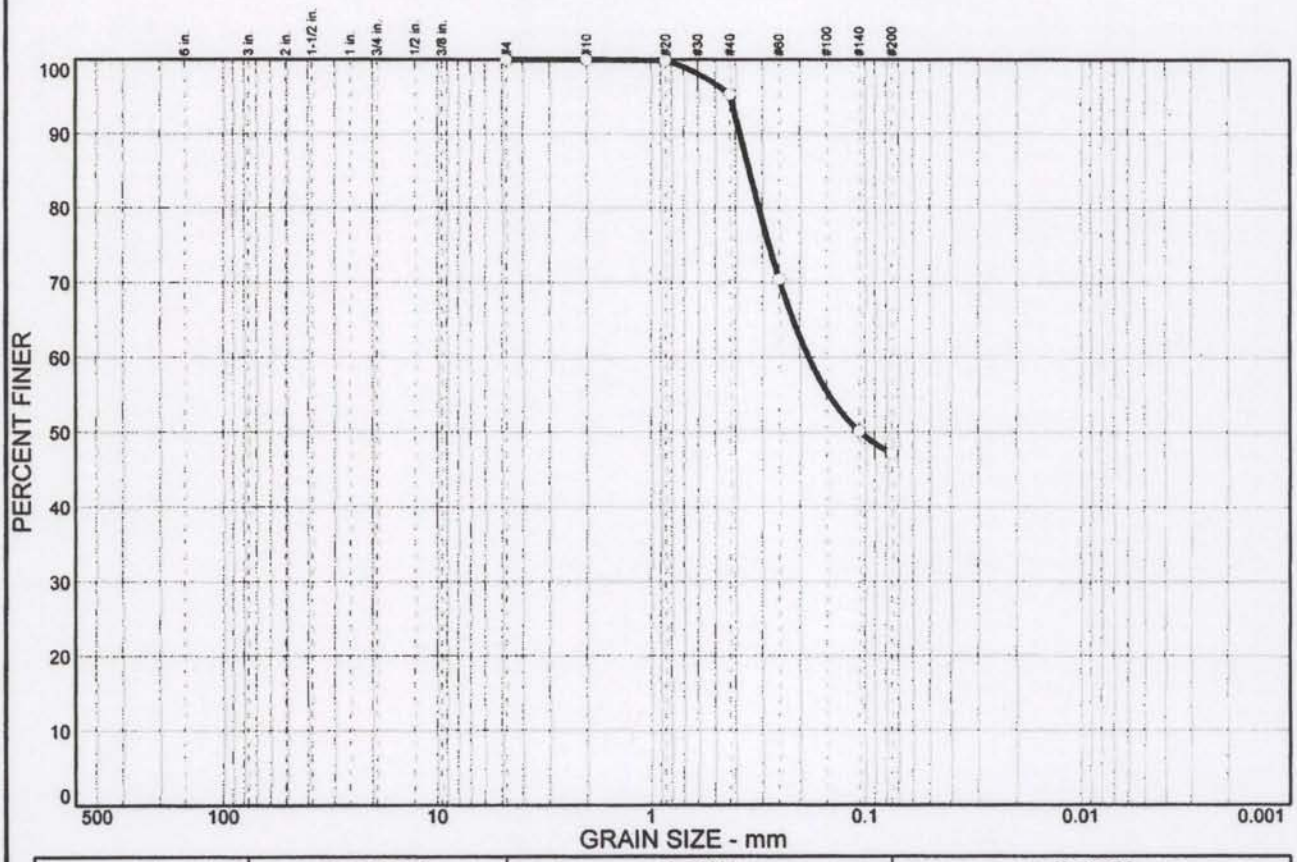
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	4.7	48.1	47.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	95.3		
#60	70.4		
#140	50.1		
#200	47.2		

* (no specification provided)

Soil Description

Brown Silty, clayey sand

Atterberg Limits

PL= 16 LL= 23 PI= 7

Coefficients

D_{85}= 0.345 D_{60}= 0.183 D_{50}= 0.105
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

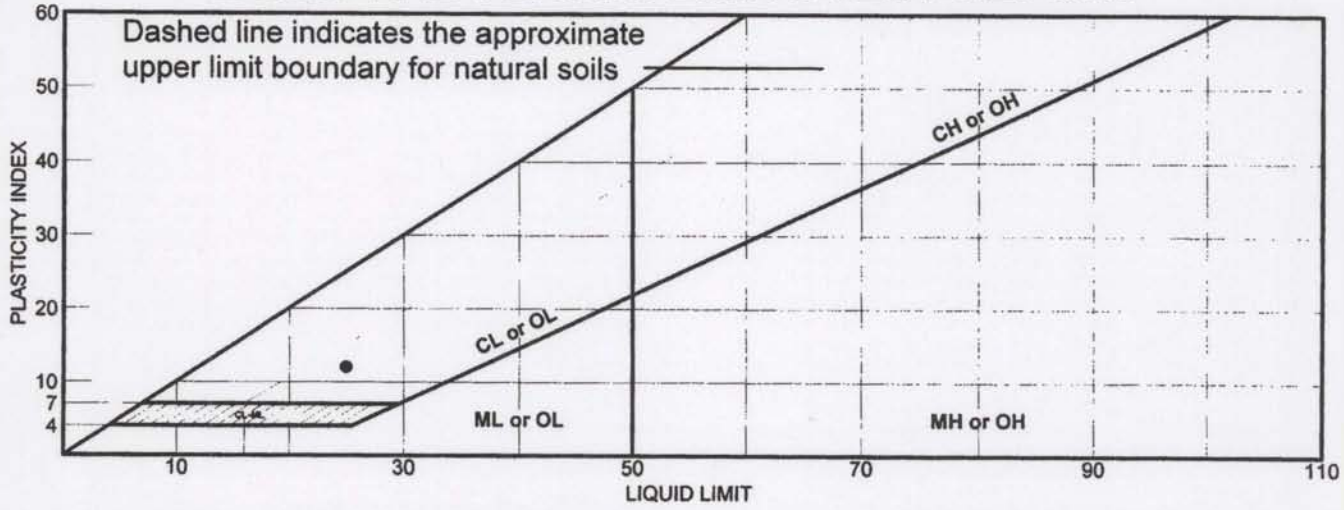
Remarks

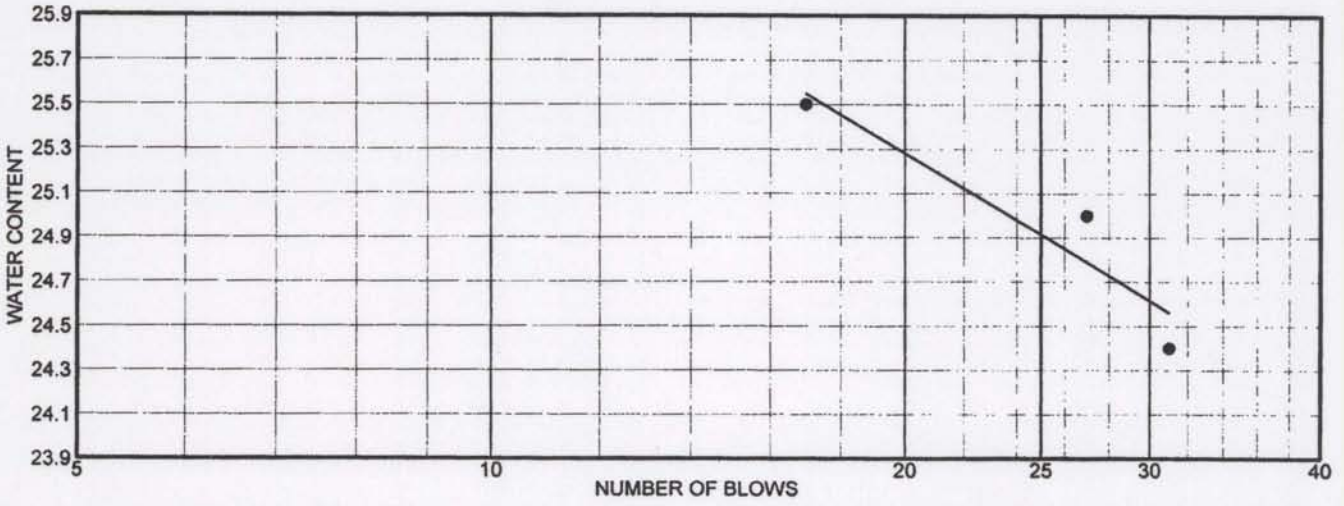
Sample No.: 9 Bottom **Source of Sample:** RW8-R1 **Date:**
Location: **Elev./Depth:** 22.5-25

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy clay	25	13	12			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 9 Top Section **Elev./Depth:** 22.5-25

Remarks:

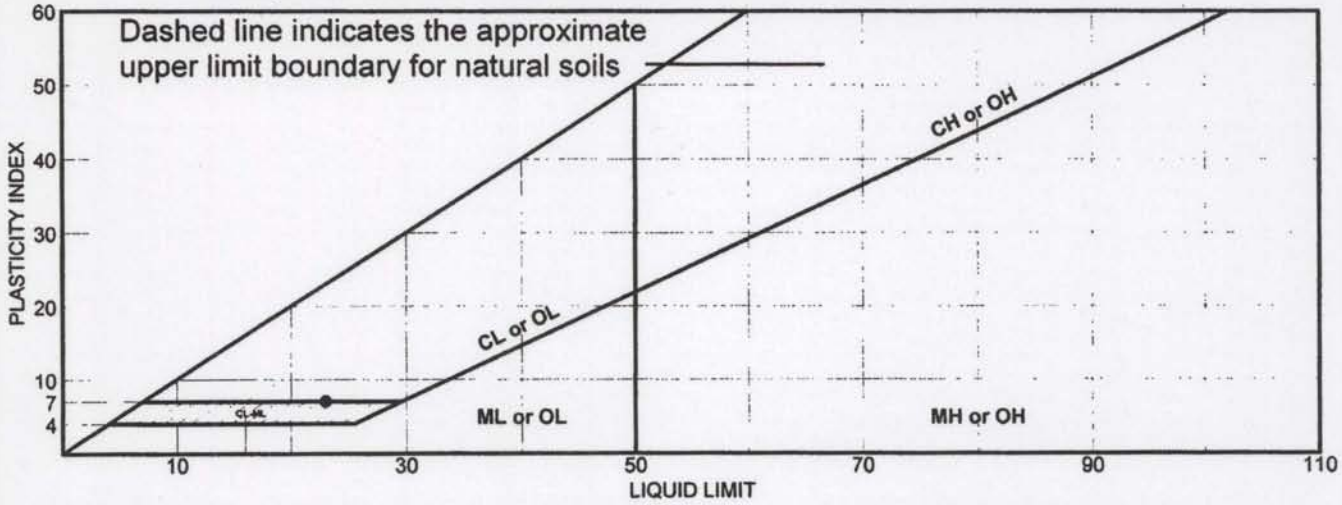
●

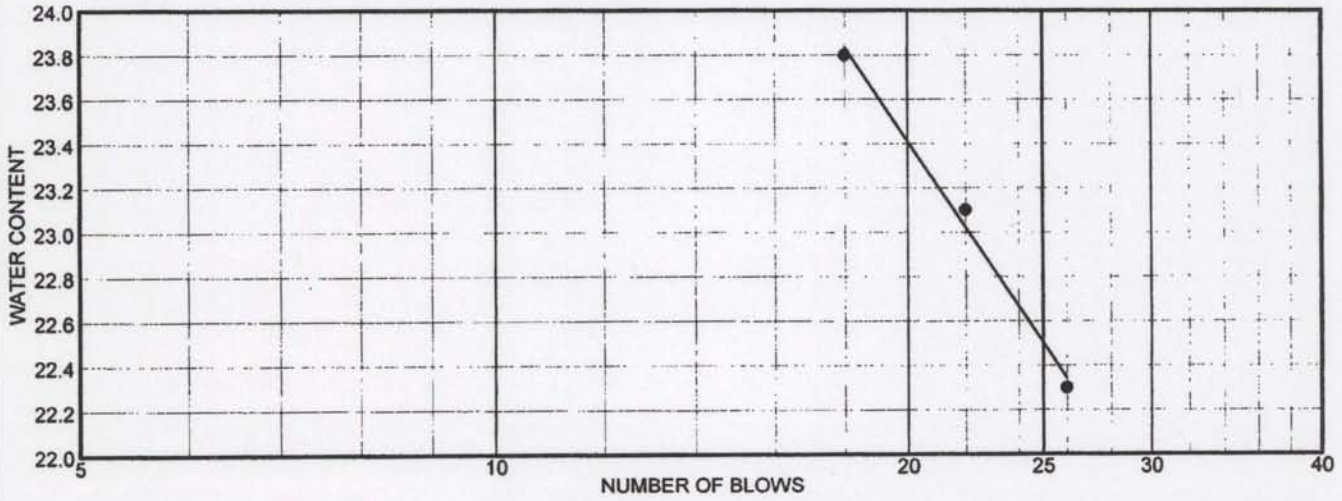
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown Silty, clayey sand	23	16	7	95.3	47.2	SC-SM

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 9 Bottom **Elev./Depth:** 22.5-25

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

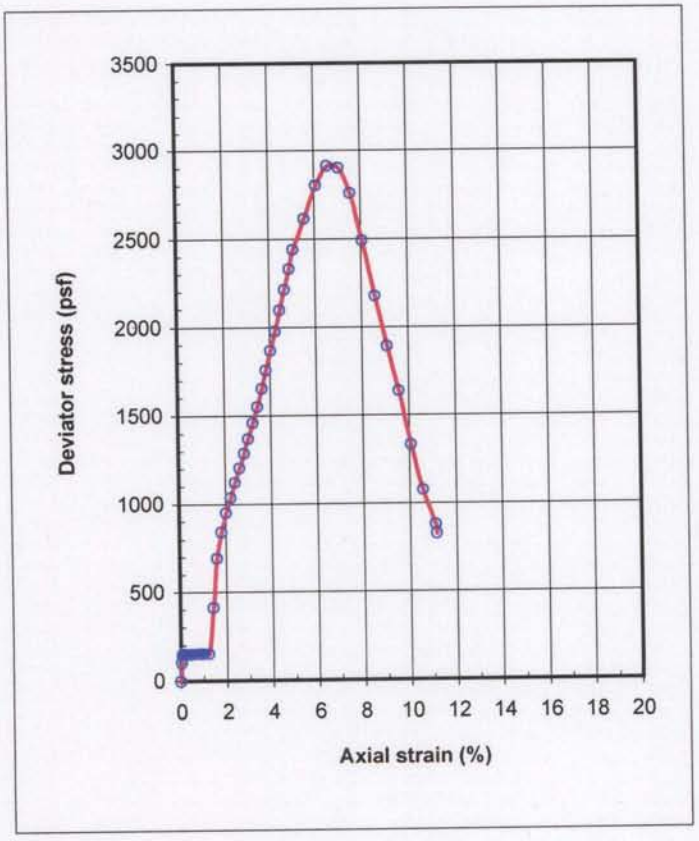
Client : Arup
Project : Doyle Drive Replacement Project - Retaining Wall #8
Job # : EA04-163701
Boring # RW8-R1
Sample # : 9
Depth (ft) : 22.5
Date tested : 01/27/09
Soil : Brown sandy clay

Data Reduction:

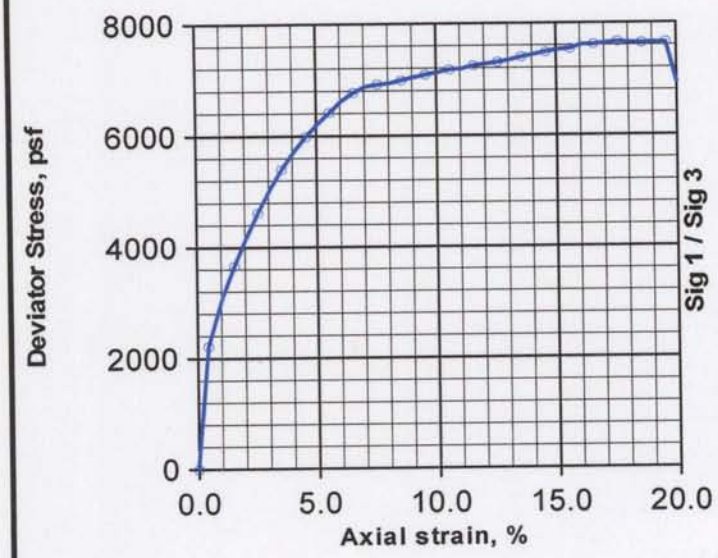
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

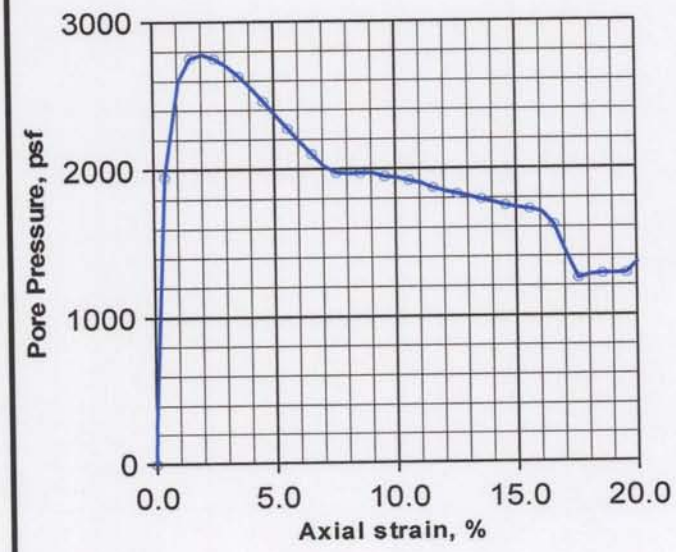
Specimen:
Total wt. = 1243.4 gms
Ht. = 5.910 in
Ave dia. = 2.840 in
Area = 6.337 sq.in
Volume = 613.7 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

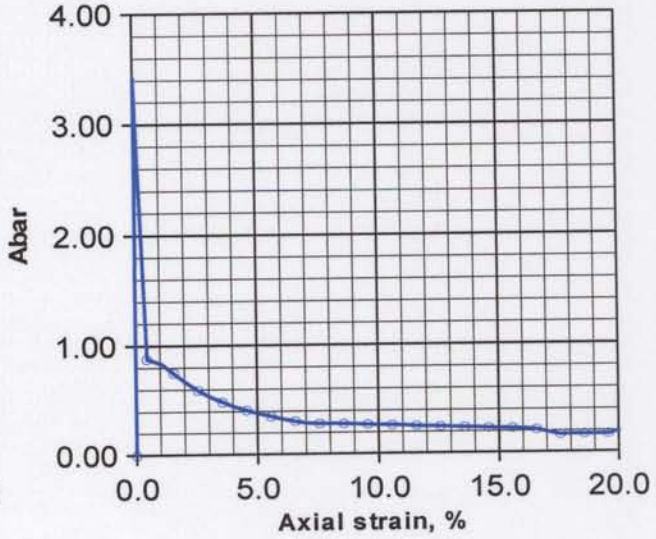
Test Report:
Void ratio = 0.594
Ht/Dia ratio = 2.08
Moisture = 19.6 %
Total density = 126.4 pcf
Dry density = 105.7 pcf
Saturation = 89.0 %
Chamber pressure = 4200 psf
Max. deviator stress = 2914 psf
Strain @ failure = 6.57 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	4.5	0.05	103.2
0.003	6.4	0.07	145.5
0.004	6.8	0.10	154.6
0.007	6.6	0.15	150.4
0.010	6.6	0.20	149.3
0.013	6.5	0.25	147.3
0.016	6.6	0.30	148.4
0.018	6.5	0.32	147.9
0.021	6.6	0.37	149.5
0.024	6.6	0.42	148.4
0.027	6.6	0.47	148.8
0.030	6.6	0.52	150.0
0.032	6.6	0.57	149.7
0.035	6.7	0.62	150.6
0.038	6.7	0.67	151.1
0.041	6.7	0.72	151.2
0.044	6.7	0.77	151.6
0.047	6.8	0.82	153.7
0.050	6.8	0.87	152.2
0.053	6.8	0.92	153.1
0.056	6.7	0.97	151.8
0.059	6.8	1.02	153.4
0.071	6.8	1.23	152.0
0.083	18.5	1.43	414.7
0.095	31.1	1.63	695.9
0.107	37.8	1.83	844.3
0.119	42.7	2.03	951.5
0.131	46.7	2.24	1038.2
0.143	50.8	2.44	1125.1
0.155	54.5	2.64	1206.5
0.166	58.3	2.84	1287.3
0.178	62.3	3.04	1372.2
0.190	66.4	3.24	1459.6
0.202	70.8	3.44	1553.5
0.214	75.6	3.65	1654.9
0.226	80.4	3.85	1757.5
0.238	85.6	4.06	1866.9
0.250	90.9	4.26	1977.9
0.263	96.6	4.47	2098.0
0.274	102.2	4.66	2214.6
0.286	107.9	4.87	2332.3
0.298	113.2	5.07	2442.3
0.328	121.9	5.57	2615.9
0.357	131.5	6.07	2805.7
0.387	137.3	6.57	2914.1
0.417	137.5	7.07	2903.3
0.446	131.5	7.58	2761.0
0.476	119.3	8.08	2491.8







Line type	SigC psf	Peak Deviator str., psf	Strain @ fail. %	PWP psf	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio			Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Strain Rate %/hr.
solid	4650	5982	4.6	2460	18.2	110.8	94	0.521			18.2	113.7	102	0.482	1.0
dash															
dot															

Client: **Arup**	Boring #: **RW8-R1** Sample #: **9 BOTTOM**
Project: **Doyle Drive Replacement Project**	Depth (ft): **22.5-25.2**
Project #: **EA04-163701**	Soil: **Brown silty clayey sand**

TEST REPORT: **Consolidated Undrained Triaxial Compression Test**

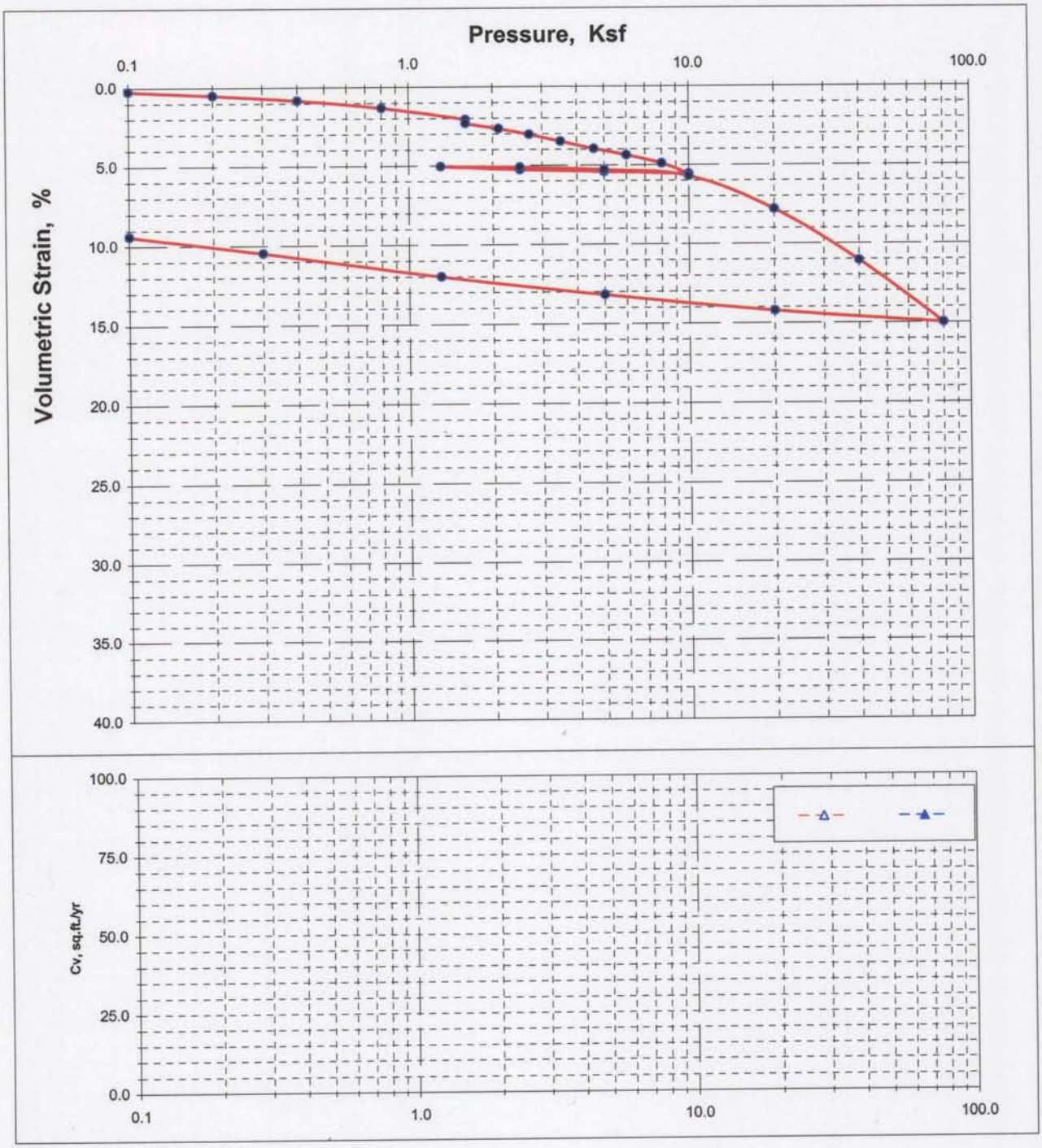
Signet Testing Labs, Inc.

Plate no: _____

CONSOLIDATION TEST

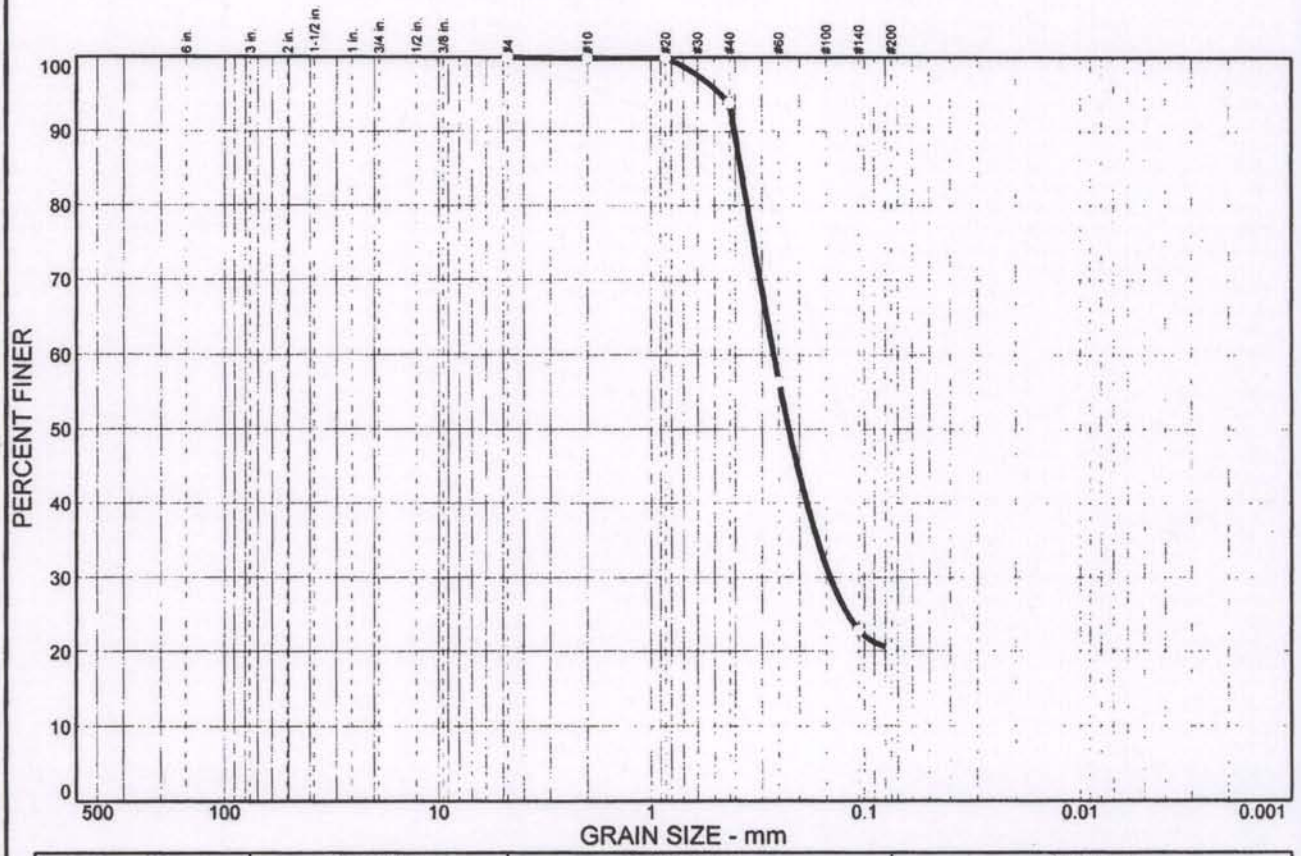
Boring Number	RW8-R1	Sample Number	9 (TOP)	Depth (ft)	22.5-25.2	
Soil Description	Brown sandy clay					

	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	19.8	124.5	0.623	85.9	1.00	2.420	(assumed) 2.70	25	12
Final	17.6	134.8	0.471	101.0	0.906				



EA04-163701

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	6.1	73.4	20.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	93.8		
#60	56.4		
#140	22.8		
#200	20.4		

* (no specification provided)

Soil Description

Dark yellowish brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.377 D_{60}= 0.264 D_{50}= 0.225
D_{30}= 0.144 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

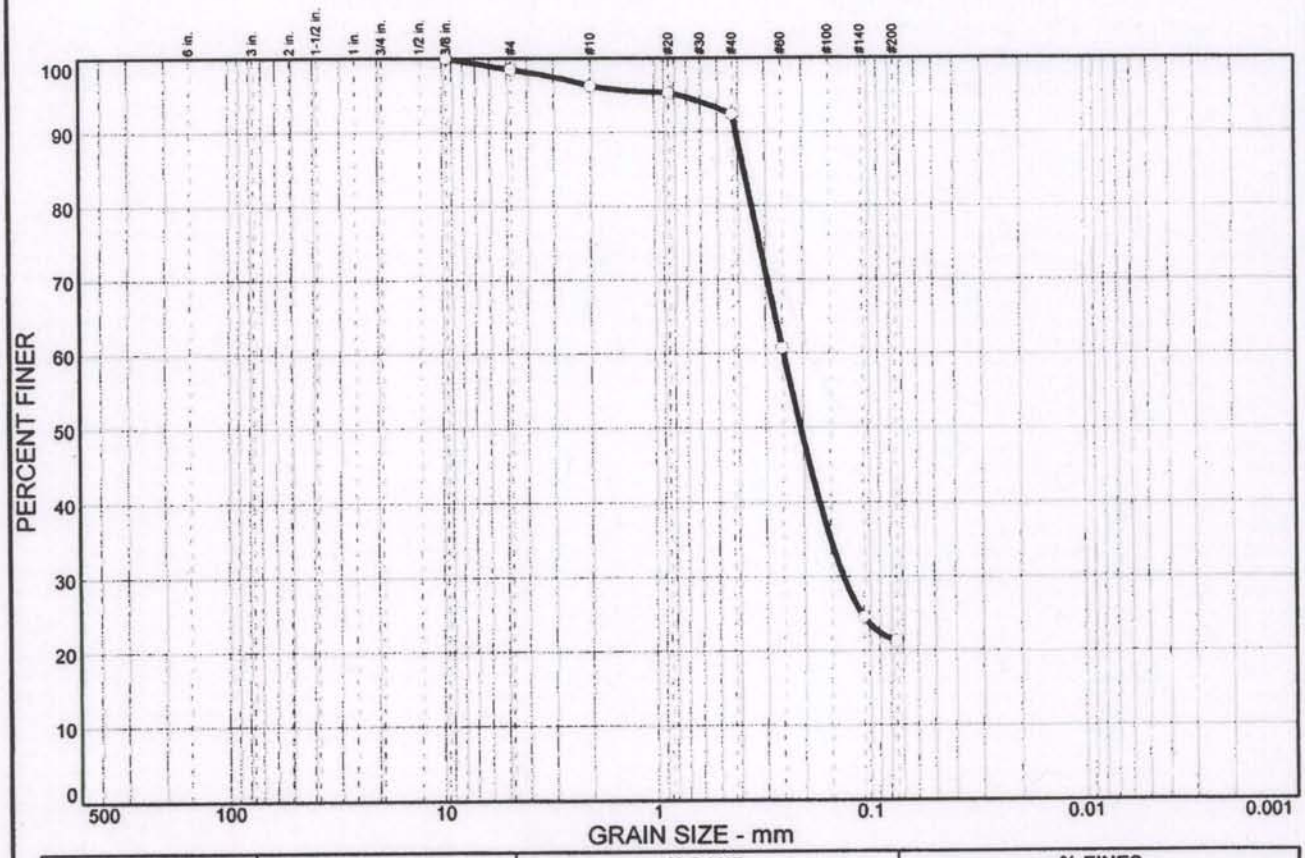
Remarks

Sample No.: 11 **Source of Sample:** RW8-R1 **Date:** 1-29-09
Location: **Elev./Depth:** 29-30.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.5	2.3	3.8	71.1	21.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.5		
#10	96.2		
#20	95.3		
#40	92.4		
#60	60.7		
#140	24.5		
#200	21.3		

* (no specification provided)

Soil Description

Brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.376 D_{60}= 0.247 D_{50}= 0.206
D_{30}= 0.131 D_{15}= D_{10}=
C_u= C_c=

Classification

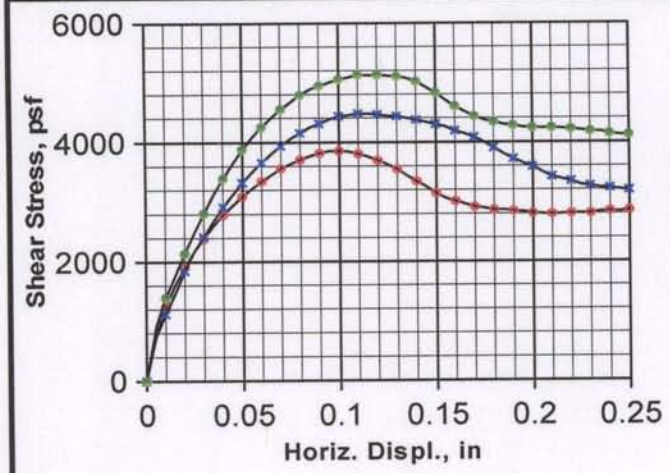
USCS= SC AASHTO=

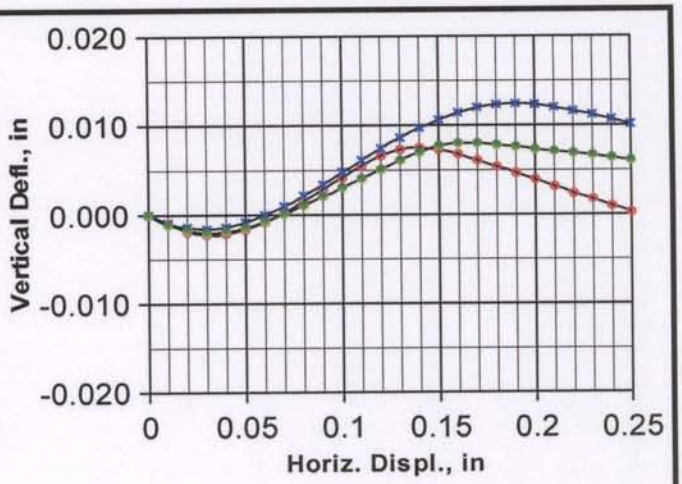
Remarks

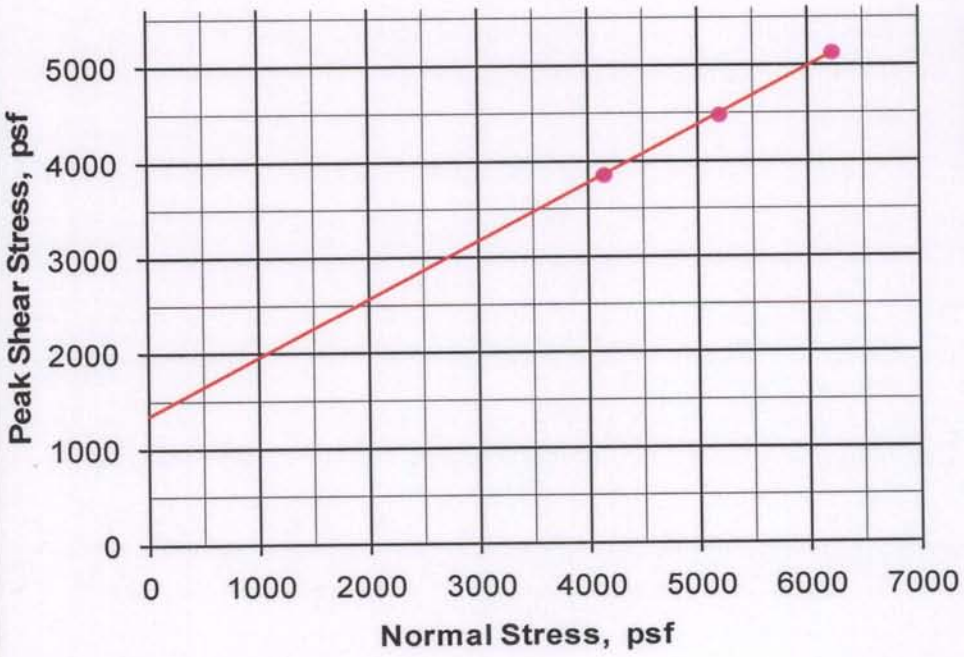
Sample No.: 12A **Source of Sample:** RW8-R1 **Date:**
Location: **Elev./Depth:** 33-33.5

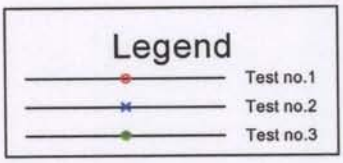
SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**









Results

C = 1350 psf
phi = 31 deg.

Gs = 2.70
Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	4150	3852	0.095	0.18	19.6	108.9	97	0.548	1.00	2.416	19.4	105.9	89	0.591	1.028
2	5200	4476	0.110	0.18	20.0	108.6	98	0.551	1.00	2.416	19.5	104.2	85	0.618	1.043
3	6225	5124	0.110	0.18	19.5	111.5	103	0.512	1.00	2.416	18.6	107.1	87	0.574	1.041

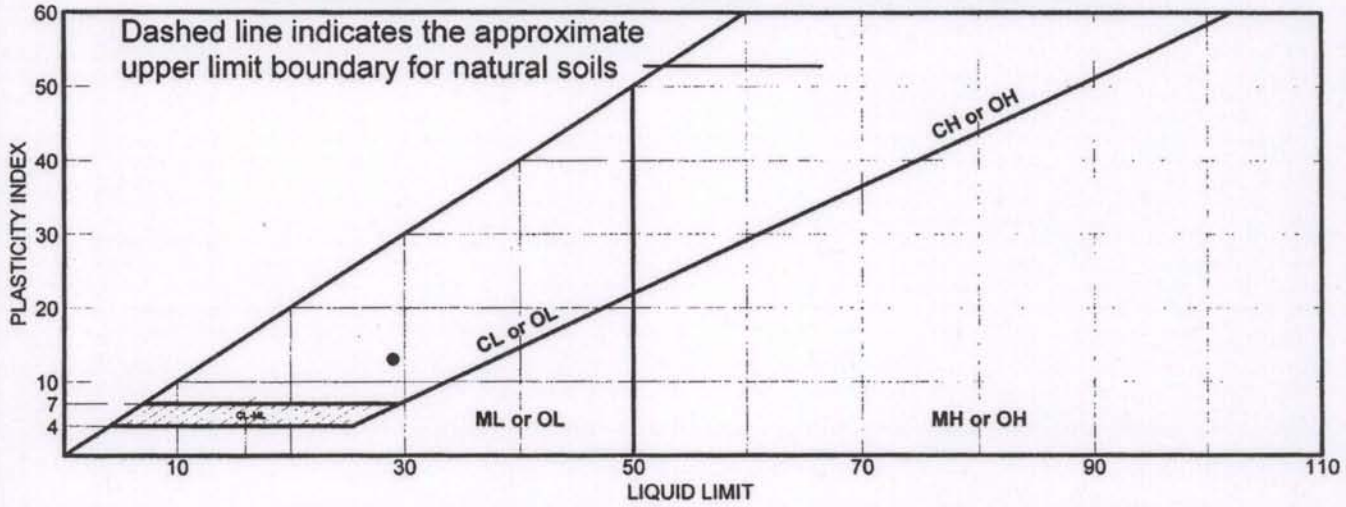
Client: **Arup**	Boring #: **RW8-R1** Sample #: **12A**
Project: **Doyle Dr. Replacement Project**	Depth (ft): **33-33.5**
Project #: **EA04-163701**	Soil: **Undisturbed brown clayey sand**

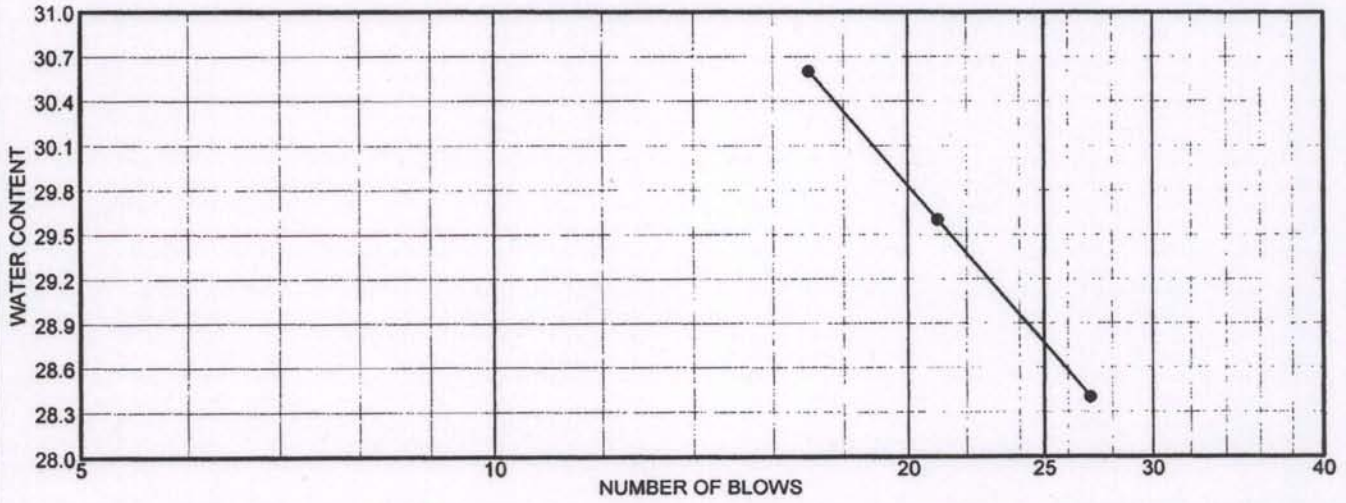
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay with gravel	29	16	13			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 16A **Elev./Depth:** 43-43.5

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

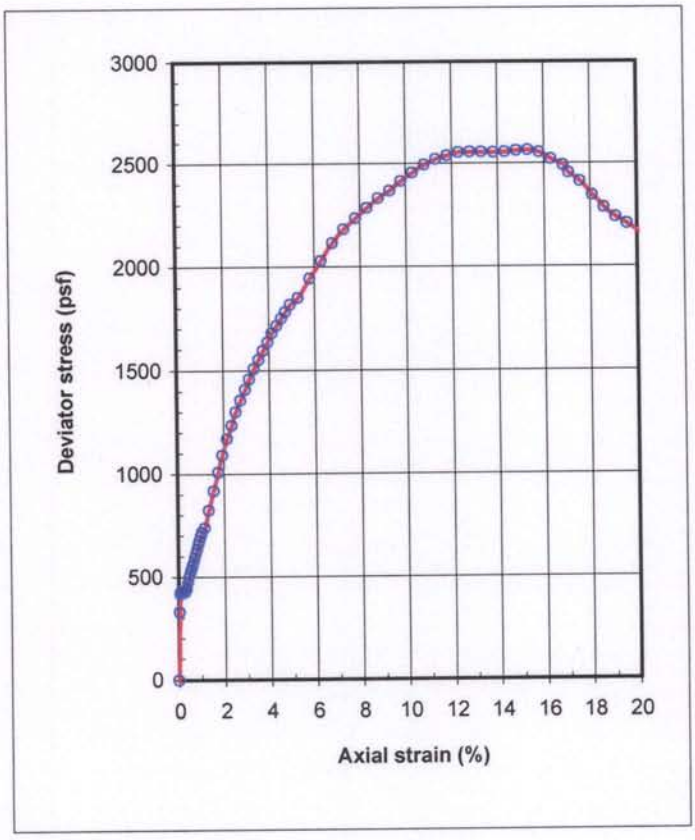
Client : Arup
Project : Doyle Drive Replacement Project - Retaining Wall #8
Job # : EA04-163701
Boring # RW8-R1
Sample # : 16A
Depth (ft) : 43
Date tested : 01/24/09
Soil : Brown clay with gravel

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 799.0 gms
Ht. = 5.210 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 392.9 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.634
Ht/Dia ratio = 2.15
Moisture = 23.1 %
Total density = 126.9 pcf
Dry density = 103.1 pcf
Saturation = 98.4 %
Chamber pressure = 8175 psf
Max. deviator stress = 2564 psf
Strain @ failure = 15.33 %

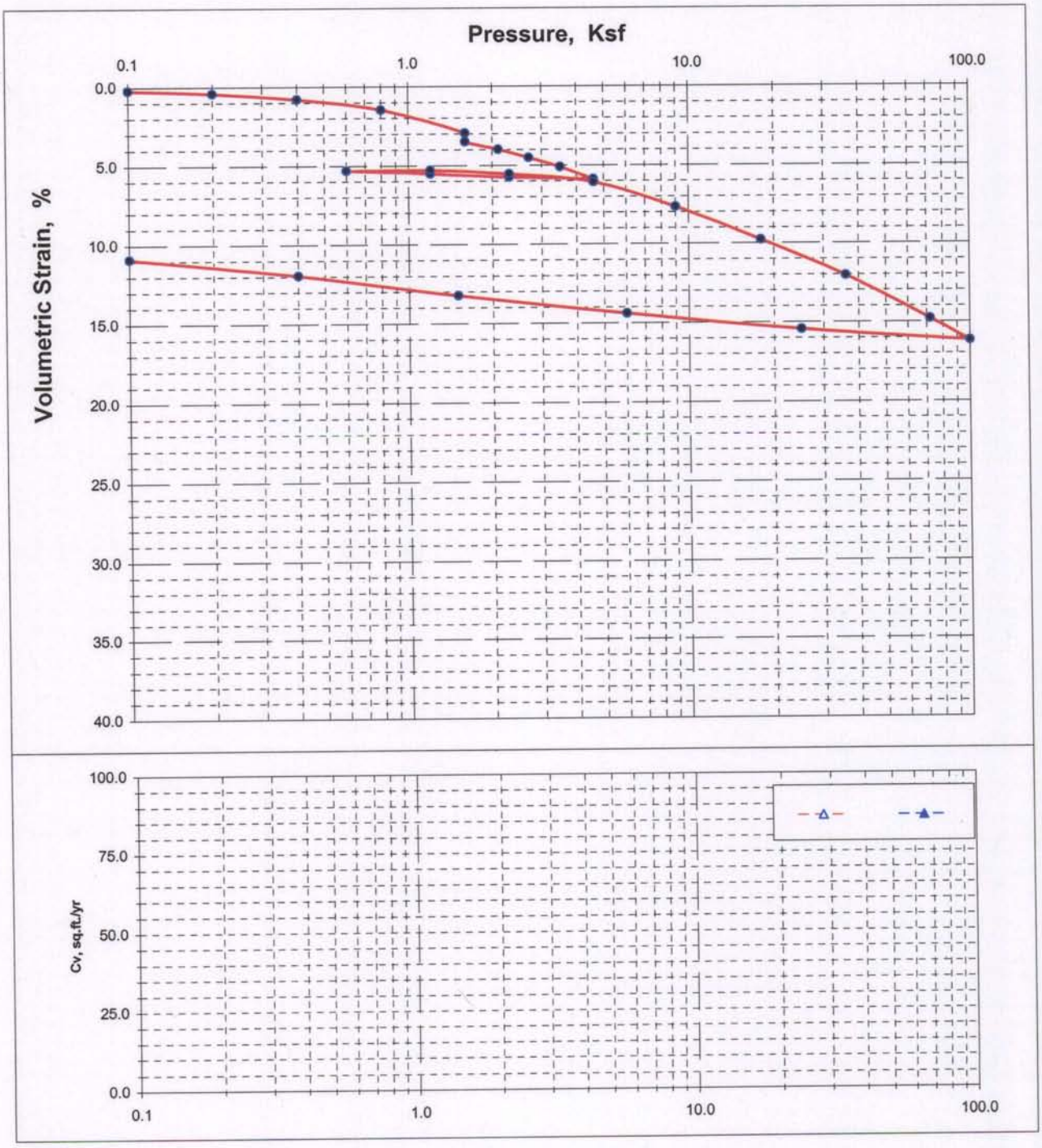


Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	10.5	0.06	328.8
0.003	13.4	0.08	418.7
0.004	13.7	0.11	428.9
0.007	13.6	0.16	424.1
0.009	13.6	0.21	423.7
0.012	13.5	0.27	422.9
0.015	13.7	0.32	427.3
0.018	14.1	0.37	441.1
0.020	15.1	0.43	471.7
0.023	15.9	0.48	495.6
0.026	16.5	0.53	513.9
0.028	17.2	0.58	535.3
0.031	17.8	0.63	554.1
0.034	18.5	0.68	574.4
0.037	19.1	0.73	593.5
0.039	19.8	0.79	615.3
0.042	20.5	0.84	635.1
0.045	21.2	0.89	657.1
0.047	21.8	0.94	675.1
0.050	22.5	0.99	696.0
0.052	23.1	1.04	716.7
0.059	23.8	1.17	737.4
0.069	26.7	1.37	824.0
0.080	29.8	1.57	917.6
0.090	32.8	1.77	1008.8
0.101	35.6	1.97	1091.0
0.111	38.2	2.17	1168.2
0.121	40.4	2.36	1234.6
0.132	42.6	2.57	1298.5
0.142	44.5	2.76	1353.2
0.153	46.4	2.97	1408.9
0.163	48.1	3.16	1458.5
0.174	49.8	3.36	1507.0
0.184	51.4	3.56	1552.2
0.194	53.0	3.76	1596.2
0.205	54.5	3.96	1637.0
0.215	56.1	4.16	1681.9
0.226	57.3	4.36	1715.6
0.236	58.6	4.56	1751.0
0.246	59.8	4.76	1782.7
0.257	61.1	4.97	1818.1
0.275	62.5	5.31	1851.4
0.301	66.0	5.81	1944.9
0.327	69.2	6.31	2030.0
0.353	72.5	6.82	2114.3
0.380	75.2	7.32	2181.8
0.406	77.5	7.82	2235.0
0.432	79.7	8.32	2287.3

CONSOLIDATION TEST

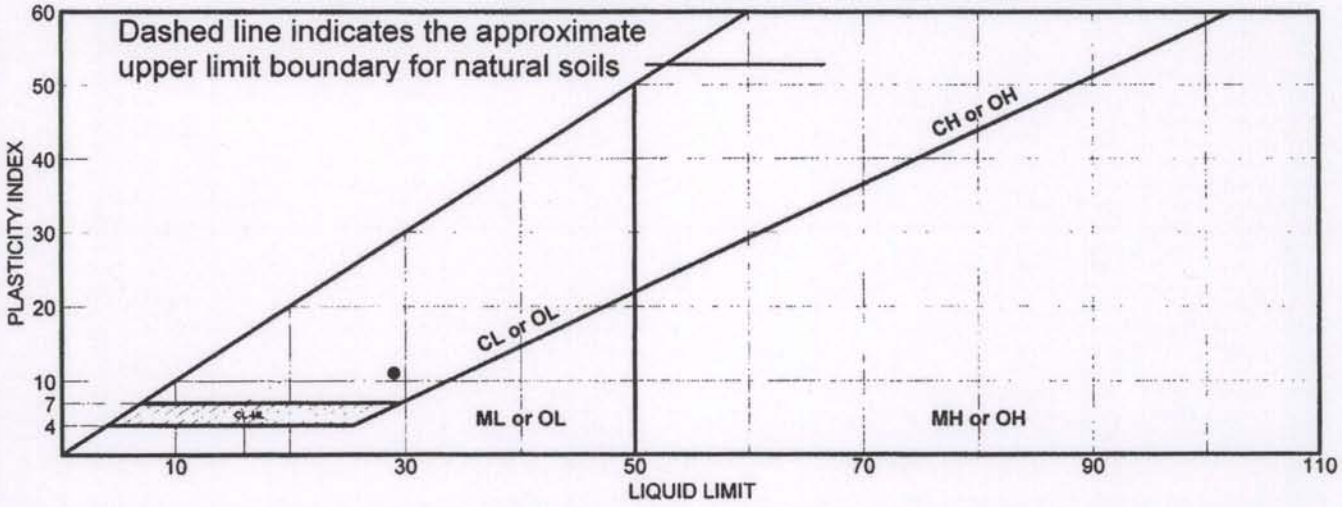
Boring Number	RW8-R1	Sample Number	16B	Depth (ft)	43.5-44	
Soil Description	Reddish brown clay with gravel					

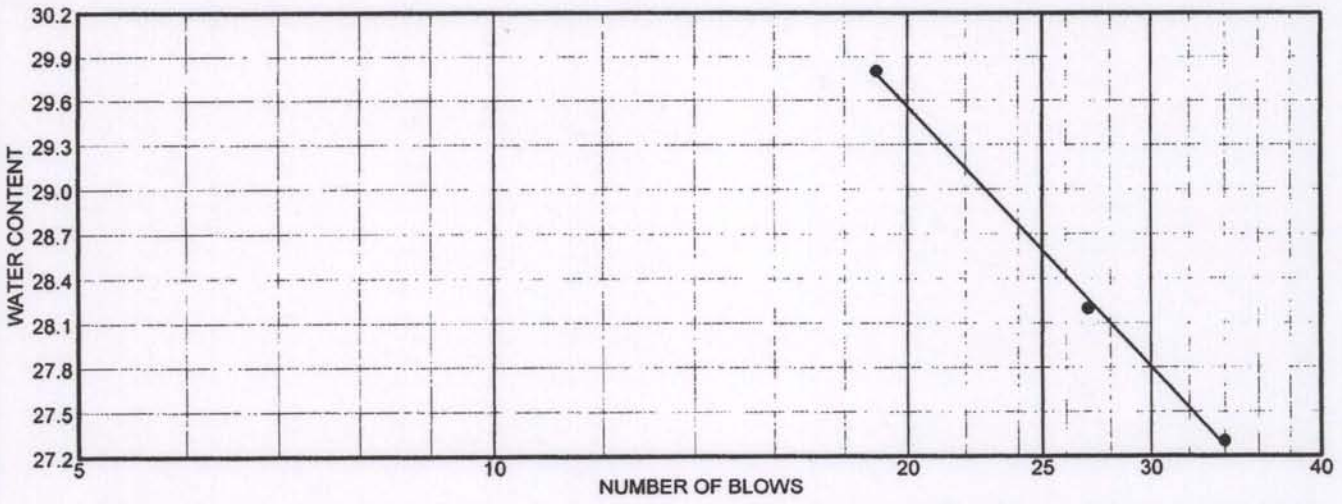
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	21.1	124.0	0.646	88.1	1.00	2.420	(assumed) 2.70	29	11
Final	17.0	135.4	0.457	100.2	0.885				



EA04-163701

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay with gravel	29	18	11			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 16B **Elev./Depth:** 43.5-44

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LABORATORY TEST DATA

Boring RW8-R2

MOISTURE CONTENT DETERMINATION
(CTM 226)

County : SF Route : 101 P.M. : 8.3/9.4 E.A.: 163701 Job No. : 5186

Limits : DOYLE DRIVE R.E. : R. Nashed

Date Received : 11/25/08 Date Calculated : 12/01/08

Date Reported : DEC 01 2008 By : KC/AU PAGE :

HOLE	SAMPLE	DEPTH	TEST (MC/PI/MA/GRAD)	GROSS WEIGHT Wet	GROSS WEIGHT Dry	TARE Weight	NET WEIGHT Wet	NET WEIGHT Dry	MOISTURE Weight	% Moisture
RW8-R2	#1	5'-6.5'	MC/MA	1083.9	981.2	242.2	841.7	739.0	102.7	13.9%
	#2	10'-11.5'	MC/MA	785.3	706.4	101.5	683.8	604.9	78.9	13.0%
	#3	15'-16.5'	MC/MA/PI	1017.7	891.3	100.2	917.5	791.1	126.4	16.0%
	#4	20'-21.5'	MC/MA/PI	1142.6	992.6	100.1	1042.5	892.5	150.0	16.8%
	#5	25'-26.5'	MC/MA	1255.4	1088.0	99.3	1156.1	988.7	167.4	16.9%
	#7	35'-36.5'	MC/MA	1118.0	962.6	101.0	1017.0	861.6	155.4	18.0%
	#8	40'-41.5'	MC/MA	1038.8	881.4	98.9	939.9	782.5	157.4	20.1%

MC - Moisture Content PI - Plasticity Index MA - Mechanical Analysis
MC Test Only - 230°F Oven; w/ PI and/or MA Tests - 140°F Oven; w/ AC Material - 100°F Oven

TEST NO. 5186 - 12P

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 09 2008

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT'L ENGR ☐ PAV'T. SECT
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C63850

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

SHIPMENT NO.

AUTHORIZATION NO. 1-3701

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

P.O. OR REQ. NO.

5186-12P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R2, SAMPLE #1

DEPTH 5-6.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R2-1

AND IS ON E OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST, CO, RTE, PM 4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. 1-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAKLAND, CA 946

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

JUL 25 2008

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	99				
100	22				
200	8				
5μ	5				
1μ	4				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
S.E	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

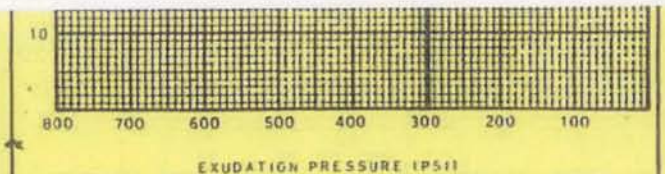
	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTIN
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

MAIL TO SAME DESTINATION AS SAMPLE



-TL-361 (Rev. 10/78)

TEST NO. 5186-13P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 09 2008

BILLED

☐ DISTRICT DIR[illegible]OR ☐ TRANS. LAB.
☐ DIS. MAT[illegible]R ☐ PAV'T. SECTI
☐ RESIDENT E[illegible]INEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SPECIF. SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4	100				
8	99				
16	98				
30	97				
50	92				
100	69				
200	61				
5μ	22				
1μ	12				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - 4 CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

		SPEC.
LL. P.L. P.I.		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_1	
	D_2	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN DR ☐ BULK (SSD) ☐ APPARENT

	FINE	COARS
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIMU
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CA[illegible]MBER C6[illegible]851

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☐ DIST[illegible]

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

P.O. OR REQ. [illegible]

5186-13P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R2
SAMPLE #2

DEPTH

LOCATION OF SOURCE DOYLE DRIVE

JUL 25 2008

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R2-2

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS., BILLS, STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 3/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM
4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

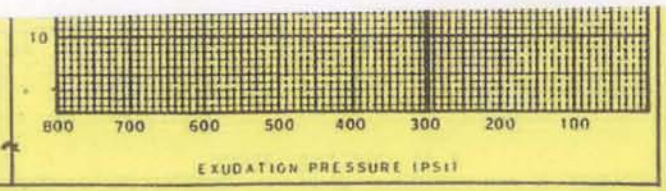
FED. NO. 1-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE 8TH FL. MS16 OAKLAND, CA 946[illegible]

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-14P

DATE RECEIVED JUL 25 2008

CALC. BY ______ APPROVED BY ______

DATE REPORTED DEC 09 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT. ENGR. ☐ PAV'T. SECT.
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	99				
100	86				
200	81				
5μ	33				
1μ	22				

GRADING AS USED WAS OBTAINED AS FOLLOWS:
% BY WT. % BY VOL. TEST NO. DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE / EXPANSION PRESSURE / AT EQUILIBRUM SPEC

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_H AT 2000 LBS				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS — SPEC.

LL 28 P.L. 13 P.I. 15

CV

S.E.: AS REC'D / CRUSHED / COMBINED

LART: GRADE 100 REV. / 500 REV.

DUR: D_f / D_c

% CRUSHED PARTICLES

SP. GR. ☐ BULK (OVEN) ☐ BULK (SSD) ☐ APPARENT — FINE / CO

AS REC'D. / CRUSHED

REL. COMPACTION D — IN PLACE / OPT

DENSITY / MOISTURE / % REL. COMP. / SPEC.

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

EXUDATION PRESSURE (PSI): 800 700 600 500 400 300 200 100 (10)

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C6 852

JUL 25 2008

5186-14P

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIS. LAB

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 163701

SAMPLE OF: SOIL

FOR USE IN: FOUNDATION DESIGN

SAMPLE FROM: BORING No RW8-R2 SAMPLE 3

DEPTH: 15-16.5'

LOCATION OF SOURCE: DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS): RW8-R2-3 AND IS ONE OF A GROUP OF: 28 SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)

OWNER OR MANUFACTURER: CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED: ☒ NORMAL ☐ PRIORITY

DATE NEEDED: 8/24/08

REMARKS:
MOISTURE CONTENT, PI
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED: 01/15-17/2008

BY: R. NASHED TITLE: ENG. GEOLOGIST

DIST. CO. RTE. PM: 4-SF-101-8.3/9.4

LIMITS

CONT. NO.: 163701

FED. NO.: 1-240

RES. ENGR. OR SUPT.: TUNG NGUYEN

ADDRESS: 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94

CONTRACTOR: PHONE 510-622-1775 FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

TEST NO. 5186-15P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 09 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB.
☐ DIS. MAT. ENGR. ☐ PAV'T. SECT.
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐
3					SOUGHT ☐
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	87				
100	62				
200	53				
5μ	25				
1μ	14				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

		SPEC.
LL 20 P.L 13 P.I (7)		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE	
	100 REV.	
	500 REV.	
DUR	D_f	
	D_t	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN D) ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CA NUMBER C 4853

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☐ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

5186-15P

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 163701

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R2-SAMPLE #4

DEPTH 20-21.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS)	AND IS ON E OF A GROUP OF	SAMPLES REPRESENTING (TONS, GALS., BBLS., STA. ETC.)
RW8-R2-4	28	

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE	TEST RESULTS DESIRED	DATE NEEDED
	☒ NORMAL ☐ PRIORITY	8/24/08

REMARKS

MOISTURE CONTENT, PI
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM

4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. I-240

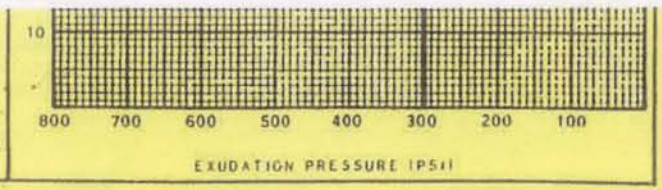
RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAKLAND, CA 94

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



BF 46743

TEST NO. 5186 - 16P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 09 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT L[illegible]R ☐ PAV'T. SECT
☐ RESIDENT L[illegible]NEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SPECIF. SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	99				
100	32				
200	22				
5μ	16				
1μ	12				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

			SPEC.
LL	P.L	P.I.	
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_t		
% CRUSHED PARTICLES			

SP. G.R. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C6[illegible]854

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
SHIPMENT NO.
AUTHORIZATION NO.

FIELD NO.
DIST. LAB NO. 5186
LOT NO.
P.O. OR REQ. NO.

5186-16P

JUL 25 2008

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R2, SAMLE #5
DEPTH 25 - 26.5'
LOCATION OF SOURCE DOYLE DRIVE

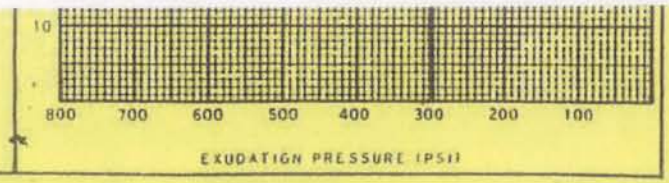
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R2-5
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST, CO, RTE, PM
4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNE NGUYEN
ADDRESS 111 GRAND AVE 8TH FL, MS16 OAKLAND, CA94
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



5186-179P

BILLED

CALC. BY _____ APPROVED BY _____ JUL 25 2008

DATE REPORTED DEC 09 2008

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT LAB ☐ PAV'T. SECT
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	75				
100	27				
200	17				
5μ	11				
1μ	6				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS:

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - ♯ CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN) ☐ BULK (SSD) ☐ APPARENT

	FINE	CO
AS REC'D.		
CRUSHED		

REL. COMPACTION D

	IN PLACE	OPT
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev.10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CAR NUMBER C6 855

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.
DIST. LAB NO. 5186
LAT NO.
SHIPMENT NO. P.O. OR REQ. NO.
AUTHORIZATION NO. 163701

5186-179P

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

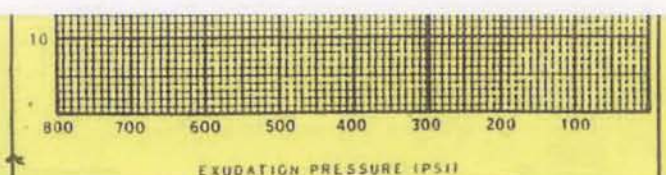
JUL 25 2008

SAMPLE FROM BORING No. RW8-R2, SAMLE #7
DEPTH 35-36.5'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS): RW8-R2-7
AND IS ON E OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS., SQ.FT., STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08
REMARKS
MOISTURE CONTENT
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 01/15-17/2008
BY R. NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM 4-SF-101-8.3/9.4
LIMITS
CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNE NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA94
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-189

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 09 2008

☐ DISTRICT DIRECTOR ☐ TRANS. LAB.
☐ DIS. MAT. ENGR. ☐ PAV'T. SECT.
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8	100				
16	99				
30	99				
50	98				
100	25				
200	15				
5μ	10				
1μ	7				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE) | ACTIVITY OR OBJECT | AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_{ii} AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL P.L P.I.			
CV			
S.E	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN DRY) ☐ BULK (SSD) ☐ APPARENT

	FINE	COARSE
AS REC'D.		
CRUSHED		

REL. COMPACTION DATA

	IN PLACE	OPTIMUM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CA NUMBER C[illegible]4856

JUL 25 2008

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 163701

5186.189

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R2 -SAMLE #8

DEPTH 40 - 41.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R2-8

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, CAES, BULK, STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/01

REMARKS

MOISTURE CONTENT
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM 4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. 1-240

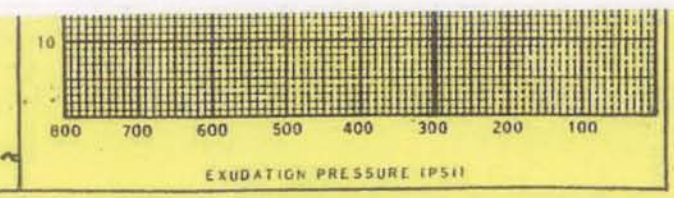
RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAK(ANN) CA 94

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



BF 46243

LABORATORY TEST DATA

Boring RW8-R3

CLASSIFICATION TEST SUMMARY

SAMPLE ID	% FINER THAN																	ATTERBERG LIMITS		AS RECEIVED		Gs
	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	5μ	1μ	LL	PI	γd (pcf)	%m	
ENB-R2_06A											100	98	43	14	11	7	7				20.0	
ENB-R2_08A										100	99	95	66	43	41	22	18				29.4	
ENB-R2_10A											100	96	36	4	3	0	0				24.0	
ENB-R2_12B												100	80	28	8	4	4				18.9	
ESB-R1_S-3A																					14.9	
ESB-R1_S-3B																		21	7		21.8	2.79
ESB-R2_16												100	64	32	28	4	3			115.1	20.4	
ESB-R2_22A												100	93	34	20	12	6			120.4	17.6	
RW05-R1_02A										100	99	98	83	58	48	26	18				16.0	
RW08-R3_03A											100	99	82	56	49	22	15	24	11	111.3	18.9	
RW08-R3_03B											100	99	85	62	55	23	18				20.4	
RW08-R3_03C																						
RW08-R3_03D																						
RW08-R4_01A																					18.4	
RW08-R4_01B																						
RW08-R4_01C									100	99	97	97	92	77	71	22	14	19	4	107.1	15.1	
RW08-R4_01D																						
RW10-A1_04B																		56	22		78.5	2.57
RW10-A1_06B										100	99	97	47	8	5	4	1			99.3	22.2	
RW14-A1_05A																					120.1	
RW14-A1_05B																		79	20		115.0	2.47
RW14-A1_08A																						
RW14-A1_10A																						
RW14-A1_S-6																						
RW18-A1_03											100	98	47	22	19	4	1				12.6	
RW18-A1_S4A											100	97	56	10	8	3	1				19.9	
RW18-A1_S6B								100	99	96	94	88	57	25	19	7	5				20.1	
RW19-A1_05B																						

MOISTURE CONTENT DETERMINATION
(CTM 226)

County : SF Route : 101 P.M. : E.A.: 163701 Job No. : 5186

Limits : R.E. : R.NASHED

Date Received : 10/17/08 Date Calculated : 10/27/08

Date Reported : OCT 28 2008 By : KC PAGE : 1 OF 1

HOLE	SAMPLE	DEPTH	TEST (MC/PI/MA/GRAD)	GROSS WEIGHT Wet	GROSS WEIGHT Dry	TARE Weight	NET WEIGHT Wet	NET WEIGHT Dry	MOISTURE Weight	% Moisture
RW8-R3	2	10.0'-11.5'	MC,PI	1560.9	1336.3	100.9	1460.0	1235.4	224.6	**18.2%**
	3A	11.0'-13.0'	MC,PI,MA	2492.3	2108.2	101.6	2390.7	2006.6	384.1	**19.1%**
	3B	15.0'-16.5'	MC,PI,MA	545.4	500.6	242.1	303.3	258.5	44.8	**17.3%**
	4	20'-21.5'	MC,MA	1349.8	1155.0	99.8	1250.0	1055.2	194.8	**18.5%**
	5	25'-26.5'	MC,MA	1115.8	962.4	101.5	1014.3	860.9	153.4	**17.8%**
	7	35.0'-36.5'	MC,MA	1111.1	940.6	99.8	1011.3	840.8	170.5	**20.3%**
	8	4.0'-41.5'	MC,MA	1136.2	977.7	101.0	1035.2	876.7	158.5	**18.1%**
	11	55.0'-56.5'	MC,MA	915.0	781.2	99.7	815.3	681.5	133.8	**19.6%**
	13	65.0'-66.5'	MC,MA	1208.5	989.7	99.6	1108.9	890.1	218.8	**24.6%**
	18	90.0'-91.5'	MC,MA	1400.9	1129.9	100.7	1300.2	1029.2	271.0	**26.3%**

MC - Moisture Content PI - Plasticity Index MA - Mechanical Analysis

MC Test Only - 230°F Oven; w/ PI and/or MA Tests - 140°F Oven; w/ AC Material - 100°F Oven

TEST NO. 5186 - 19P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 14 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. L
☐ DIS. MAT L ☐ PAV'T. SE
☐ RESIDENT ENGINEER ☐ ACCOUNTI
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30					
50					
100					
200					
5μ					
1μ					

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED–ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE–GMS				
HEIGHT OF BRIQUETTE–INCHES				
DRY DENSITY OF BRIQ. – # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R–VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R–VALUE BY EXPANSION				

TEST RESULTS

		SPEC.
LL 23 P.L 13 P.I. 10		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_i	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN ☐ BULK (SSD) ☐ APPARENT

	FINE	C
AS REC'D.		
CRUSHED		

REL. COMPACTION D

	IN PLACE	OPT
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTA

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CAR. NUMBER C634857

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TES
☐ DIST. L
☐ TRANS. LA
☐ SPECIAL TE

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ T. LAB

FIELD NO.

DIST. LAB NO. 5186

5186-19P

ON NO. 163701

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R3 SAMPLE #2

DEPTH 10-11.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-2

AND IS ON E OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS MOISTURE CONTENT, PI

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM 4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. I-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 946

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

H/ 46341

TEST NO. 5186-20P

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY ___ APPROVED BY ___

DATE REPORTED NOV 19 2008

☐ DISTRICT D…R ☐ TRANS. LAB.
☐ DIS. MAT …R ☐ PAV'T. SECTIO…
☐ RESIDENT E…EER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	79				
100	50				
200	42				
5µ	23				
1µ	17				

GRADING AS USED WAS OBTAINED AS FOLLOWS:
% BY WT. % BY VOL. TEST NO. DESCRIPTION

REMARKS:

SURFACE	
BASE	
SUBBASE	
GRAVEL EQUIVALENT FACTOR	
TRAFFIC INDEX	
R VALUE — EXUDATION PRESSURE	
R VALUE — EXPANSION PRESSURE	
R VALUE — AT EQUILIBRUM SPEC.	
INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)	

REPORT OF TESTS ON

Soil

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION
SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS	SPEC.
LL 21 P.L 12 P.I. 9	
CV	
S.E. AS REC'D	
S.E. CRUSHED	
S.E. COMBINED	
LART GRADE 100 REV.	
LART 500 REV.	
DUR D_f	
DUR D_c	
% CRUSHED PARTICLES	

SP. GR. ☐ BULK (OVEN DR…) ☐ BULK (SSD) ☐ APPARENT	FINE	COARS…
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT…

	IN PLACE	OPTIMU…
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

JUL 25 2008

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

NUMBER C0…858

5186-20P

☐ PRELIMINARY TESTS	SAMPLE SENT TO:	FIELD NO.
☒ PROCESS TESTS	☐ HDQTRS. LAB	DIST. LAB NO. 5186
☐ ACCEPTANCE TESTS	☐ BRANCH LAB	
INDEPENDENT ASSURANCE TESTS ☐ DIST. ☐ TRANS.	☒ DIST. LAB	
☐ SPECIAL TE…		

SAMPLE OF: SOIL

FOR USE IN: FOUNDATION DESIGN

SAMPLE FROM: BORING No RW8-R3 SAMPLE #3A

DEPTH: 11-13'

LOCATION OF SOURCE: DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS): RW8-R3-3A | AND IS ONE OF A GROUP OF: 28 | SAMPLES REPRESENTING (TONS, GALS., BBLS, STA. ETC.)

OWNER OR MANUFACTURER: CALTRANS

TOTAL QUANTITY AVAILABLE | TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY | DATE NEEDED 8/24/08

REMARKS: MOISTURE CONTENT, PI
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED: 01/15-17/2008

BY: R NASHED TITLE: ENG. GEOLOGIST

DIST. CO. RTE. PM: 4-SF-101-8.3/9.4

LIMITS

CONT. NO.: 163701

FED. NO.: 1-240

RES. ENGR. OR SUPT.: TUNG NGUYEN

ADDRESS: 111 GRAND AVE 8TH FL MS16 OAKLAND CA94…

CONTRACTOR: PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

EXUDATION PRESSURE (PSI): 800 700 600 500 400 300 200 100 — 10

TEST NO. 5186-21P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECTIO
☐ RESIDENT ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4	100				
8	100				
16	100				
30	99				
50	88				
100	67				
200	60				
5μ	28				
1μ	21				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS		SPEC.
LL 23 P.L 12 P.I. 11		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_i	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN DR ☐ BULK (SSD) ☐ APPARENT

	FINE	COARS
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIMU
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD
TL-0101 (REV. 10/97)

NUMBER C 4859

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.
DIST. LAB NO. 5186
LOT NO.
SHIPMENT NO. P.O. REQ. NO.
AUTHORIZATION NO. 163701

5186-21P

JUL 25 2008

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN
SAMPLE FROM BORING No. RW8-R3
SAMPLE #3B
DEPTH 15-16.5'
LOCATION OF SOURCE DOYLE DRIVE

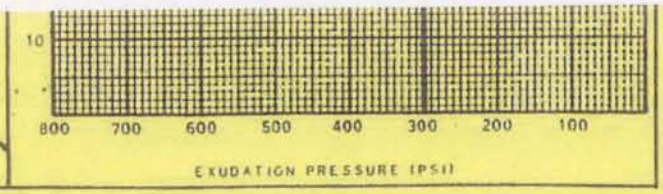
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-3B
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT PI
MECHANICAL ANALYSIS

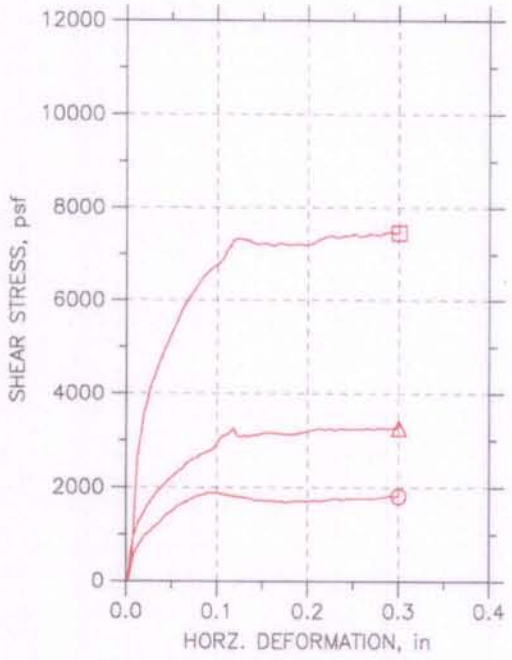
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM 4-SF-101-8.3/9.4
LIMITS

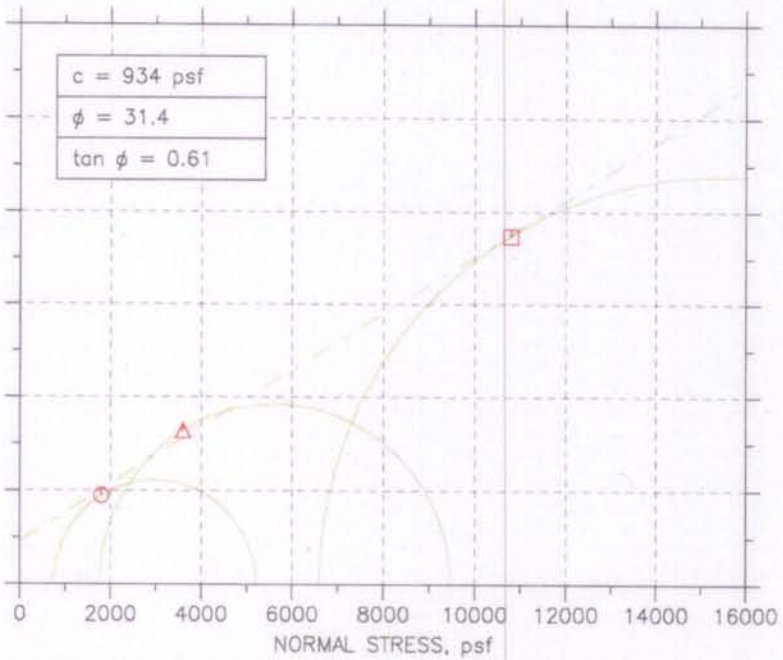
CONT. NO. 163701
FED. NO. I-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAKLAND, CA 94
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

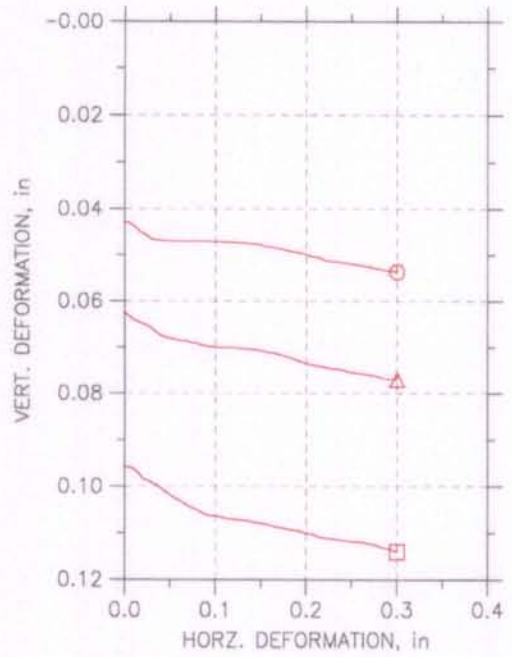
MAIL TO SAME DESTINATION AS SAMPLE



DIRECT SHEAR TEST REPORT







Symbol		⊙	△	□	
Test No.		DS09026A	DS09026B	DS09026C	
Sample No.		03B	03B	03B	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.94	1.94	1.94	
	Area, in^2	2.9559	2.9559	2.9559	
	Height, in	1	1	1	
	Water Content, %	19.41	20.17	16.50	
	Dry Density, pcf	109.55	108	117.92	
	Saturation, %	94.13	94.07	99.56	
	Void Ratio	0.56714	0.58958	0.45581	
Consol. Height, in		0.95845	0.93884	0.90486	
Consol. Void Ratio		0.50203	0.49236	0.31731	
Final	Water Content, %	17.53	16.95	10.49	
	Dry Density, pcf	115.74	116.99	133.07	
	Saturation, %	99.75	99.68	99.46	
	Void Ratio	0.48329	0.46749	0.29008	
Normal Stress, psf		1799.8	3598.3	10796	
Max. Shear Stress, psf		1905.2	3290.7	7493.4	
Ult. Shear Stress, psf		1826.4	3276.3	7485.5	
Time to Failure, min		24.002	76.002	74.002	
Disp. Rate, in/min		0.004	0.004	0.004	
Implied Specific Gravity		2.75	2.75	2.75	
Liquid Limit		0	0	0	
Plastic Limit		0	0	0	
Plasticity Index		0	0	0	

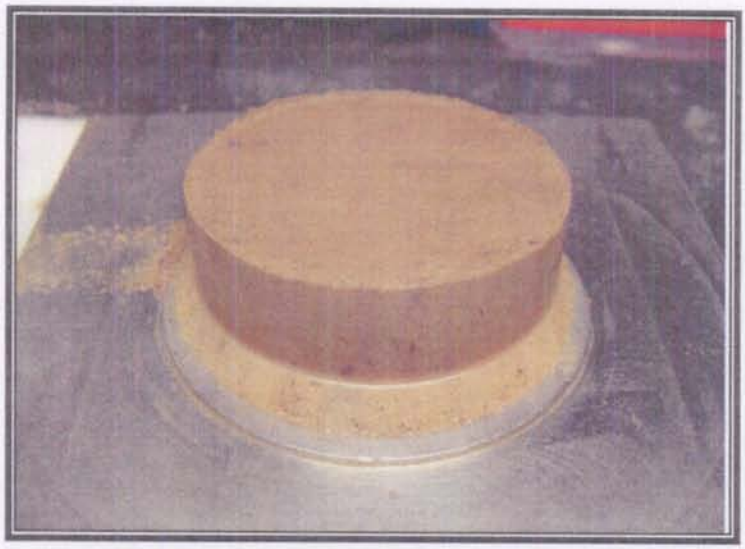
Project: Doyle Drive
Location: 04-SF-101-8-9.8
Project No.: 04-163701
Boring No.: RW08-R3
Sample Type: BRASS
Description: Moist, Very Firm, Brown, Silty Clay with Sand
Remarks: ASTM D3080

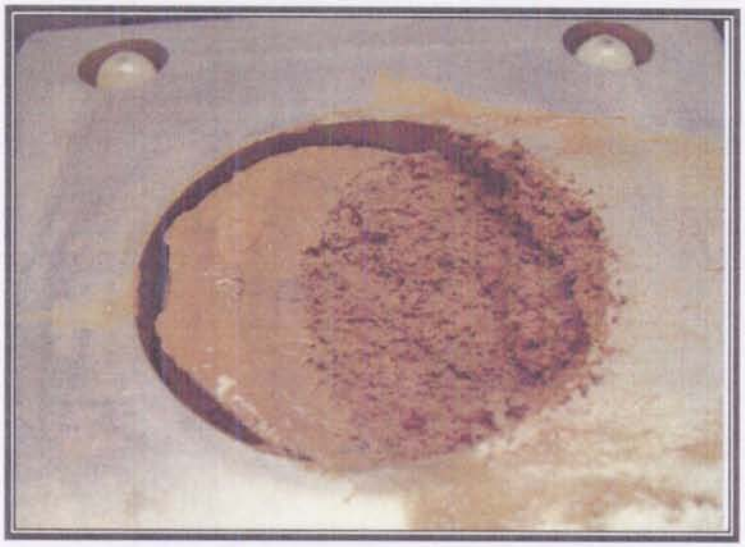
MP 3/11

Wed, 04-MAR-2009 09:09:14

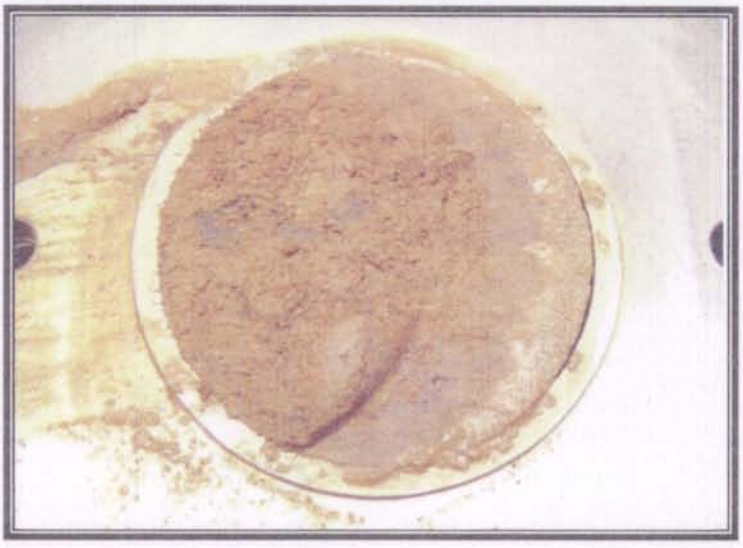
DIRECT SHEAR
JOB #: 04-163701
SAMPLE #: RW08-R3_03B
Test Specimen A

DIRECT SHEAR
JOB #: 04-163701
SAMPLE #: RW08-R3_03B
Test Specimen B





DIRECT SHEAR
JOB #: 04-163701
SAMPLE #: RW08-R3_03B
Test Specimen C



TEST NO. 5186 - 22P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT [illegible]R ☐ PAV'T. SECT
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4	100				
8	100				
16	100				
30	99				
50	80				
100	34				
200	26				
5μ	14				
1μ	10				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE) | ACTIVITY OR OBJECT | AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED–ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE–GMS				
HEIGHT OF BRIQUETTE–INCHES				
DRY DENSITY OF BRIQ. – # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R–VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R–VALUE BY EXPANSION				

TEST RESULTS

		SPEC.
LL P.L P.I.		
CV		
S.E. AS REC'D		
S.E. CRUSHED		
S.E. COMBINED		
LART GRADE 100 REV.		
LART GRADE 500 REV.		
DUR D_f		
DUR D_i		
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTI
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

[illegible]BER C00486Q

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
SHIPMENT NO
AUTHORIZATION NO

FIELD NO
DIST. LAB NO 5186
LOT NO
P.O. OR REQ.
163701

5186-22P

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R3
SAMLE #4
DEPTH 20-21.5'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-4
AND IS ON E OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS

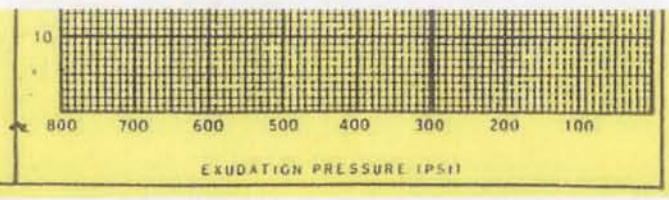
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM
4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. I-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-23P

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

☐ DISTRICT ☐ TRANS. LAB
☐ DIS. MAT ☐ PAV'T. SECT
☐ RESIDENT ☐ ACCOUNTING
☐ CONSTRUCTION

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	79				
100	28				
200	17				
5μ	12				
1μ	9				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - 4 CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_c		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV 10/97)

NUMBER Cu 861

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
☐ TRANS. LAB

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

AUTHORIZATION NO. 163701

5186-23P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R3 SAMPLE #5

DEPTH 25' ~ 26.5'

LOCATION OF SOURCE DOYLE DRIVE

JUL 25 2008

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-5

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS., BBLS., STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS

MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM

4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. 1-240

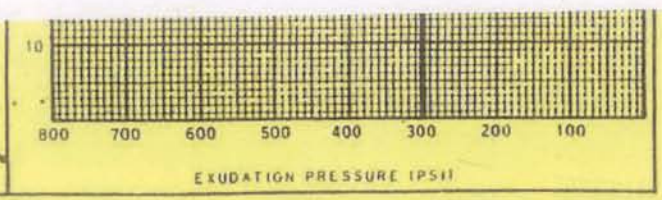
RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO 5186-24P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECTIO
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8	100				
16	99				
30	99				
50	86				
100	32				
200	17				
5μ	12				
1μ	9				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS		SPEC.
LL P.L P.I.		
CV		
S.E	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_i	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN DR ☐ BULK (SSD) ☐ APPARENT

	FINE	COARS
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIMU
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97) NUMBER C[illegible]1862

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.
DIST. LAB NO. 5186
SHIPMENT NO.
AUTHORIZATION NO. 163701

5186-24P

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

JUL 25 2008

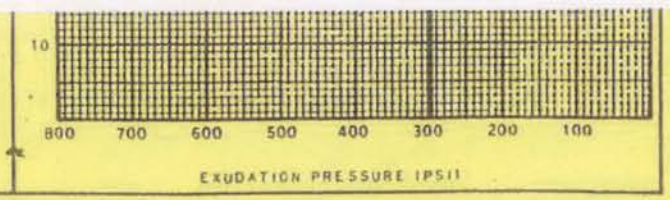
SAMPLE FROM BORING No. RW8-R3 SAMPLE #7
DEPTH 35-36.5'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-7
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS., EACH, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08
REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM 4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. I-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE, 8TH FL. MS16 OAKLAND, CA 94
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-25P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECT
☐ RESIDENT ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	77				
100	27				
200	19				
5μ	14				
1μ	10				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE) | ACTIVITY OR OBJECT | AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS	SPEC.
LL P.L P.I.	
CV	
S.E. AS REC'D	
S.E. CRUSHED	
S.E. COMBINED	
LART GRADE 100 REV.	
LART GRADE 500 REV.	
DUR D_f	
DUR D_t	
% CRUSHED PARTICLES	

SP. GR. ☐ BULK (OVEN DR ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CONTROL NUMBER C U 863

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB

☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

5186-25P

SHIPMENT NO.

P.O. OR REL. NO.

AUTHORIZATION NO. 15371

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R3
SAMPLE #8

DEPTH 40-41.5'

LOCATION OF SOURCE DOYLE DRIVE

JUL 25 2008

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS)	AND IS ONE OF A GROUP OF	SAMPLES REPRESENTING (TONS, GALS., BBLS., STA. ETC.)
RW8-R3-8	28	

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE	TEST RESULTS DESIRED	DATE NEEDED
	☒ NORMAL ☐ PRIORITY	8/24/08

REMARKS
MOISTURE CONTENT
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM 4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

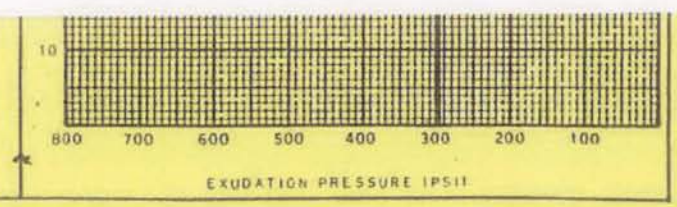
FED. NO. 1-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAK(ANN) CA 94

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-264

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT L[illegible]R ☐ PAV'T. SECT
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	94				
100	26				
200	13				
5μ	8				
1μ	7				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL P.L P.I.			
CV			
S.E	AS REC'D		
	CRUSHED		
	COMBINED		
SAND EQUIV.	GRADE	100 REV.	
		500 REV.	
DURO	D_i		
	D_f		
% CRUSHED PARTICLES			

SP. G.R. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CONTRACT NUMBER C[illegible]864

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIS. LAB

FIELD NO. —

DIST. LAB NO. 5186

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SHIPMENT NO.

AUTHORIZATION NO. 16[illegible]7C

5186-264

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R3
SAMPLE # 11

DEPTH 55-56.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3-11

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, SACS, BBLS, ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT.
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST. CO. RTE. PM
4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

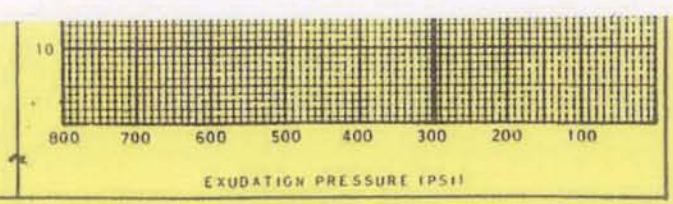
FED. NO. I-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAKLAND, CA 94

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-27P

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECT.
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	57				
100	22				
200	12				
5μ	7				
1μ	5				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL. P.L. P.I.			
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

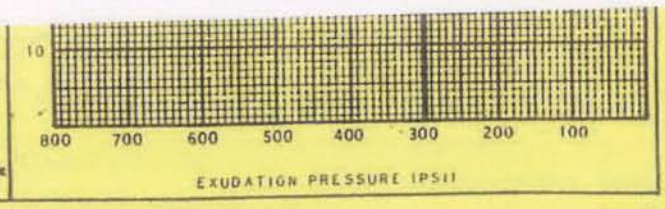
SP. GR. ☐ BULK (OVEN DR) ☐ BULK (SSD) ☐ APPARENT

	FINE	COARSE
AS REC'D.		
CRUSHED		

REL. COMPACTION DATA

	IN PLACE	OPTIMUM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B



-TL-361 (Rev.10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97) C[illegible]1865

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB

☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD

DIST. LAB NO. 5186

SHIPMENT NO.

AUTHORIZATION NO. 163701

5186-27P

JUL 25 2008

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R3
SAMPLE # 13

DEPTH 65-66.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN RW8-R3-13 (NO. CONTAINERS)

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, CAKE, BBLS, STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/28/08

REMARKS
MOISTURE CONTENT.
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST, CO, RTE, PM 4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. I-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAK(ANN) CA 94612

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

M 46-43

TEST NO. 5186-28P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTR[illegible]TOR ☐ TRANS. LAB.
☐ DIS. M[illegible]R ☐ PAV'T. SECTI
☐ RESIDENT E[illegible]NEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	89				
100	28				
200	17				
5μ	7				
1μ	4				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL. P.L. P.I.			
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LA RT	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN DR) ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97) NUMBER C[illegible]1866

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
SHIPMENT NO.
AUTHORIZATION NO. 163701

FIELD NO.
DIST. LAB NO. 5186
5186-28P
P.O. OR REQ. NO.

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

JUL 25 2008

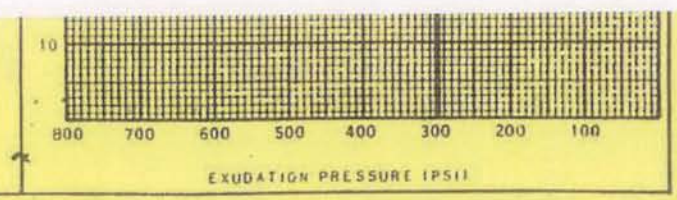
SAMPLE FROM BORING No. RW8-R3 -SAMPLE #18
DEPTH 90'N 91.5'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-23-18
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST. CO. RTE. PM 4-SF-101-8.3/9.4
LIMITS
CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94612
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



LABORATORY TEST DATA

Boring RW8-R4-PZ

CLASSIFICATION TEST SUMMARY

SAMPLE ID	% FINER THAN																	ATTERBERG LIMITS		AS RECEIVED		Gs
	3"	2 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	5μ	1μ	LL	PI	γd (pcf)	%m	
ENB-R2_06A											100	98	43	14	11	7	7				20.0	
ENB-R2_08A										100	99	95	66	43	41	22	18				29.4	
ENB-R2_10A											100	96	36	4	3	0	0				24.0	
ENB-R2_12B												100	80	28	8	4	4				18.9	
ESB-R1_S-3A																					14.9	
ESB-R1_S-3B																		21	7		21.8	2.79
ESB-R2_16												100	64	32	28	4	3			115.1	20.4	
ESB-R2_22A												100	93	34	20	12	6			120.4	17.6	
RW05-R1_02A										100	99	98	83	58	48	26	18				16.0	
RW08-R3_03A											100	99	82	56	49	22	15	24	11	111.3	18.9	
RW08-R3_03B											100	99	85	62	55	23	18				20.4	
RW08-R3_03C																						
RW08-R3_03D																						
RW08-R4_01A																					18.4	
RW08-R4_01B																						
RW08-R4_01C									100	99	97	97	92	77	71	22	14	19	4	107.1	15.1	
RW08-R4_01D																						
RW10-A1_04B																		56	22		78.5	2.57
RW10-A1_06B										100	99	97	47	8	5	4	1			99.3	22.2	
RW14-A1_05A																					120.1	
RW14-A1_05B																		79	20		115.0	2.47
RW14-A1_08A																						
RW14-A1_10A																						
RW14-A1_S-6																						
RW18-A1_03											100	98	47	22	19	4	1				12.6	
RW18-A1_S4A											100	97	56	10	8	3	1				19.9	
RW18-A1_S6B								100	99	96	94	88	57	25	19	7	5				20.1	
RW19-A1_05B																						

MOISTURE CONTENT DETERMINATION
(CTM 226)

County : SF Route : 101 P.M. : 8.3/9.4 E.A.: 163701 Job No. : 5186

Limits : R.E. : R.NASHED

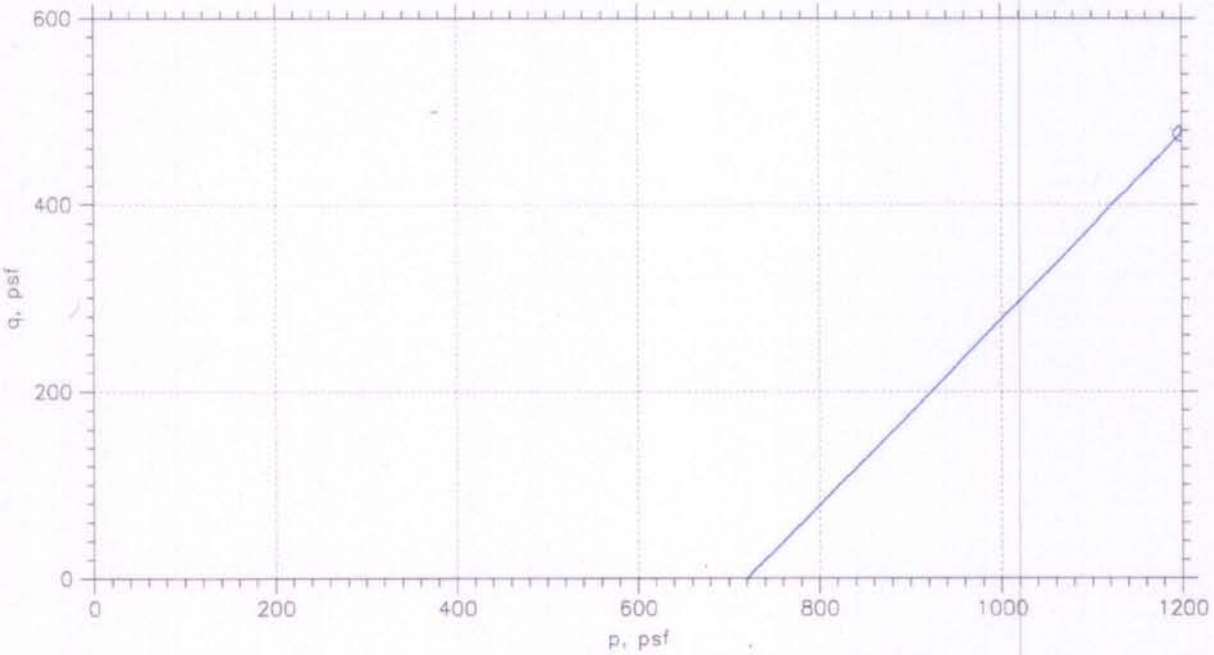
Date Received : Date Calculated : 10/27/08

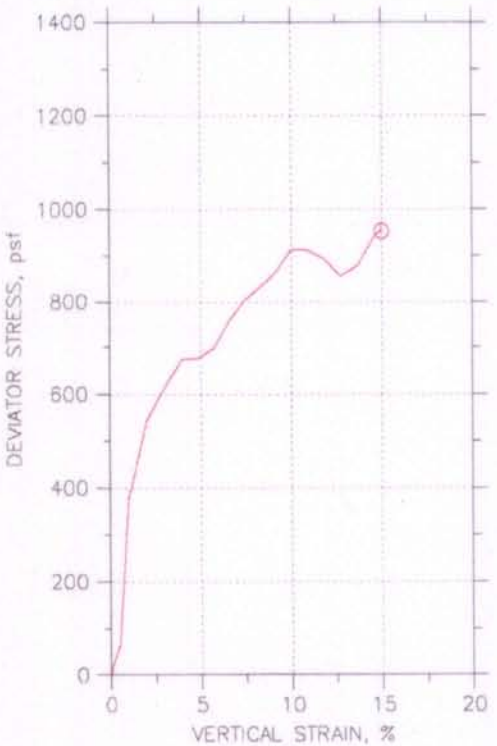
Date Reported : OCT 28 2008 By : AU/KC PAGE : 1 OF 1

HOLE	SAMPLE	DEPTH	TEST (MC/PI/MA/GRAD)	GROSS WEIGHT Wet	GROSS WEIGHT Dry	TARE Weight	NET WEIGHT Wet	NET WEIGHT Dry	MOISTURE Weight	% Moisture
RW8-R4	2	10.0'-11.5'	MC,MA,PI	1212.0	1089.6	270.6	941.4	819.0	122.4	14.9%
	3	15.0'-16.5'	MC,PI,MA	1313.0	1155.5	266.8	1046.2	888.7	157.5	17.7%
	4	20.0'-21.5'	MC,MA	1138.1	1014.8	270.8	867.3	744.0	123.3	16.6%
	5	25.0'-26.5'	MC,MA	1157.2	1035.8	290.4	866.8	745.4	121.4	16.3%
	6	30.0'-31.5'	MC,MA	1079.9	967.3	269.1	810.8	698.2	112.6	16.1%
	11	55.0'-56.5'	MC,MA	1267.6	1078.5	269.0	998.6	809.5	189.1	23.4%
	13A	60.0'-65.5'	MC,SA	3687.1	3107.3	265.8	3421.3	2841.5	579.8	20.4%
	17	90.0'-91.5'	MC	1404.9	1182.6	269.9	1135.0	912.7	222.3	24.4%

MC - Moisture Content PI - Plasticity Index MA - Mechanical Analysis
MC Test Only - 230°F Oven; w/ PI and/or MA Tests - 140°F Oven; w/ AC Material - 100°F Oven

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		⏲
Sample No.		01A
Test No.		U09-006
Depth		5-6.5
Initial	Diameter, in	1.94
	Height, in	3.15
	Water Content, %	18.4
	Dry Density, pcf	110.8
	Saturation, %	92.3
	Void Ratio	0.55
Before Shear	Water Content, %	
	Dry Density, pcf	
	Saturation*, %	
	Void Ratio	
	Back Press., psf	
Ver. Eff. Cons. Stress, psf		720.2
Shear Strength, psf		477.3
Strain at Failure, %		15
Strain Rate, %/min		1
B-Value		---
Implied Specific Gravity		2.75
Liquid Limit		---
Plastic Limit		---

Caltrans

Project: Doyle Drive

Location: 04-SF-101-8-9.8

Project No.: 04-163701

Boring No.: RW08-R4

Sample Type: ASTM D2850

Description: Very Firm, Brown, Sandy Clay with Silt.

Remarks: Tube not full. Specimen does not meet dimensional requirements.

WP 96

Phase calculations based on start and end of test.

TEST NO. 5186-29P

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

☐ DISTRICT D[illegible]OR ☐ TRANS. LAB
☐ DIS. MAT L[illegible]R ☐ PAV'T. SECT
☐ RESIDENT E[illegible]NEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	86				
100	57				
200	49				
5μ	24				
1μ	16				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS

		SPEC.
LL 19 P.L 10 P.I. 9		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_t	
% CRUSHED PARTICLES		

SP. G R. ☐ BULK (OVER D ☐ BULK (SSD) ☐ APPARENT

	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTI
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CU 867

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 163701

5186-29P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R4 SAMPLE 2

DEPTH 10-11.5'

LOCATION OF SOURCE DOYLE DRIVE

JUL 25 2008

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-2

AND IS ON E OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS., BBLS., ETA, ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS

MOISTURE CONTENT PI
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST. CO. RTE. PM

4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. 1-240

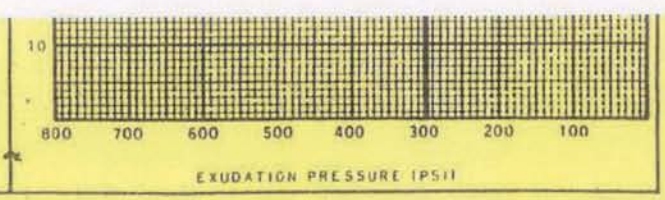
RES. ENGR. OR SUPT. TUNE NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-30P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECTION
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	83				
100	36				
200	26				
5μ	18				
1μ	13				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

		SPEC.
LL 21 PL 15 PI 6		
CV		
SIEVE: AS REC'D		
SIEVE: CRUSHED		
SIEVE: COMBINED		
CLEAN SAND: GRADE		
CLEAN SAND: 100 REV.		
CLEAN SAND: 500 REV.		
DURO: D_f		
DURO: D_i		
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN DRY) ☐ BULK (SSD) ☐ APPARENT

	FINE	COARSE
AS REC'D.		
CRUSHED		

REL. COMPACTION DATA

	IN PLACE	OPTIMUM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

NUMBER C U 1868

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
☐ INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO: ☐ HDQTRS. LAB ☐ BRANCH LAB

FIELD NO.

DIST. LAB NO. 5186

5186-30P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R4 SAMPLE #3

DEPTH 15-16.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-3

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS

MOISTURE CONTENT PI
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST. CO. RTE. PM

4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. I-240

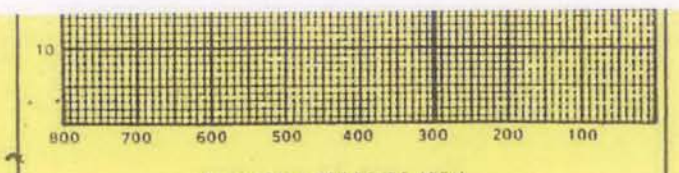
RES. ENGR. OR SUPT. TUNE NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4939

MAIL TO SAME DESTINATION AS SAMPLE



5181 - 31P

BILLED

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

JUL 25 2008

☐ DISTRICT ☐ TRANS. LAB
☐ DIS. MAT ☐ PAV'T. SECT
☐ RESIDENT ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	79				
100	35				
200	26				
5μ	18				
1μ	11				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

			SPEC.
LL	P.L	P.I.	
CV			
S.E	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. G R. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev.10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CONTROL NUMBER C[illegible]1869

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS LAB

SHIPMENT NO.

AUTHORIZATION NO. 163701

5186-31P

☐ SPECIAL TESTS

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R4
SAMPLE #4

DEPTH 20-21.5'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-4

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 3/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST. CO. RTE. PM
4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. I-240

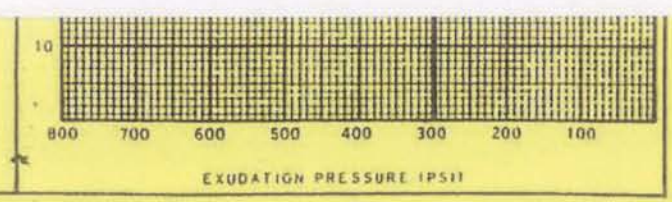
RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL, MS16 OAKLAND, CA 94

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

JUL 25 2008



TEST NO. 5186-32P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 19 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECT
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	78				
100	33				
200	21				
5μ	11				
1μ	6				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
S.E	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_1		
	D_2		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV 10/97)

CONTRACT NUMBER C[illegible]4870

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
SHIPMENT NO.
AUTHORIZATION NO. 163701

FIELD NO.
DIST. LAB NO. 5186
LAB NO.
DEPT'S NO.

5186-32P

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R4 -SAMPLE #5
DEPTH 25-26.5'
LOCATION OF SOURCE DOYLE DRIVE

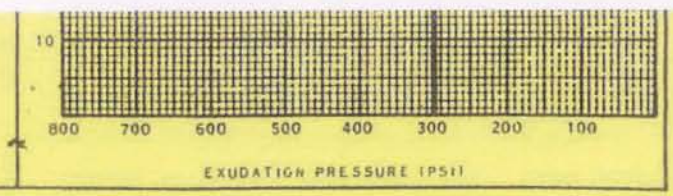
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-5
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS., BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM
4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNE NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94612
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



5186 - 33P

BILLED

CALC. BY _____ APPROVED BY _____ JUL 25 2008

DATE REPORTED NOV 19 2008

☐ DISTRICT DIRECTOR ☐ TRANS. LAB.
☐ DIS. MAT L[illegible]R. ☐ PAV'T. SECTI
☐ RESIDENT E[illegible]EER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16	100				
30	99				
50	88				
100	33				
200	18				
5μ	9				
1μ	6				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE
- EXUDATION PRESSURE
- EXPANSION PRESSURE
- AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS

		SPEC.
LL P.L P.I.		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_t	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN D[illegible]) ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97) NUMBER C[illegible]871

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST[illegible]

FIELD NO.

DIST. LAB NO. 5186

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

LOT NO.

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 163701

5186-33P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R4, SAMPLE #6

DEPTH 30-31.5

LOCATION OF SOURCE DOYLE DRIVE

5186-33P

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-6 AND IS ON E OF A GROUP OF 2[illegible]

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST, CO, RTE, PM
4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

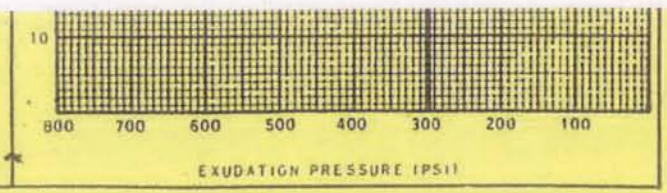
FED. NO. I-240

RES. ENGR. OR SUPT. TUNE NGUYEN

ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND CA94[illegible]

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



BT 46243

5186 - 34P

BILLED

CALC. BY _____ APPROVED BY _____

JUL 25 2008

DATE REPORTED NOV 19 2008

☐ DISTRICT D[illegible]TOR ☐ TRANS. LAB
☐ DIS. MAT L[illegible]R ☐ PAV'T. SECT
☐ RESIDENT [illegible]EER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	82				
100	23				
200	14				
5μ	9				
1μ	6				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT. | % BY VOL. | TEST NO. | DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS

		SPEC.
LL. P.L. P.I.		
CV		
S.E. AS REC'D		
S.E. CRUSHED		
S.E. COMBINED		
LART GRADE 100 REV.		
LART GRADE 500 REV.		
DUR D_f		
DUR D_i		
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVER D ☐ BULK (SSD) ☐ APPARENT

	FINE	COA
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CONTRACT NUMBER C[illegible]872

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TEST

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. [illegible]

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 1637[illegible]

5186-34P

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

JUL 25 2008

SAMPLE FROM BORING No. RW8-R4
-SAMPLE # 11

DEPTH 55-56.5'

LOCATION OF SOURCE DOYLE DRIVE

5186-34P

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-11

AND IS ONE OF A GROUP OF 2[illegible]

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R NASHED TITLE ENG. GEOLOGIST

DIST, CO, RTE, PM
4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

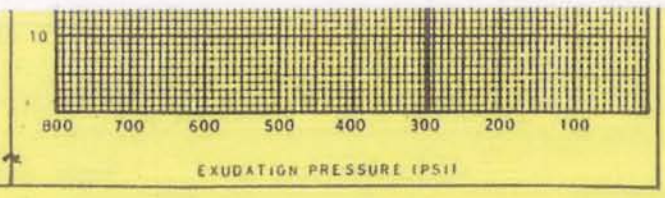
FED. NO. 1-240

RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE, 8TH FL MS16 OAKLAND CA 94

CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST NO. 5186-35P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED DEC 01 2008

BILLED

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT L[illegible] ☐ PAV'T. SECT
☐ RESIDENT [illegible]NEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4	100				
8	100				
16	100				
30	100				
50	84				
100	31				
200	19				
5μ	9				
1μ	5				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_N AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS

		SPEC.
LL P.L P.I.		
CV		
S.E.	AS REC'D	
	CRUSHED	
	COMBINED	
LART	GRADE 100 REV.	
	500 REV.	
DUR	D_f	
	D_i	
% CRUSHED PARTICLES		

SP. GR. ☐ BULK (OVEN) ☐ BULK (SSD) ☐ APPARENT

	FINE	CO
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPT
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CAR[illegible]MBER C6[illegible]873

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST.
SHIPMENT
AUTHORIZATION

FIELD NO.
DIST. LAB NO. 5186
LOT NO.
IP OR CH REQ. NO.
5186-35P
163701

SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R4, SAMPLE 13A
DEPTH 60-65'
LOCATION OF SOURCE DOYLE DRIVE

JUL 25 2008

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4-13A
AND IS ONE OF A GROUP OF [illegible]
5186-35P
SAMPLE [illegible] REQUIRED (NOTE RAIL CAR STA. ETC.)
OWNER OR MANUFACTURER CALTRANS

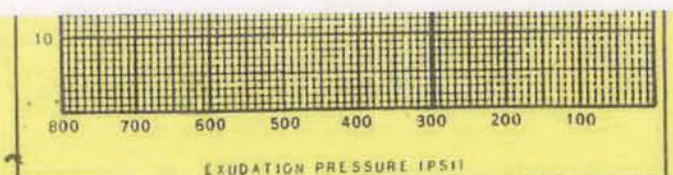
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 8/24/08

REMARKS
MOISTURE CONTENT,
MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R. NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM 4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. I-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAKLAND, CA 946
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



RJ 46243

5186-37P

BILLED

JUL 25 2008

CALC. BY ___ APPROVED BY ___

DATE REPORTED DEC 09 2008

☐ DISTRICT DIRECTOR ☐ TRANS. LAB
☐ DIS. MAT. ENGR. ☐ PAV'T. SECT.
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30	100				
50	94				
100	28				
200	13				
5µ	6				
1µ	4				

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT. % BY VOL. TEST NO. DESCRIPTION

REMARKS

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE / EXPANSION PRESSURE / AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION
SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

	A	B	C	D
TEST SPECIMEN				
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - # CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS	SPEC.
LL. P.L. P.I.	
CV	
SE AS REC'D	
SE CRUSHED	
SE COMBINED	
CART GRADE 100 REV.	
CART GRADE 500 REV.	
DUR D_f	
DUR D_c	
% CRUSHED PARTICLES	

SP. GR. ☐ BULK (OVEN) ☐ BULK (SSD) ☐ APPARENT — FINE / CO[ARSE]: AS REC'D. / CRUSHED

REL. COMPACTION DA[TA]: IN PLACE / OPT[IMUM] — DENSITY / MOISTURE / % REL. COMP. / SPEC.

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

EXUDATION PRESSURE (PSI): 800 700 600 500 400 300 200 100 — 10

-TL-361 (Rev. 10/78)

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C6 875

JUL 25 2008

5186-37P

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH
☒ DIST. LAB

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION 163701

SAMPLE OF: SOIL

FOR USE IN: FOUNDATION DESIGN

SAMPLE FROM: BORING No RW8-R4, SAMPLE #17

DEPTH: 90-91.5'

LOCATION OF SOURCE: DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS): RW8-R4-17

AND IS ONE OF A GROUP OF

SAMPLE REPRESENTS (TONS, ETC.)

OWNER OR MANUFACTURER: CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED: ☒ NORMAL ☐ PRIORITY

DATE NEEDED: 8/24/08

REMARKS: MOISTURE CONTENT, MECHANICAL ANALYSIS

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED: 01/15-17/2008

BY: R. NASHED TITLE: ENG. GEOLOGIST

DIST, CO, RTE, PM: 4-SF-101-8.3/9.4

LIMITS

CONT. NO.: 163701

FED. NO.: 1-240

RES. ENGR. OR SUPT.: TUNG NGUYEN

ADDRESS: 111 GRAND AVE 8TH FL MS16 OAKLAND CA 94[612]

CONTRACTOR: PHONE 510-622-1775, FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE

87 46741

LABORATORY TEST DATA

Boring RW8-R5-PZ

MOISTURE & DENSITY TEST

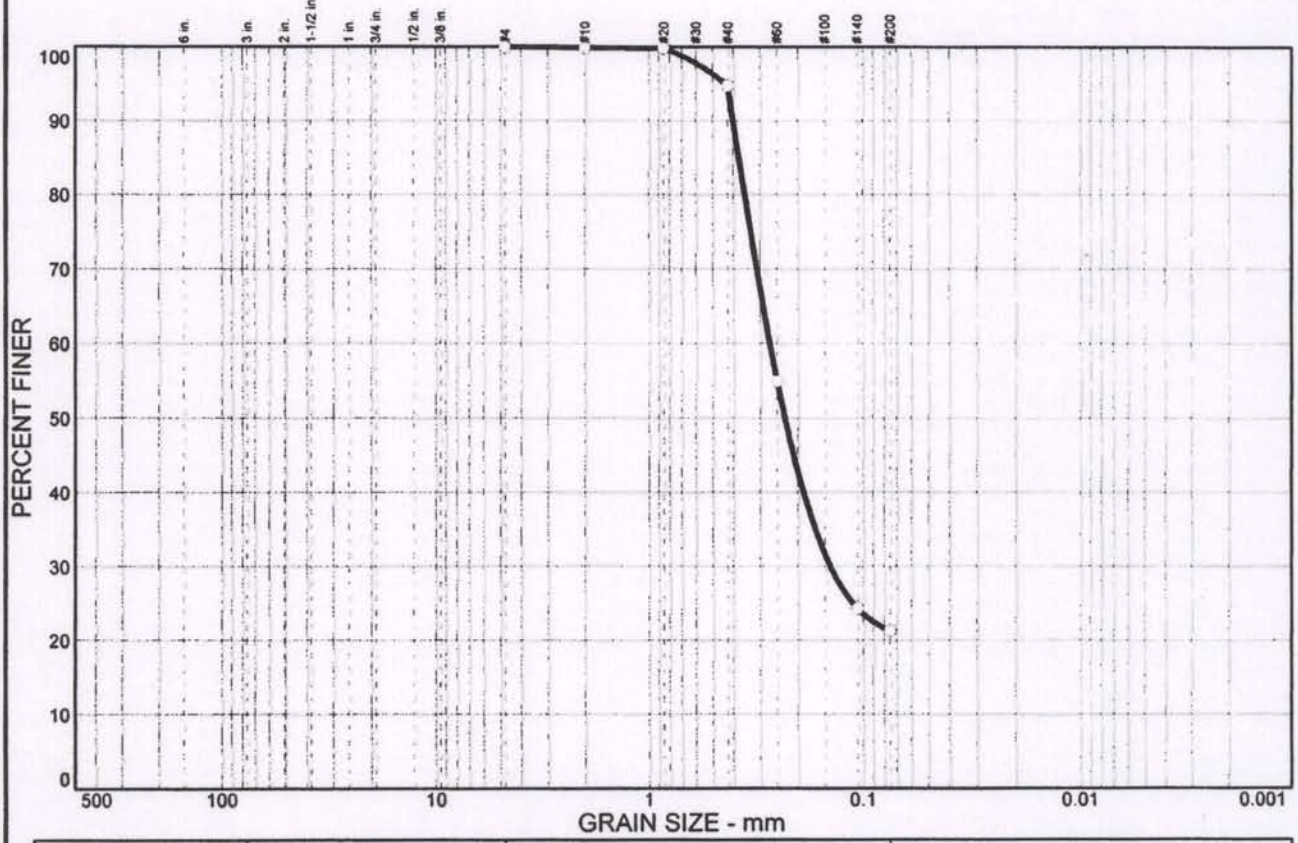
Client : Arup Project : Doyle Drive Replacement Project Retaining Wall Job no : EA04-163701

	Boring #	RW8-R1	RW8-R1	RW8-R1	RW8-R5	RW8-R5	RW8-R5	RW8-R5		
	Sample #	3B	5A	7B	3A	5B	17	24		
	Depth (ft.)	8.5-9.0	13.0-13.5	18.5-19.0	8.0-8.5	13.5-14.0	43.0-43.5	67.5-69.0		
	Soil type: (visual)	Very dark brown silty sand	Very dark brown silty clay with sand	Yellowish brown clay	Dark yellowish brown clayey sand	Olive brown poorly graded sand with silt	Olive brown poorly graded sand with silt	Olive brown silty sand		
1.	Date tested:	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09		1.
2.	Tested by:	KA	KA	KA	KA	KA	KA	KA		2.
3.	Specimen height (in.)	5.98	5.51	5.84	5.76	5.96	6.00			3.
4.	Wt. of specimen + tare (gm)	787.7	847.3	926.5	896.0	935.7	972.3			4.
5.	Tare wt. (gm)	0.00	0.00	0.00	0.00	0.00	0.00			5.
6.	Diameter (in.)	2.42	2.42	2.42	2.42	2.42	2.42			6.
7.	Wet wt. of soil + dish wt. (gm)	246.59	663.67	224.63	275.43	290.62	202.36	616.50		7.
8.	Dry wt. of soil + dish wt. (gm)	228.70	597.74	195.25	239.90	259.43	175.95	516.91		8.
9.	Wt. of dish (gm)	42.09	303.28	40.26	51.36	52.18	43.17	165.58		9.
10.	Dish ID									10.
	Wet Density (pcf)	109.0	127.3	131.3	128.7	129.9	134.1			
	Dry Density (pcf)	99.5	104.0	110.4	108.3	112.9	111.9			
	Moisture Content (%)	9.6	22.4	19.0	18.8	15.0	19.9	28.3		
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.694	0.620	0.527	0.555	0.492	0.506			
	Saturation (%)	37.3	97.4	97.2	91.6	82.6	106.1			

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	5.2	73.5	21.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	94.7		
#60	54.9		
#140	24.2		
#200	21.2		

* (no specification provided)

Soil Description

Dark yellowish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.377 D_{60}= 0.270 D_{50}= 0.230
D_{30}= 0.142 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

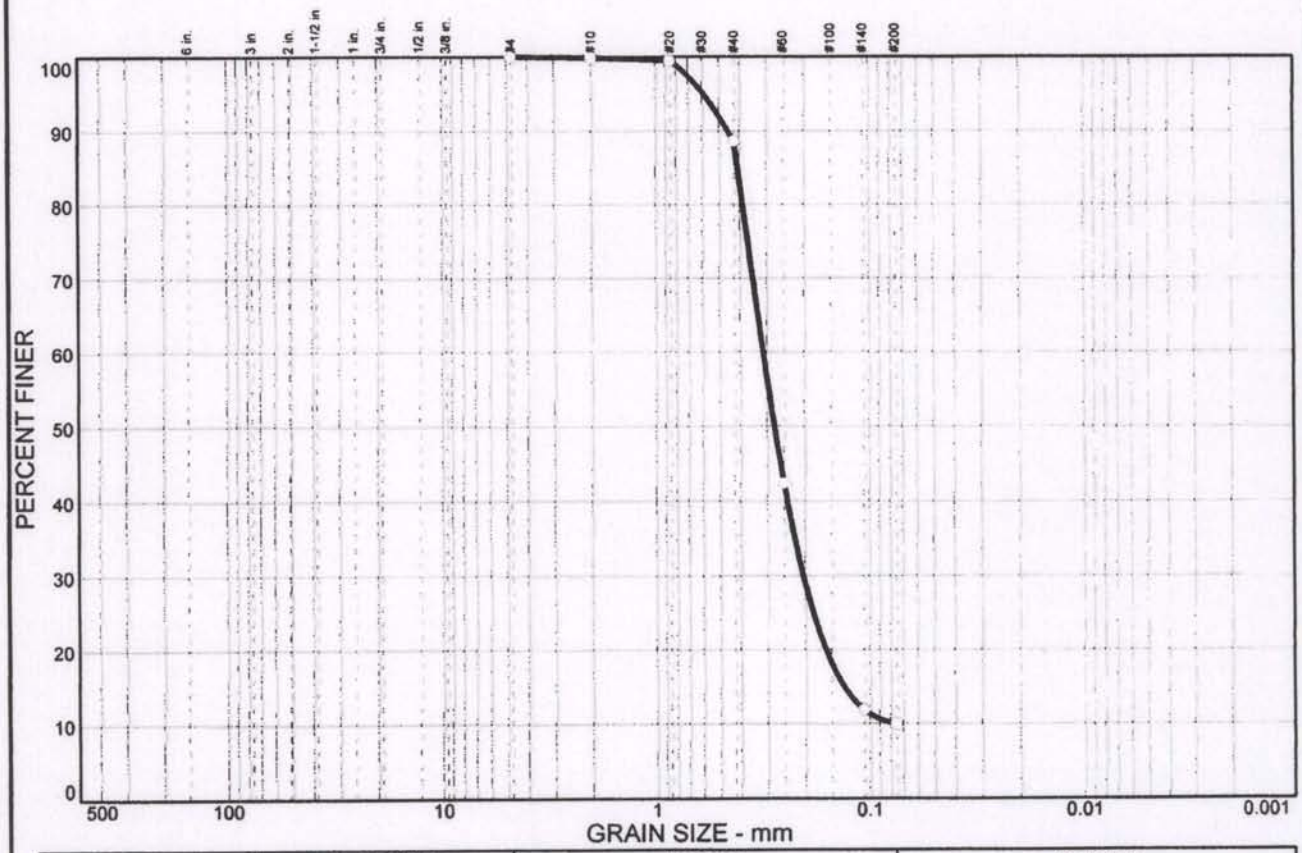
Remarks

Sample No.: 3A **Source of Sample:** RW8-R5 **Date:** 1-22-09
Location: **Elev./Depth:** 8-8.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	11.3	78.7	9.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.5		
#40	88.6		
#60	42.4		
#140	11.8		
#200	9.9		

* (no specification provided)

Soil Description

Olive brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.409 D_{60}= 0.311 D_{50}= 0.277
D_{30}= 0.204 D_{15}= 0.132 D_{10}= 0.0773
C_u= 4.03 C_c= 1.72

Classification

USCS= SP-SM AASHTO=

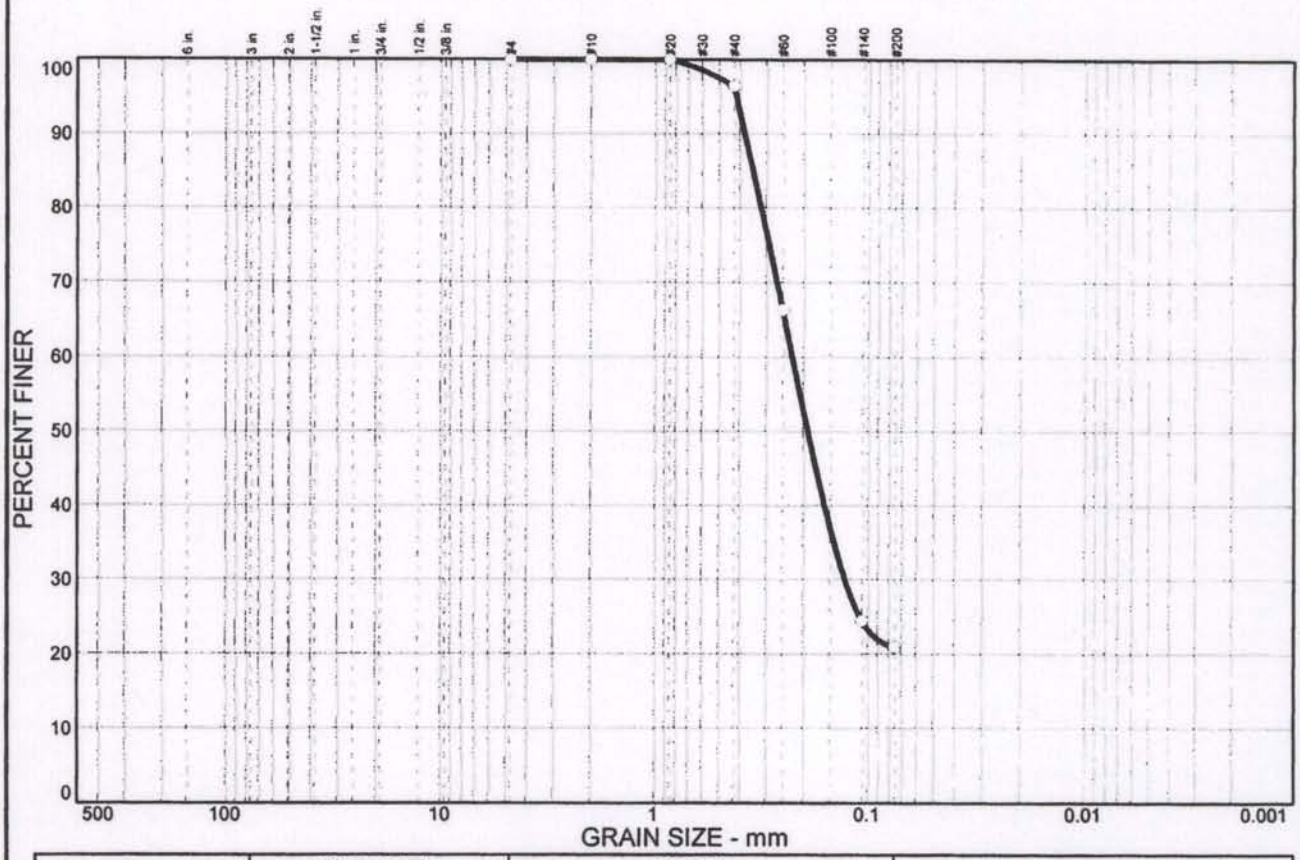
Remarks

Sample No.: 5B **Source of Sample:** RW8-R5 **Date:** 1-22-09
Location: **Elev./Depth:** 13.5-14

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	3.6	75.5	20.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	96.4		
#60	66.3		
#140	24.4		
#200	20.9		

* (no specification provided)

Soil Description

Dark yellowish brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.346 D_{60}= 0.225 D_{50}= 0.190
D_{30}= 0.127 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

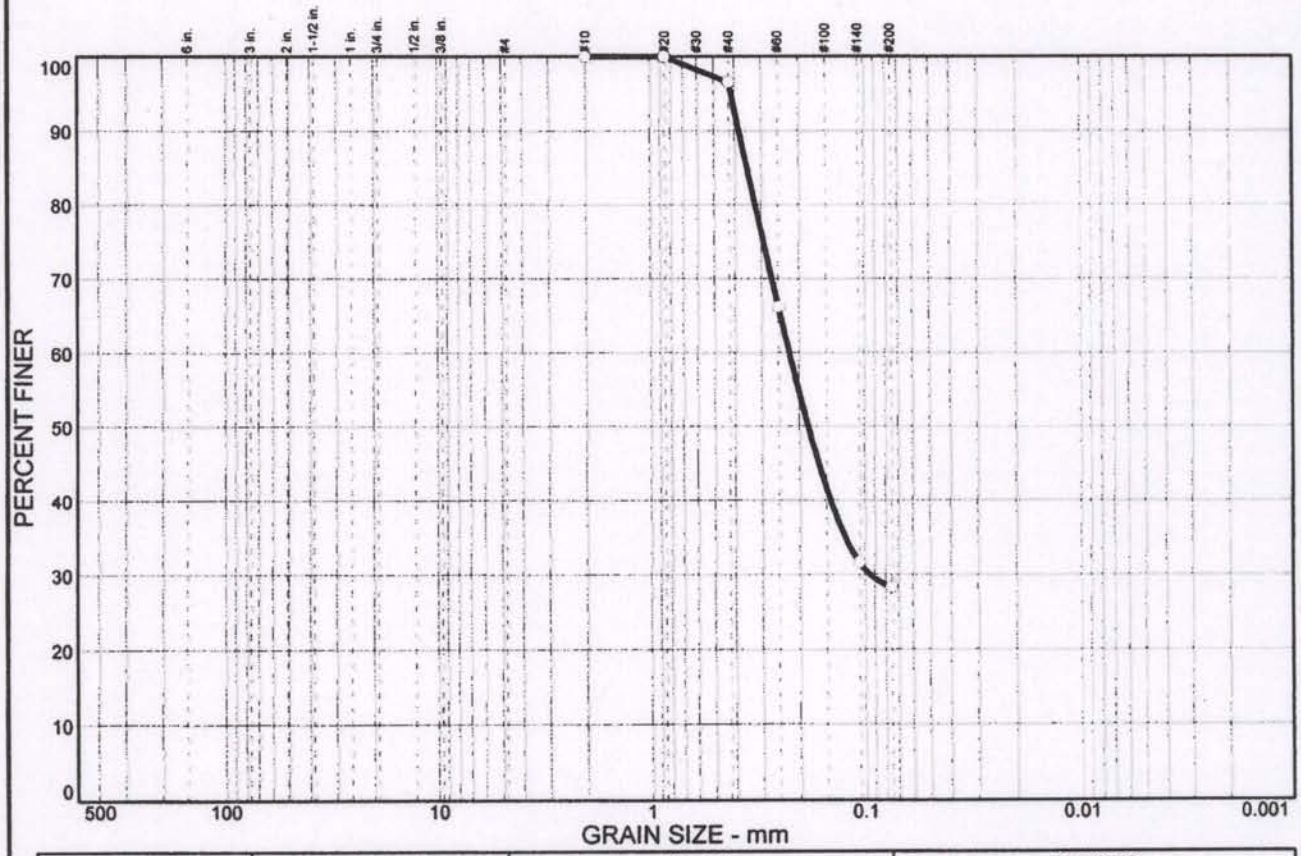
Remarks

Sample No.: 8 **Source of Sample:** RW8-R5 **Date:** 1-29-09
Location: **Elev./Depth:** 18-19.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	3.5	68.2	28.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	96.5		
#60	66.2		
#140	31.6		
#200	28.3		

* (no specification provided)

Soil Description

Olive brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.349 D_{60}= 0.223 D_{50}= 0.182
D_{30}= 0.0947 D_{15}= D_{10}=
C_u= C_c=

Classification

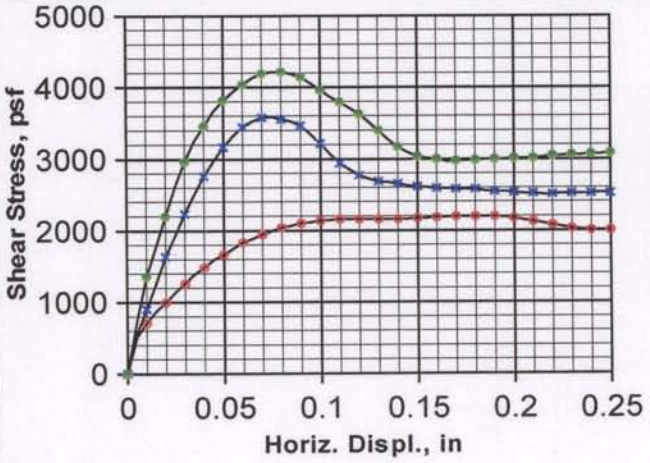
USCS= SM AASHTO=

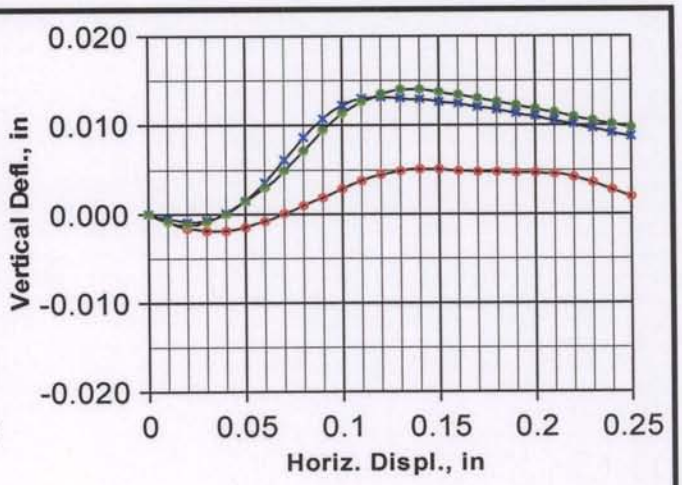
Remarks

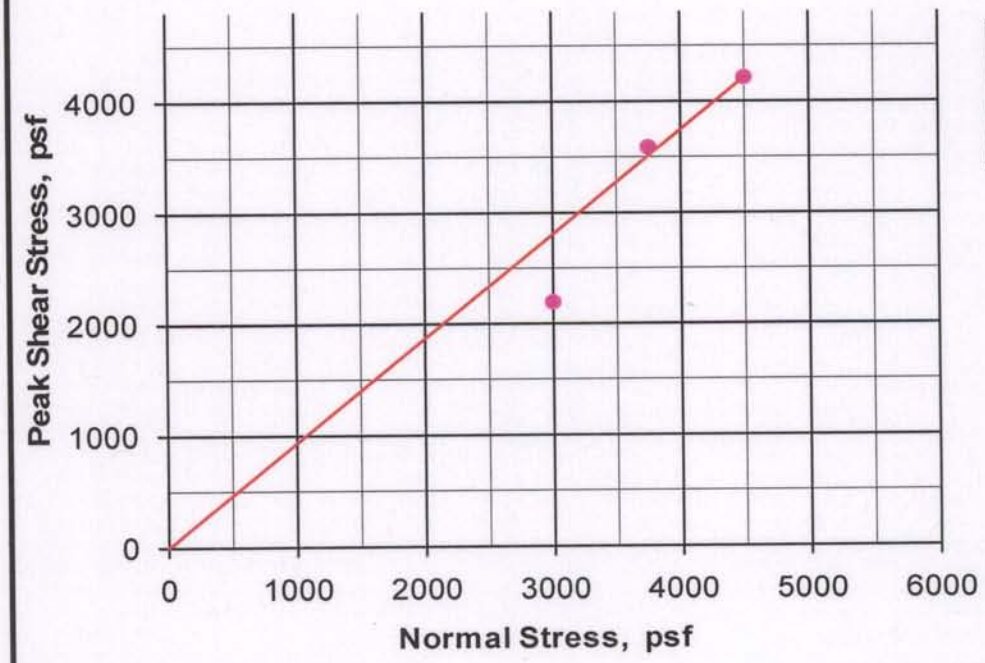
Sample No.: 9B **Source of Sample:** RW8-R5 **Date:**
Location: **Elev./Depth:** 23.5-24

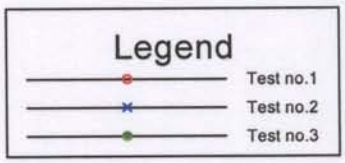
SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**









Results

C = 0 psf
phi = 43 deg.

Gs = 2.70
Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	3000	2196	0.170	0.18	25.9	106.7	121	0.580	1.00	2.416	18.4	102.8	78	0.639	1.037
2	3750	3588	0.075	0.18	14.4	115.6	85	0.458	1.00	2.416	16.1	111.6	85	0.510	1.036
3	4500	4212	0.075	0.18	5.1	116.9	31	0.442	1.00	2.416	15.9	113.2	88	0.489	1.033

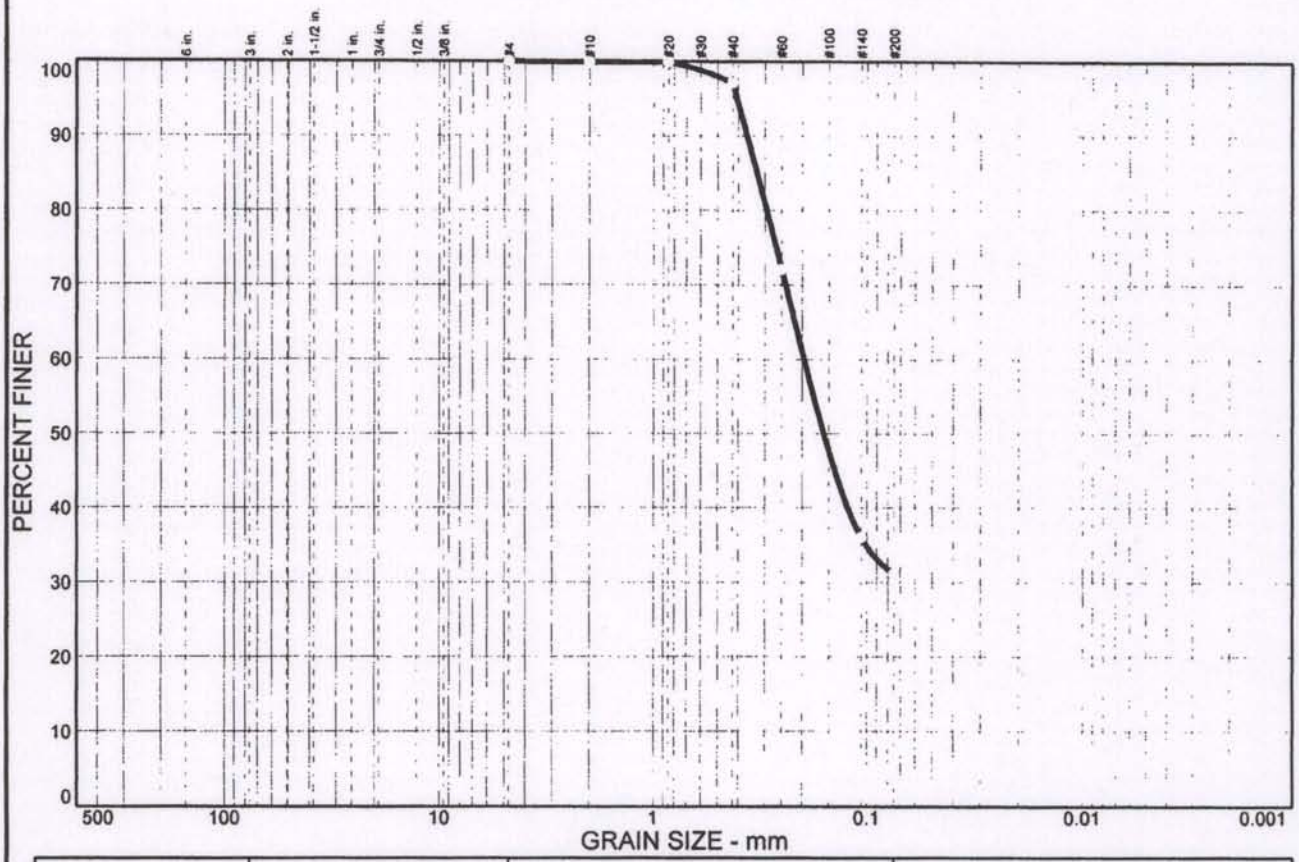
Client: **Arup**	Boring #: **RW8-R5** Sample #: **9B**
Project: **Doyle Dr. Replacement Project**	Depth (ft): **23.5-24**
Project #: **EA04-163701**	Soil: **Undisturbed olive brown silty sand**

TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	2.8	66.0	31.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	97.1		
#60	72.1		
#140	36.0		
#200	31.1		

* (no specification provided)

Soil Description

Olive yellow Silty, clayey sand

Atterberg Limits

PL= 19 LL= 26 PI= 7

Coefficients

D_{85}= 0.327 D_{60}= 0.196 D_{50}= 0.159
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

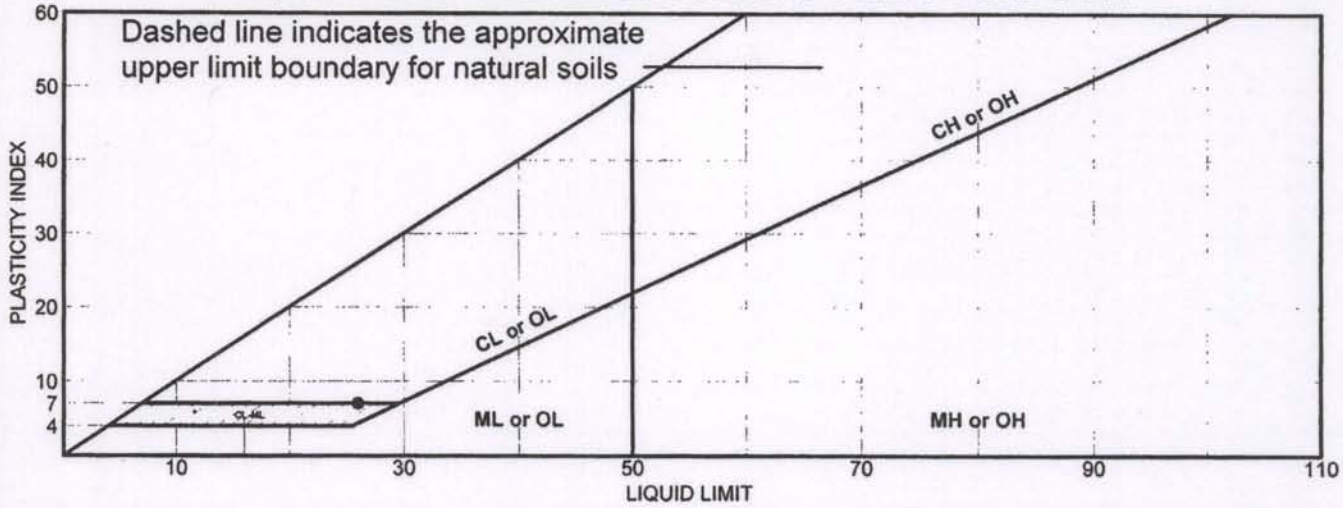
Remarks

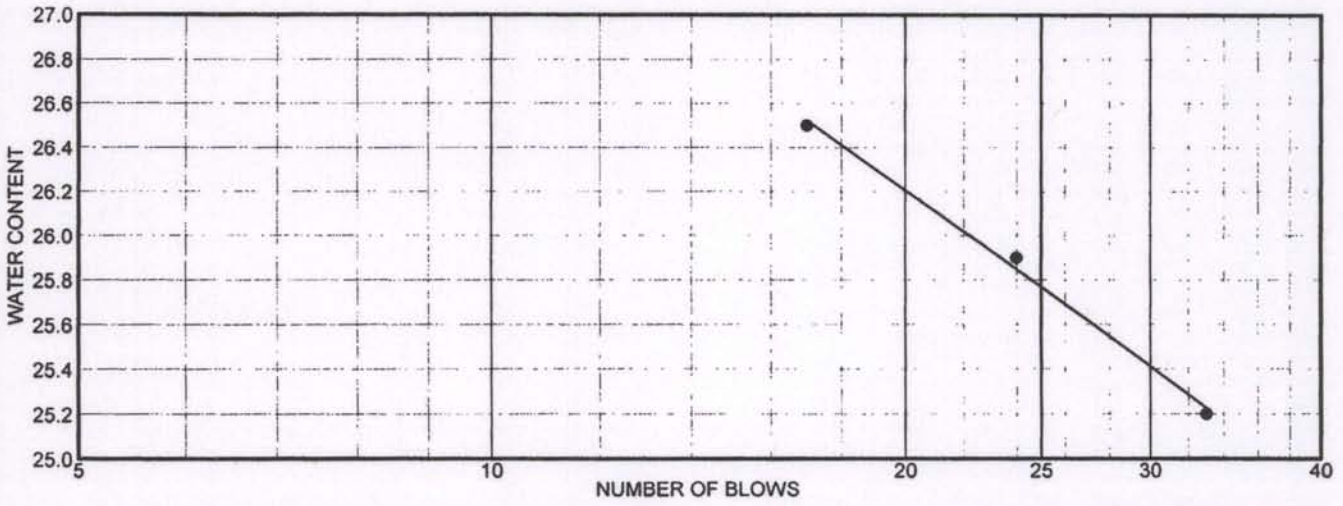
Sample No.: 10 **Source of Sample:** RW8-R5 **Date:** 1-22-09
Location: **Elev./Depth:** 24-25.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive yellow Silty, clayey sand	26	19	7	97.1	31.1	SC-SM

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R5 **Sample No.:** 10 **Elev./Depth:** 24-25.5

Remarks:

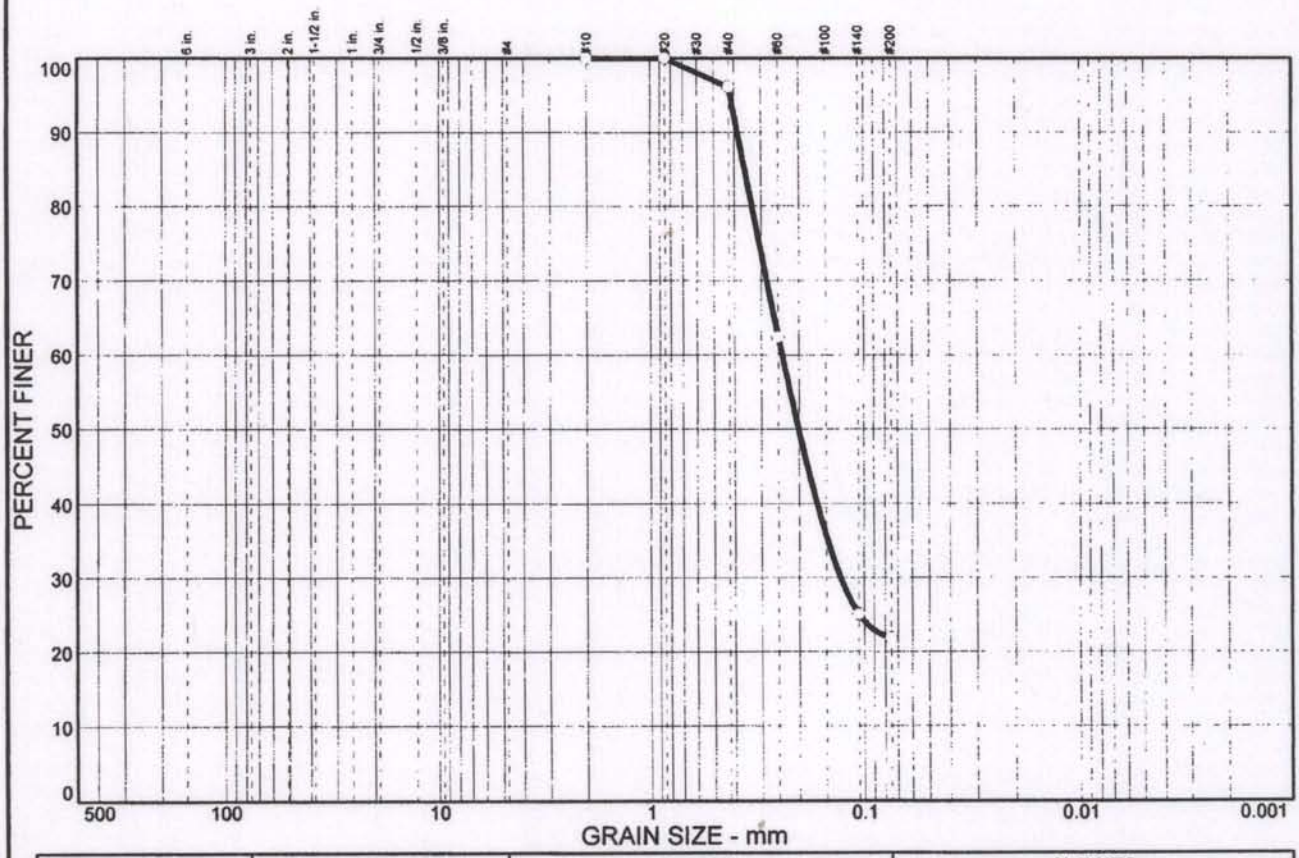
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	3.9	74.3	21.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	96.1		
#60	62.4		
#140	25.0		
#200	21.8		

* (no specification provided)

Soil Description

Olive brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.358 D_{60}= 0.240 D_{50}= 0.202
D_{30}= 0.129 D_{15}= D_{10}=
C_u= C_c=

Classification

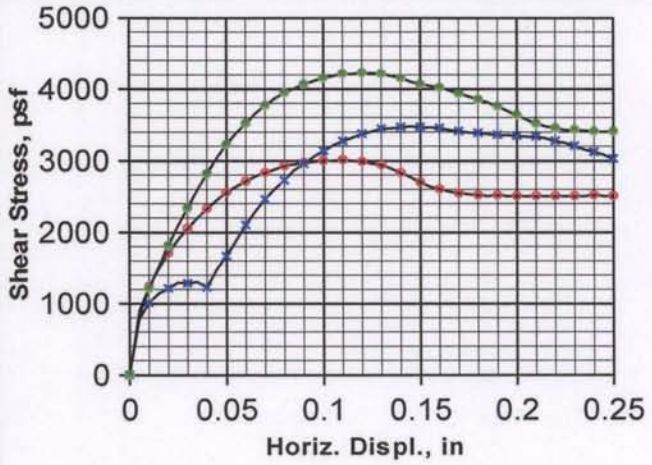
USCS= SC AASHTO=

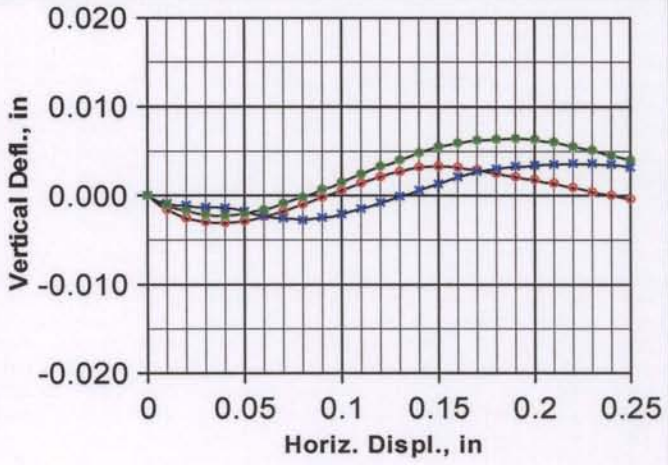
Remarks

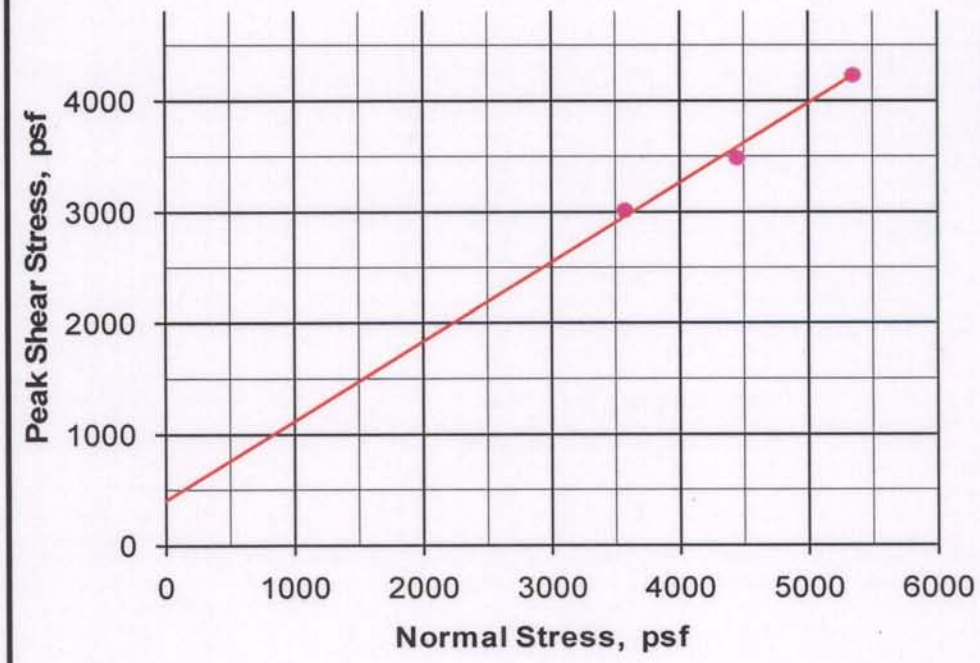
Sample No.: 11A **Source of Sample:** RW8-R5 **Date:**
Location: **Elev./Depth:** 28-28.5

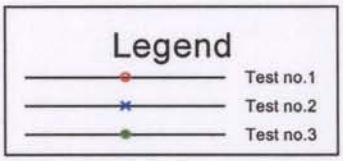
SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**









Results

C = 400 psf
phi = 36 deg.

Gs = 2.70
Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	3575	3012	0.110	0.18	24.2	103.3	103	0.631	1.00	2.416	22.7	100.3	90	0.680	1.030
2	4450	3480	0.145	0.18	23.8	104.9	106	0.606	1.00	2.416	22.0	101.5	90	0.660	1.034
3	5350	4224	0.120	0.18	22.5	106.7	105	0.580	1.00	2.416	21.4	103.4	91	0.631	1.032

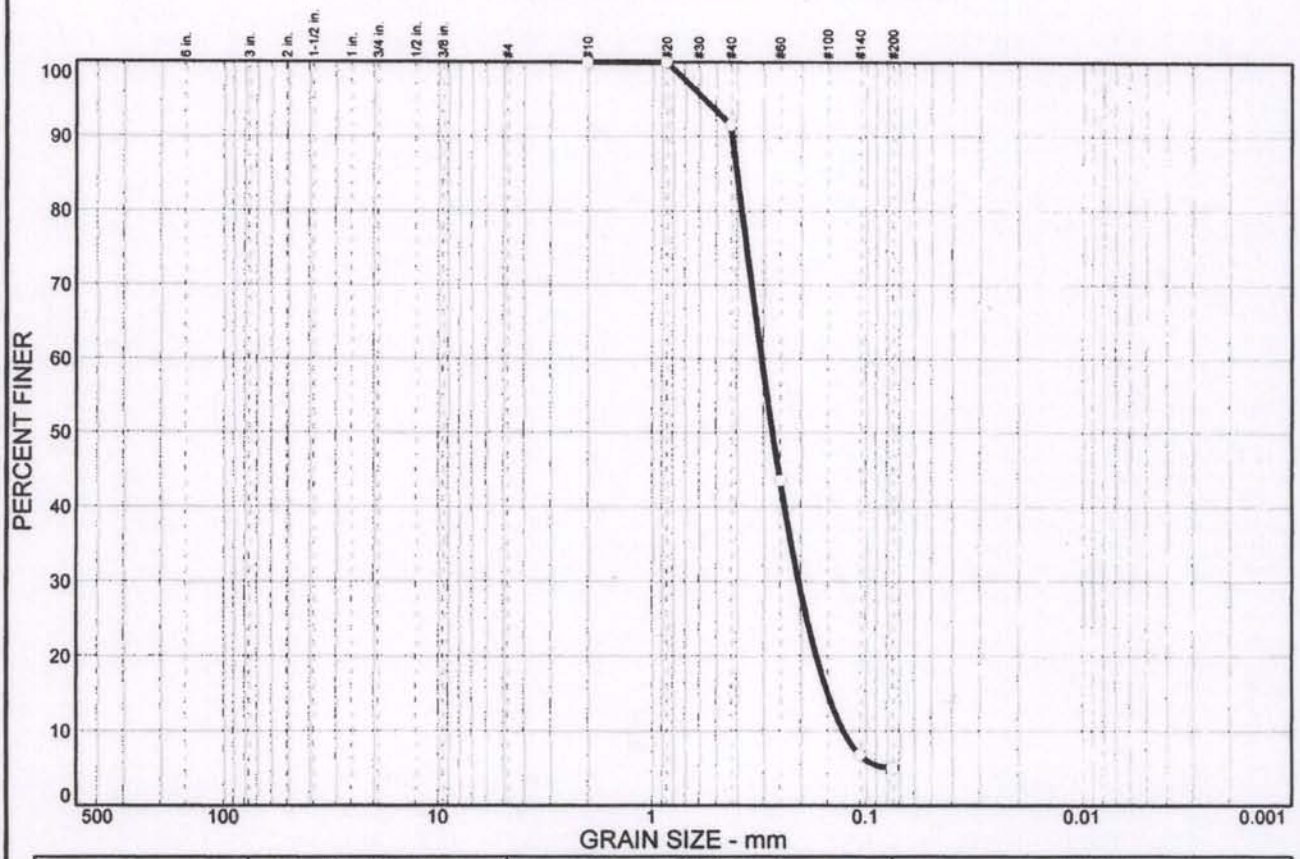
Client: **Arup**	Boring #: **RW8-R5** Sample #: **11A**
Project: **Doyle Dr. Replacement Project**	Depth (ft): **28-28.5**
Project #: **EA04-163701**	Soil: **Undisturbed olive brown clayey sand**

TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	8.5	86.5	5.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	91.5		
#60	43.5		
#140	6.7		
#200	5.0		

* (no specification provided)

Soil Description

Olive brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.398 D_{60}= 0.305 D_{50}= 0.271
D_{30}= 0.205 D_{15}= 0.150 D_{10}= 0.127
C_u= 2.40 C_c= 1.08

Classification

USCS= SP-SM AASHTO=

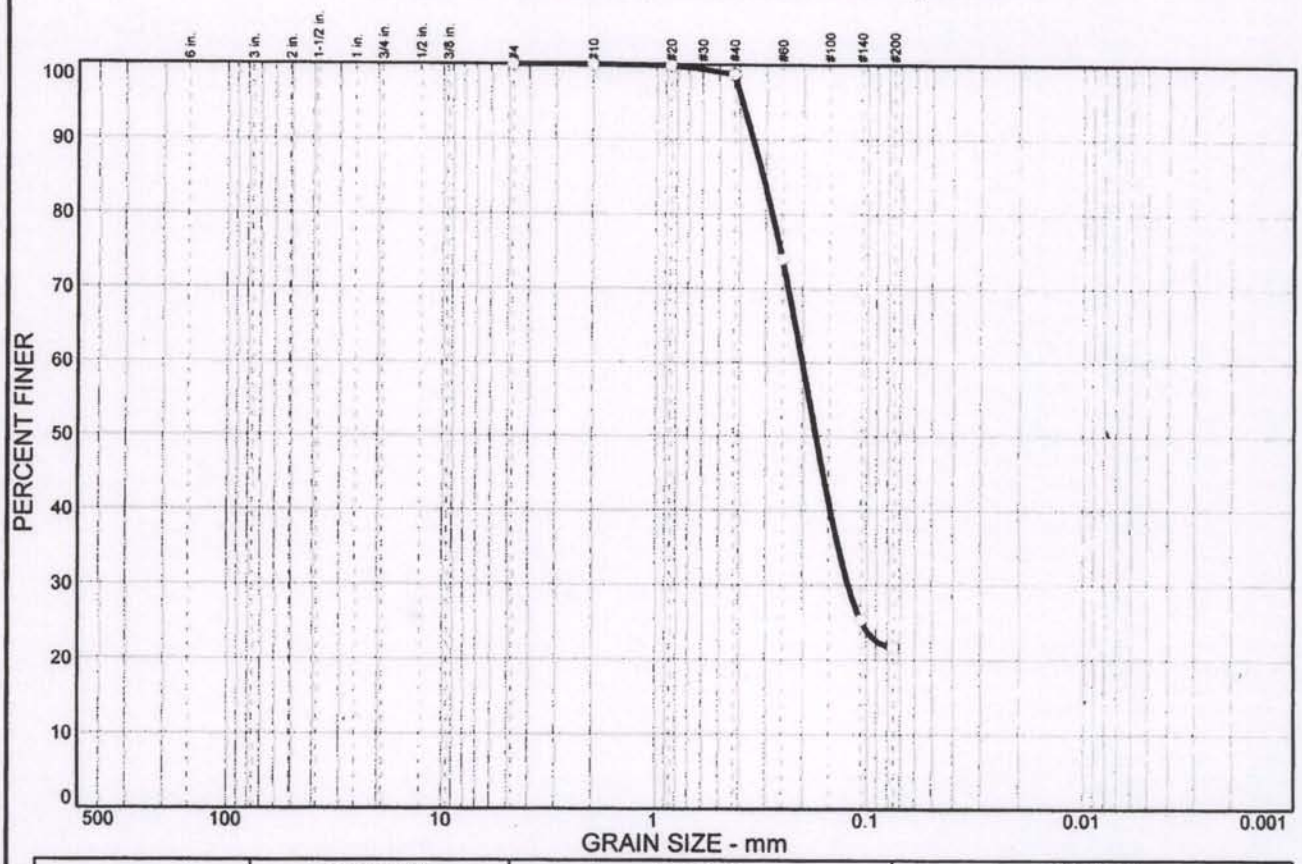
Remarks

Sample No.: 17 **Source of Sample:** RW8-R5 **Date:** 1-22-09
Location: **Elev./Depth:** 43-43.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	1.3	77.0	21.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	98.7		
#60	74.0		
#140	25.3		
#200	21.7		

* (no specification provided)

Soil Description

Olive brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.309 D_{60}= 0.200 D_{50}= 0.172
D_{30}= 0.121 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

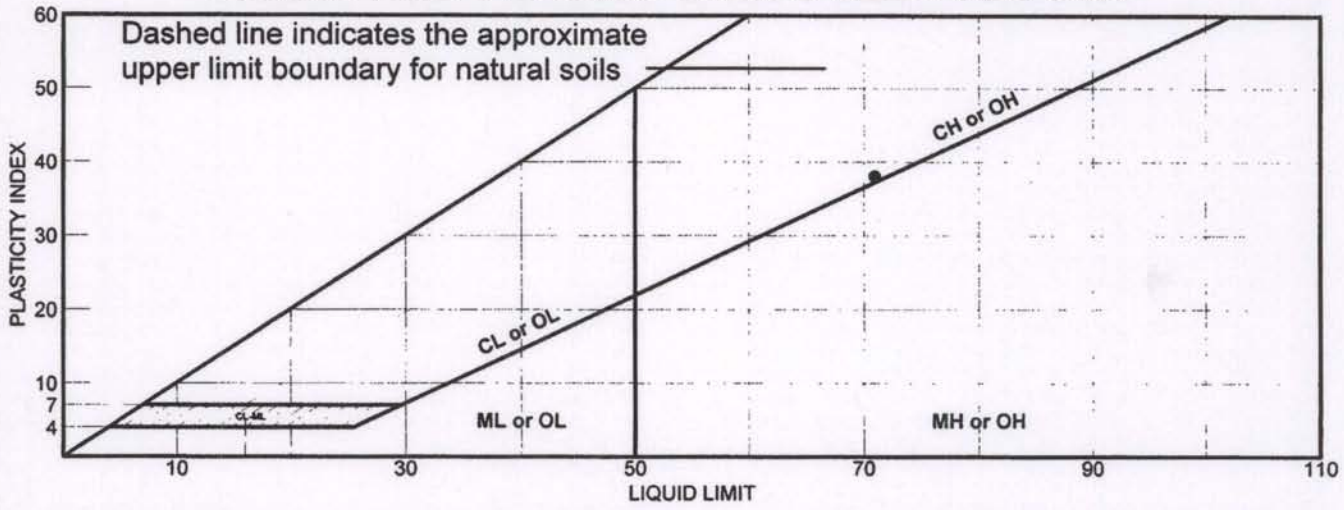
Remarks

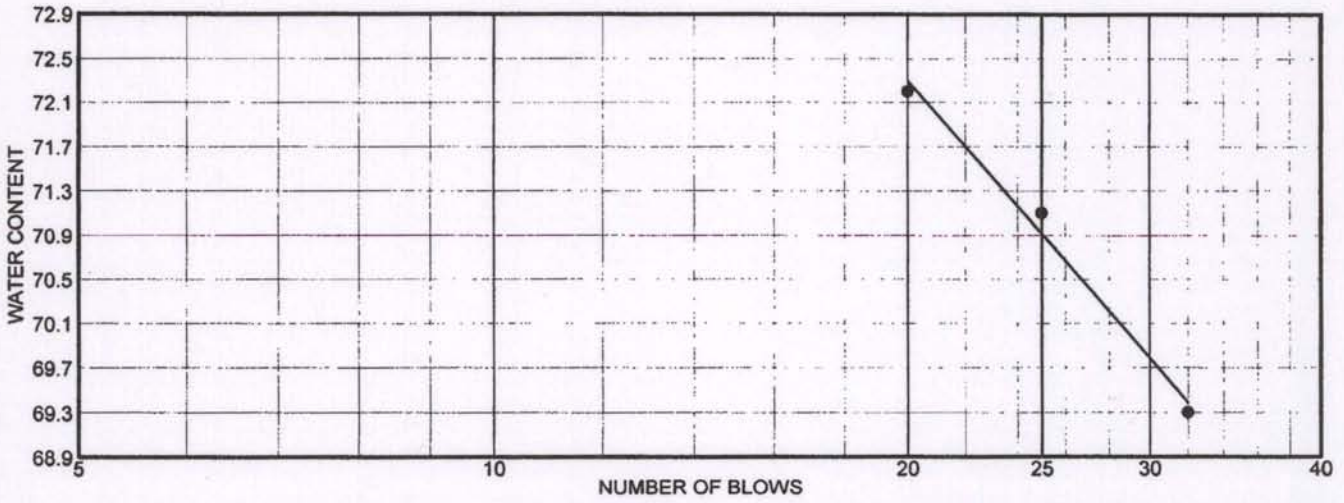
Sample No.: 24 **Source of Sample:** RW8-R5 **Date:** 1-22-09
Location: **Elev./Depth:** 67.5-69

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray silty clay	71	33	38			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R5 **Sample No.:** 33A **Elev./Depth:** 113.5-114

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

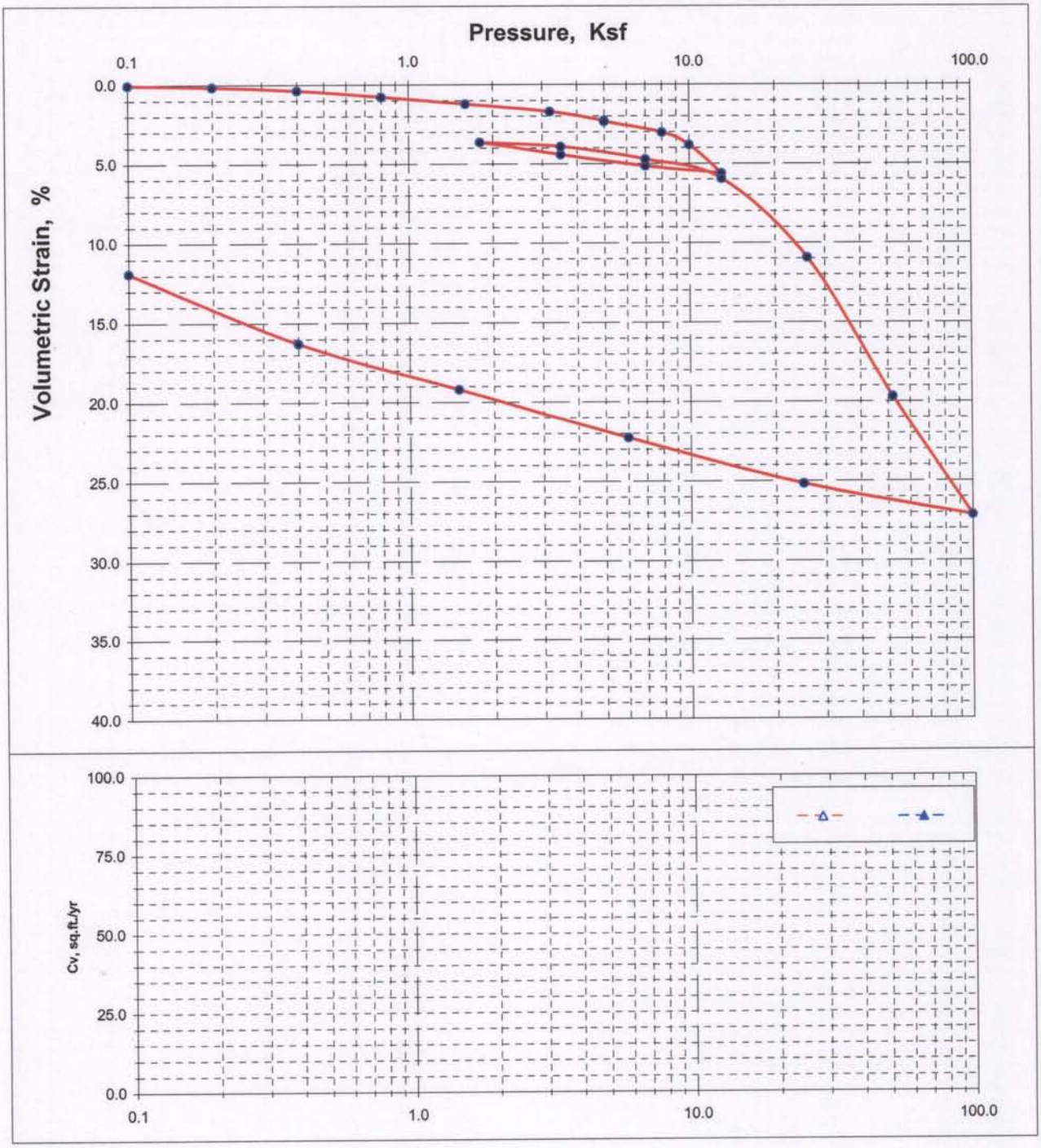
SIGNET TESTING LABS, INC.

Figure

CONSOLIDATION TEST

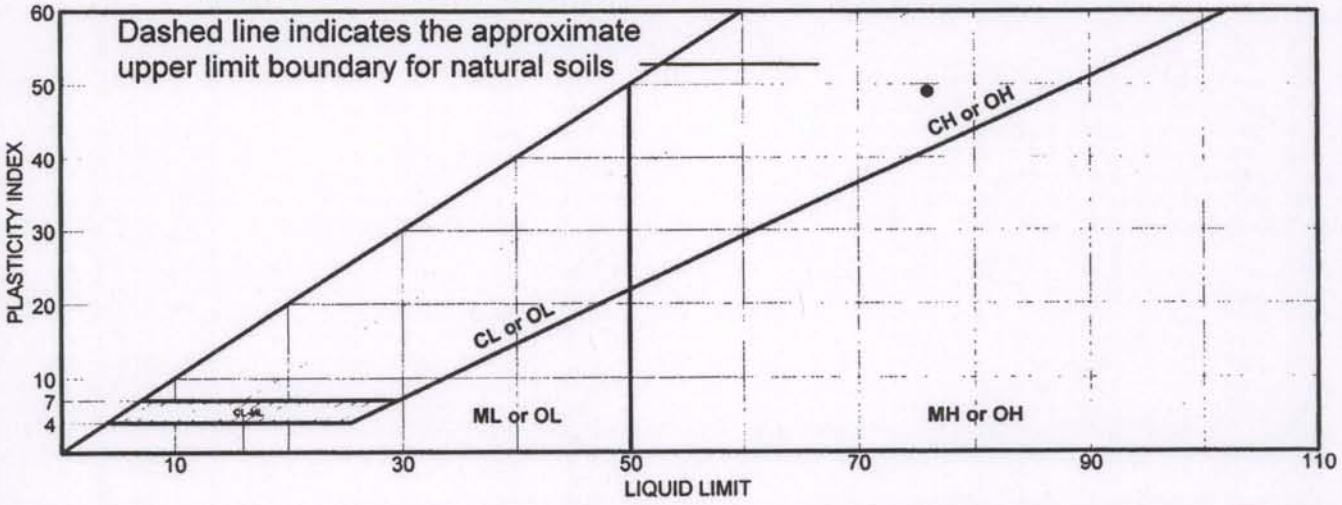
Boring Number	RW8-R5	Sample Number	33A	Depth (ft)	113.5-114	
Soil Description	Olive gray silty clay					

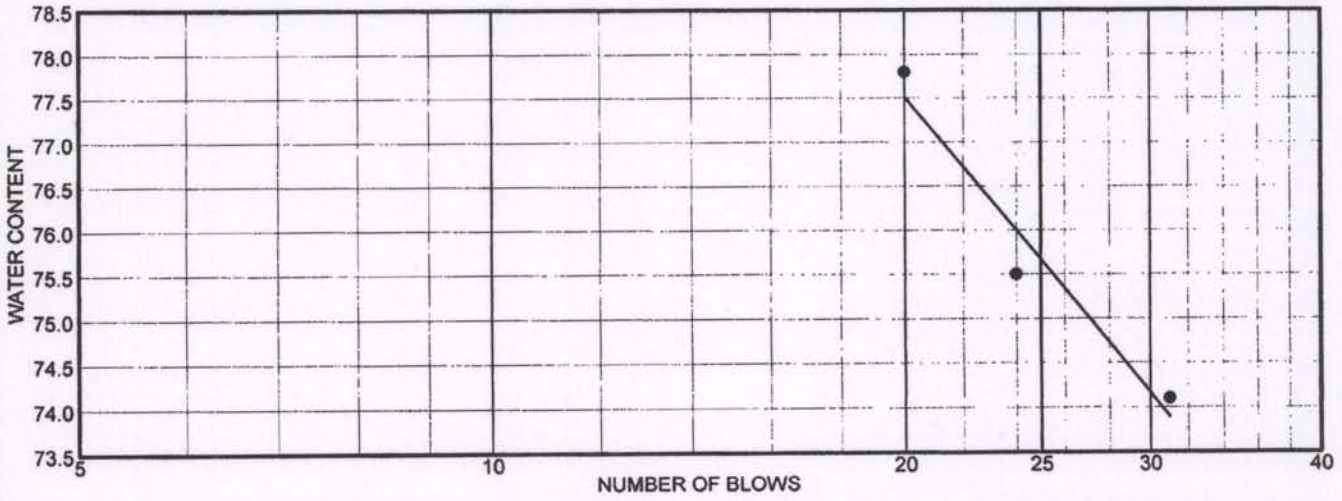
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	43.2	111.1	1.172	99.5	1.00	2.420	(assumed) 2.70	71	38
Final	33.9	118.0	0.914	100.2	0.881				



EA04-163701

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray clay with organics	76	27	49			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R5 **Sample No.:** 35 **Elev./Depth:** 123-123.6

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

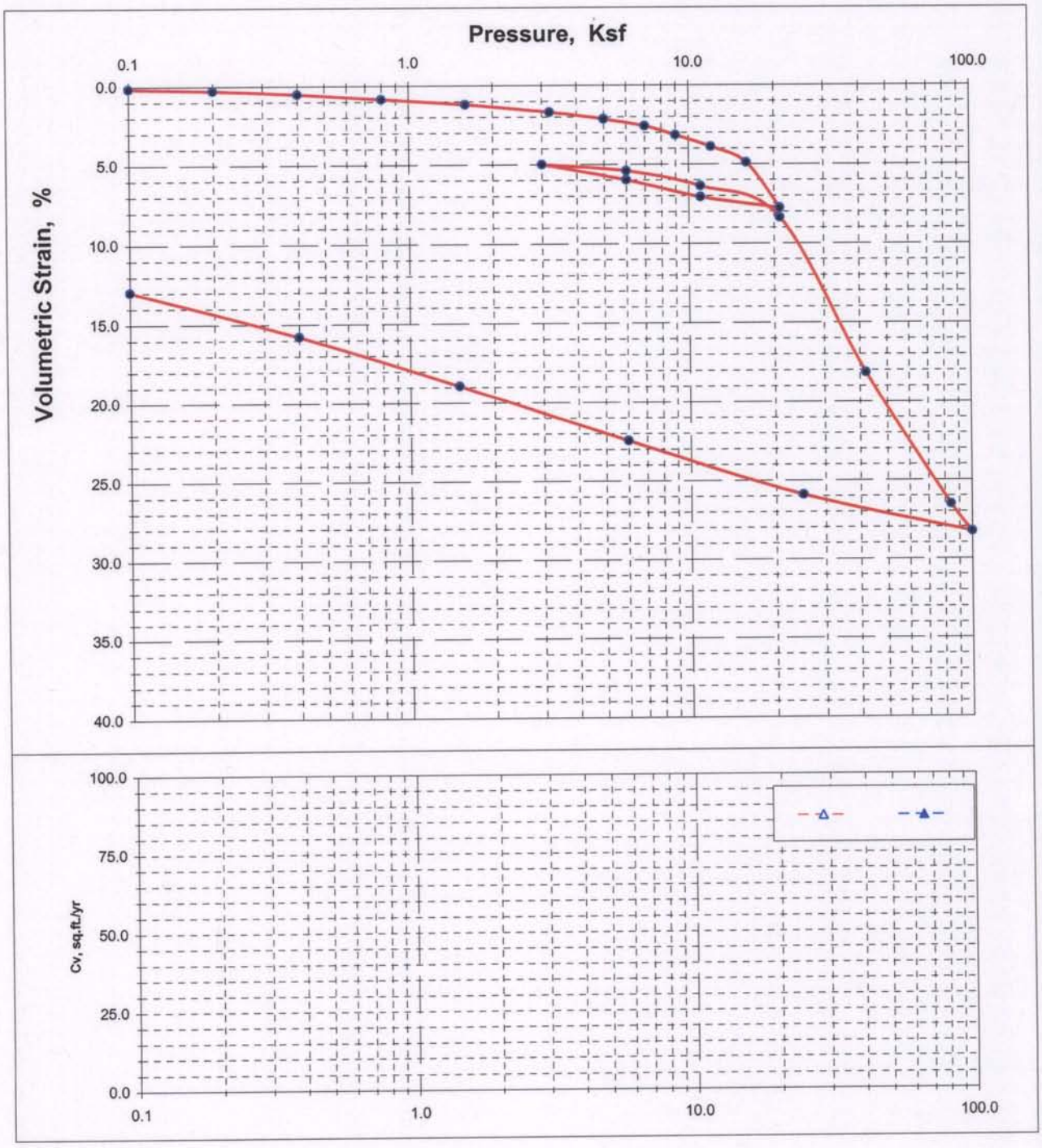
SIGNET TESTING LABS, INC.

Figure

CONSOLIDATION TEST

Boring Number	RW8-R5	Sample Number	35	Depth (ft)	123-123.6	
Soil Description	Olive gray clay with organics					

	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	45.7	109.5	1.243	99.3	1.00	2.420	(assumed) 2.70	76	49
Final	35.5	117.1	0.952	100.7	0.870				



EA04-163701

LABORATORY TEST DATA

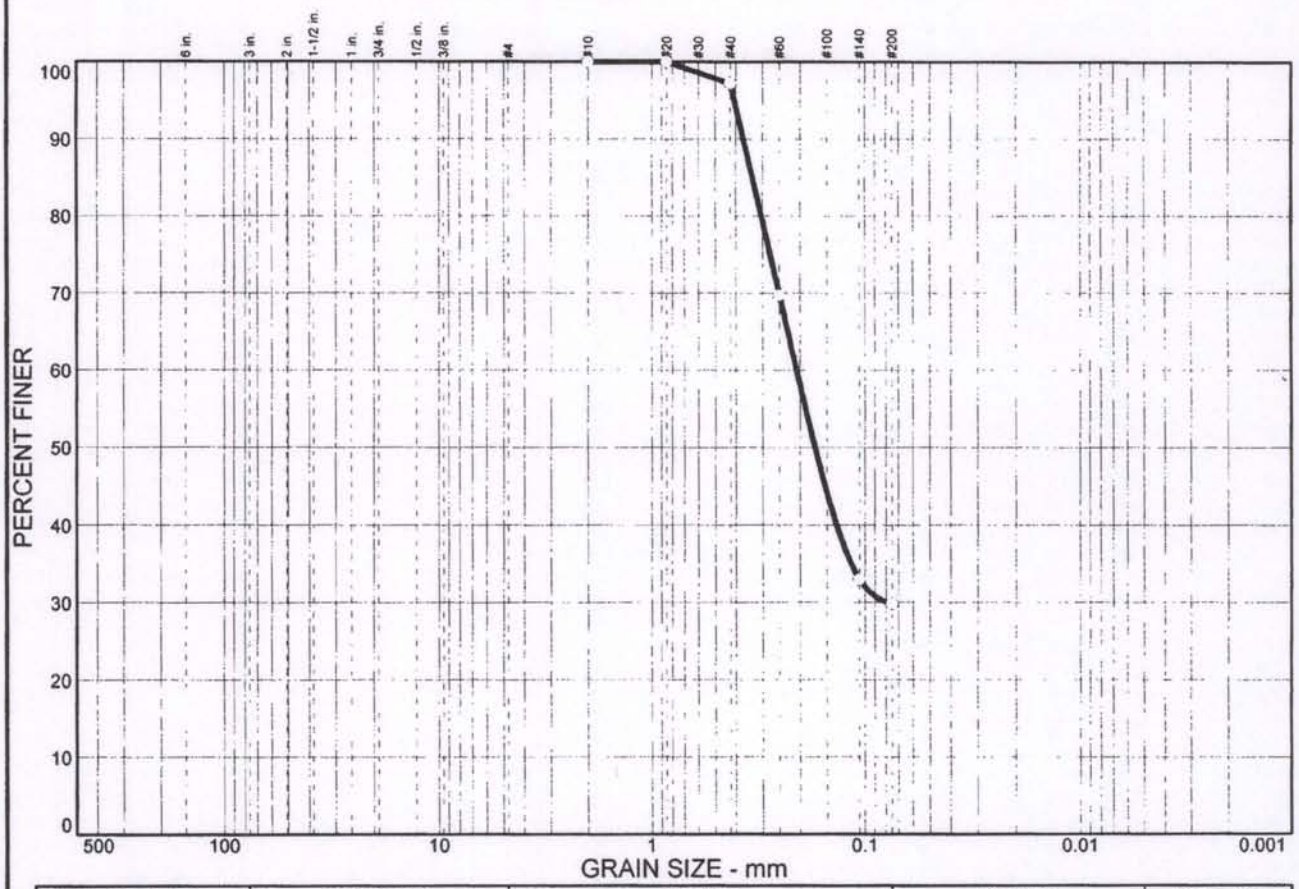
Boring MPTSB-R1

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	MPTSB-R1	MPTSB-R1	MPTSB-R2	MPTSB-R2	MPTSB-R3	MPTSB-R3	TS-R1	TS-R1	
	Sample #	8A	20B	2A	7B	2A	19A	2B	28A	
	Depth (ft.)	18-18.5	48.5-49	2.5-3	18.5-19	2.5-3	53-53.5	3-3.5	90.5-91	
	Soil type: (visual)	Brown silty sand	Brown silty sand	Brown clayey sand with gravel	Brown silty sand	Dark brown sandy clay	Brown silty sand	Dark brown sandy clay and reddish brown clay with gravel	Greenish gray clay with shells	
1.	Date tested:	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	1.
2.	Tested by:	KA	KA	KA	KA	KA	KA	KA	KA	2.
3.	Specimen height (in.)	6.00	6.00	5.10	5.90	6.00	6.00	5.50	5.85	3.
4.	Wt. of specimen + tare (gm)	948.0	952.1	929.6	922.9	913.3	982.4	1024.3	1061.3	4.
5.	Tare wt. (gm)	0.00	0.00	206.40	0.00	0.00	0.00	212.23	204.73	5.
6.	Diameter (in.)	2.41	2.41	2.41	2.41	2.42	2.41	2.41	2.41	6.
7.	Wet wt. of soil + dish wt. (gm)	636.52	663.22	888.60	1025.00	219.00	1148.60	978.60	1019.20	7.
8.	Dry wt. of soil + dish wt. (gm)	574.58	600.14	830.00	860.50	192.21	992.60	888.60	805.60	8.
9.	Wt. of dish (gm)	284.09	303.13	165.94	102.10	43.20	166.22	167.23	166.45	9.
10.	Dish ID									10.
	Wet Density (pcf)	131.8	132.4	118.3	130.5	126.0	136.6	123.2	122.2	
	Dry Density (pcf)	108.7	109.2	108.7	107.3	106.8	114.9	109.5	91.6	
	Moisture Content (%)	21.3	21.2	8.8	21.7	18.0	18.9	12.5	33.4	
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.550	0.543	0.550	0.571	0.578	0.466	0.538	0.840	
	Saturation (%)	104.6	105.7	43.4	102.6	84.0	109.4	62.6	107.4	
	Additional data:									
	Wt. of dry soil + dish before washing (gm)									
	Wt. of dry soil + dish after washing (gm)									
	% Passing # 200 sieve									
	USCS symbol									

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	70.2	29.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	97.2		
#60	69.7		
#140	33.0		
#200	29.8		

* (no specification provided)

Soil Description

Reddish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.335 D_{60}= 0.208 D_{50}= 0.171
D_{30}= 0.0785 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Sample No.: 4A **Source of Sample:** MPTSB-R1 **Date:**
Location: **Elev./Depth:** 8-8.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

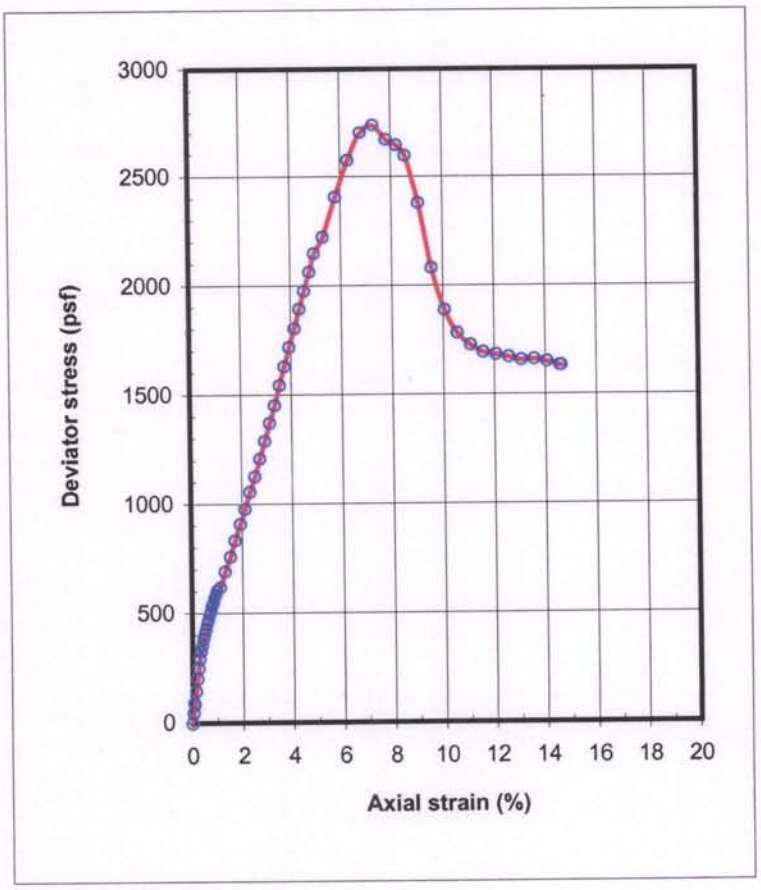
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # MPTSB-R1
Sample # : 4A
Depth (ft) : 8-8.5
Date tested : 06/01/08
Soil : Reddish brown clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

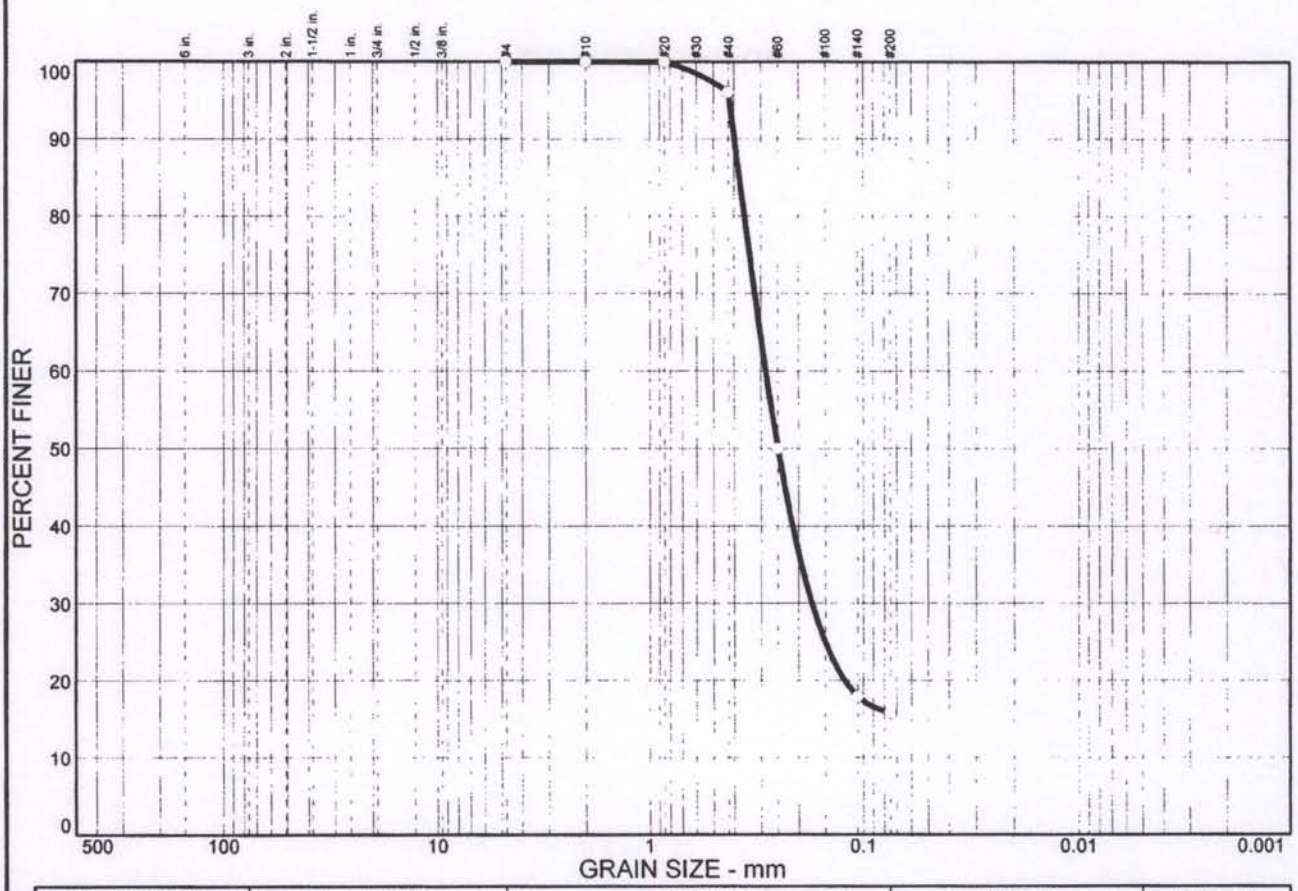
Specimen:
Total wt. = 935.8 gms
Ht. = 6.000 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 452.4 c.c.
Shearing rate = 0.05 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.620
Ht/Dia ratio = 2.48
Moisture = 24.1 %
Total density = 129.1 pcf
Dry density = 104.0 pcf
Saturation = 105.0 %
Chamber pressure = 1390 psf
Max. deviator stress = 2743 psf
Strain @ failure = 7.31 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	1.5	0.05	46.7
0.003	2.9	0.07	92.1
0.004	2.8	0.10	87.2
0.007	4.7	0.15	145.9
0.010	6.5	0.20	203.8
0.013	8.1	0.25	251.7
0.016	9.4	0.30	292.7
0.019	10.4	0.35	325.6
0.022	11.3	0.40	352.0
0.025	12.3	0.45	383.1
0.028	13.1	0.50	406.4
0.031	13.8	0.55	429.4
0.034	14.5	0.60	452.4
0.037	15.2	0.65	471.3
0.040	16.0	0.70	496.4
0.043	16.5	0.75	511.6
0.046	17.2	0.80	534.2
0.049	17.7	0.85	548.7
0.052	18.4	0.90	569.6
0.055	18.9	0.95	584.6
0.058	19.5	1.00	603.8
0.066	20.0	1.13	620.0
0.078	22.4	1.33	692.4
0.090	24.7	1.53	760.2
0.102	27.2	1.73	836.1
0.114	29.7	1.94	910.4
0.126	32.0	2.14	980.5
0.138	34.6	2.33	1058.0
0.150	37.0	2.53	1129.4
0.163	39.7	2.74	1209.5
0.174	42.5	2.93	1290.1
0.187	45.3	3.14	1372.7
0.199	48.1	3.34	1454.7
0.210	51.2	3.54	1545.9
0.222	54.1	3.74	1631.2
0.234	57.2	3.94	1719.1
0.247	60.2	4.14	1805.5
0.259	63.3	4.34	1894.6
0.271	66.2	4.54	1977.2
0.283	69.3	4.75	2064.3
0.295	72.3	4.94	2150.0
0.316	75.1	5.29	2224.3
0.346	81.7	5.80	2409.4
0.376	87.9	6.30	2576.8
0.406	92.8	6.80	2705.8
0.437	94.6	7.31	2742.8
0.467	92.6	7.81	2672.2
0.492	92.1	8.22	2646.4

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	84.2	15.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	96.1		
#60	50.0		
#140	17.9		
#200	15.8		

* (no specification provided)

Soil Description

Yellowish brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.378 D_{60}= 0.285 D_{50}= 0.250
D_{30}= 0.174 D_{15}= D_{10}=
C_u= C_c=

Classification

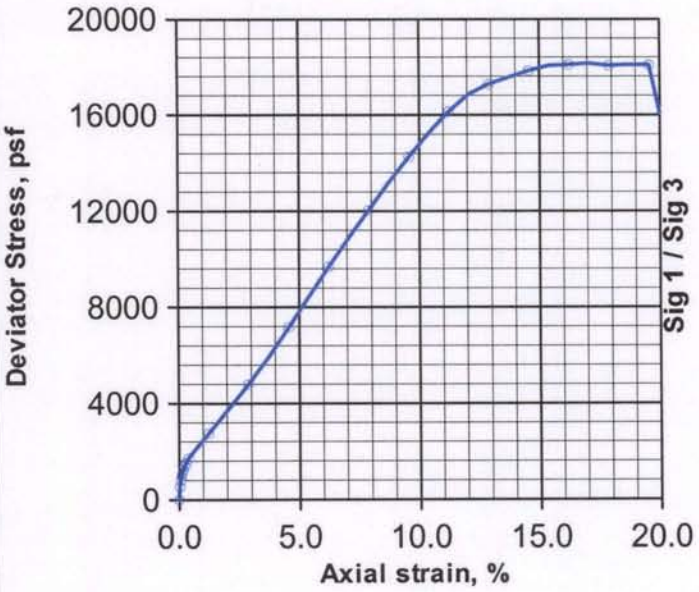
USCS= SM AASHTO=

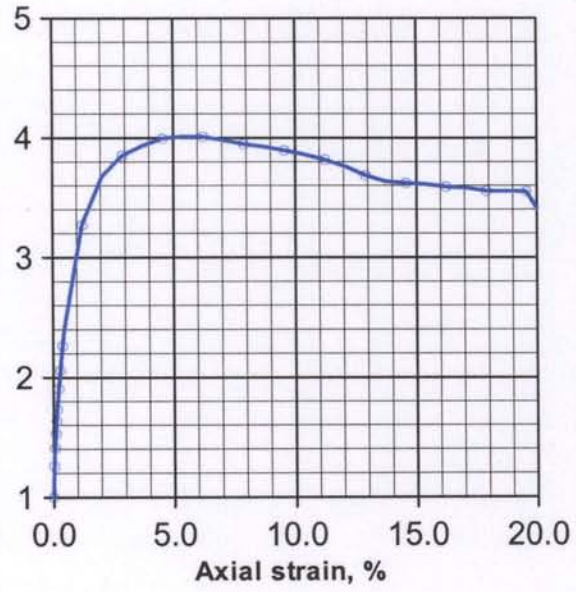
Remarks

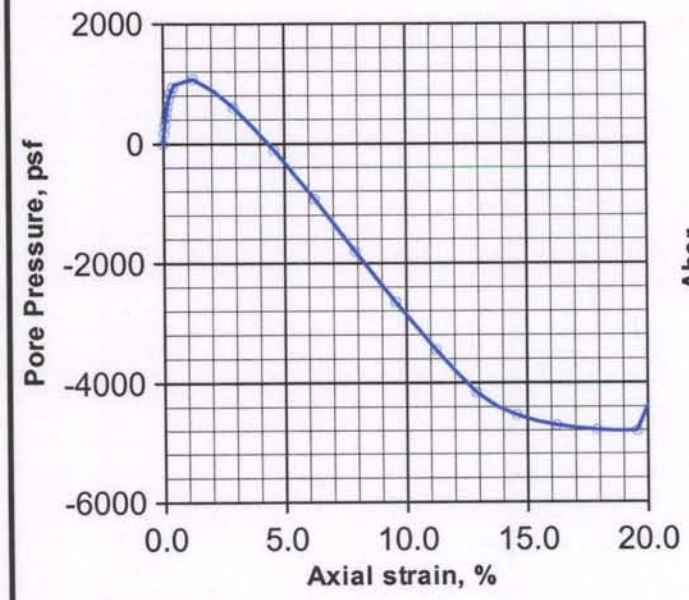
Sample No.: 6A **Source of Sample:** MPTSB-R1 **Date:**
Location: **Elev./Depth:** 13-13.5

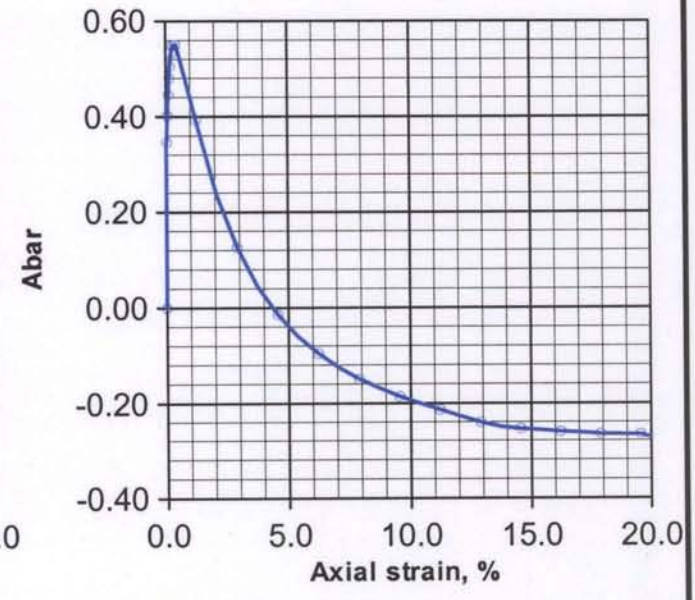
SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**









Line type	SigC psf	Peak Deviator str., psf	Strain @ fail. %	PWP psf	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio			Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Strain Rate %/hr.
solid	2290	8412	5.4	-506	23.5	101.9	97	0.654			22.4	103.4	96	0.630	1.0
dash															
dot															

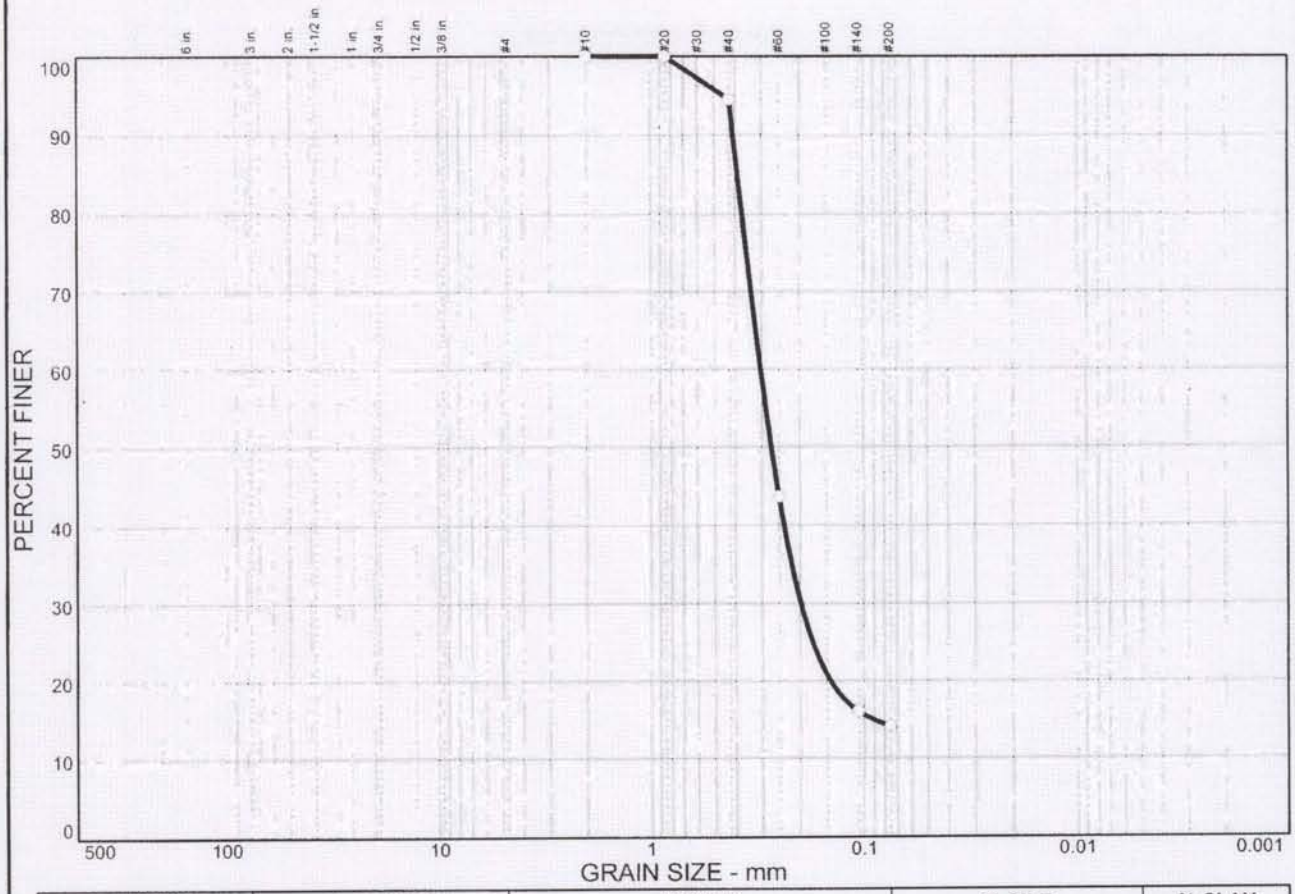
Client: **Arup**	Boring #: **MPTSB-R1** Sample #: **6A**
Project: **Doyle Drive Replacement Project**	Depth (ft): **13-13.5**
Project #: **131558**	Soil: **Yellowish brown silty sand**

TEST REPORT: **Consolidated Undrained Triaxial Compression Test**

Signet Testing Labs, Inc.

Plate no: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	85.9	14.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	94.5		
#60	43.7		
#140	16.1		
#200	14.1		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.389 D_{60}= 0.304 D_{50}= 0.271
D_{30}= 0.198 D_{15}= 0.0898 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

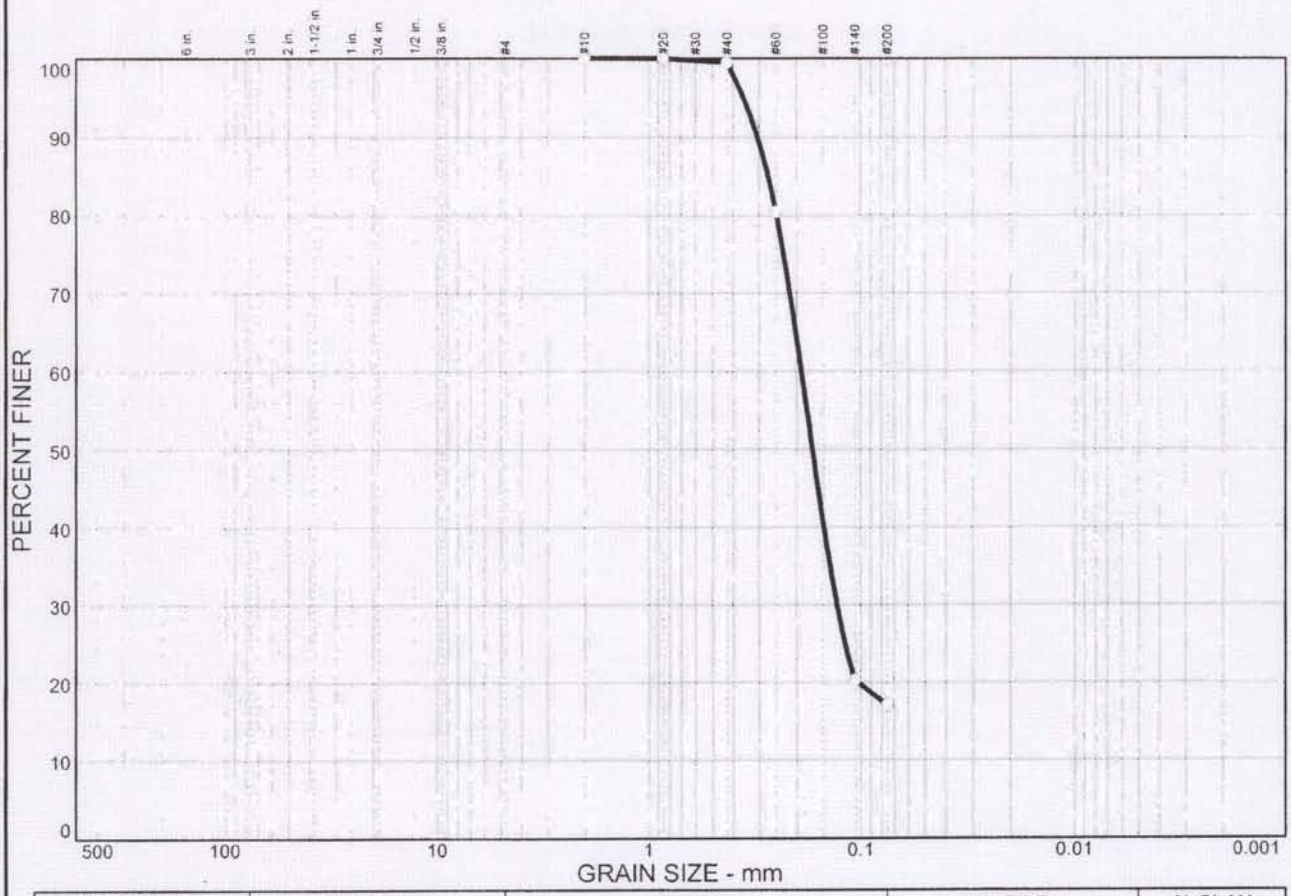
Remarks

Sample No.: 8A **Source of Sample:** MPTSB-R1 **Date:**
Location: **Elev./Depth:** 18-18.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	82.9	17.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.5		
#60	80.4		
#140	20.3		
#200	17.1		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.272 D_{60}= 0.190 D_{50}= 0.168
D_{30}= 0.129 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Sample No.: 20B **Source of Sample:** MPTSB-R1 **Date:**
Location: **Elev./Depth:** 48.5-49

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

LABORATORY CORROSION TEST DATA

Reviewed For Adequacy (RFA)
By: TC
Date: 2/11/2009

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax: 925 462 2775
www.cercoanalytical.com

28 January, 2009

Job No.0901056
Cust. No.11993

RECD FEB 11 2009

Mr. Terrence Carroll
Arup North America, Ltd.
560 Mission St., Suite 700
San Francisco, CA 94103

Subject: Project No.: 131-558
Project Name: Doyle Drive Replacement Project
Corrosivity Analysis – CalTrans Test Methods

Dear Mr. Carroll:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on January 9, 2009. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, the following is the corrosivity classifications:

Severely Corrosive
Sample No.006

Corrosive

Sample No.001	Sample No.007	Sample No.009

Moderately Corrosive

Sample No.002	Sample No.003	Sample No.004
Sample No.005	Sample No.010	Sample No.011

Mildly Corrosive
Sample No.008

All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations range from none detected to 61 mg/kg. Because the chloride ion concentrations are less than 300 mg/kg, they are determined to be insufficient to attack steel embedded in a concrete mortar coating.

The sulfate ion concentrations range from none detected to 4,300 mg/kg and are determined to be sufficient to damage reinforced concrete structures and cement mortar-coated steel at these

locations. Therefore, concrete that comes into contact with this soil should use sulfate resistant cement such as Type II, in accordance with the Uniform Building Code requirements.

The pH of the soils range from 3.3 to 8.2 which does present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures. Any soils with a pH of <6.0 is considered to be corrosive to buried iron, steel, mortar-coated steel and reinforced concrete structures. Therefore, corrosion prevention measures need to be considered for structures to be placed in this acidic soil.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax: 925 462 2775
www.cercoanalytical.com

Client: ARUP
Client's Project No.: Not Indicated
Client's Project Name: Doyle Drive Replacement Project
Date Sampled: Not Indicated
Date Received: 9-Jan-09
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 28-Jan-2009

Job/Sample No.	Sample I.D.	Moisture (%)	pH	Min.Resistivity (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
0901056-001	34-0164SB-R1 @ 10-15'	-	3.3	540	-	61	3,900 (1)
0901056-002	34-0168-R1 @ 10-15'	-	4.0	2,100	-	21	4,300 (1)
0901056-003	34-01654NB-R2 @ 10-20'	-	8.1	2,800	-	35	570
0901056-004	34-0168-R1 @ 20-25'	-	7.9	4,900	-	23	19
0901056-005	34-0164NB-A5 @ 30-50'	-	8.0	5,600	-	N.D.	20
0901056-006	34-0164NB-R4 @ 10-15'	-	3.6	480	-	42	3,900 (1)
0901056-007	34-0168-R1 @ 5-10'	-	6.2	1,500	-	N.D.	150
0901056-008	A2-R9 @ 15-25'	-	7.3	10,000	-	N.D.	N.D.
0901056-009	34-0165SB-B2 @ 20-30'	-	7.8	1,900	-	N.D.	280
0901056-010	RW8-R4 @ 5-10'	-	6.7	2,500	-	25	51
0901056-011	RW8-R3 @ 5-10'	-	8.2	3,800	-	16	51

Method:	226	CT 532/643	CT 532/643	-	CT 422/ASTM D4327	CT 417/ASTM D4327
Detection Limit:	-	-	-	50	15	15
Date Analyzed:	-	23-Dec-2008	23-Jan-2009 & 26-Jan-2009	-	21-Jan-2009	21-Jan-2009 & 22-Jan-2009

Cheryl McMillen
Laboratory Director

* Results Reported on an "As Received" Basis
N.D. - None Detected
(1) Detection limit is elevated to 75 mg/kg due to dilution

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

TEST NO. 5186 - 98

BILLED

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 24 2008

☐ DISTRICT ☐ TRANS. L/
☐ DIS. MA ☐ PAV'T. SEC
☐ RESIDENT ENGINEER ☐ ACCOUNTIN
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30					
50					
100					
200					
5μ					
1μ					

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

RESISTIVITY = 3648
SPECS: 1000 Ω-CM (MIN)

REMARKS

PH = 7.5
SPECS: 5.5 (MIN)

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE; EXPANSION PRESSURE; AT EQUILIBRUM ____ SPEC. ____

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D
DATE TESTED				
COMPACTOR FOOT PRESSURE P.S.I.				
INITIAL MOISTURE %				
SOAK WATER ML				
WATER ADDED-ML (TOTAL)				
WATER ADDED %				
MOISTURE AT COMPACTION %				
WET WT. OF BRIQUETTE-GMS				
HEIGHT OF BRIQUETTE-INCHES				
DRY DENSITY OF BRIQ. - 4" CU. FT.				
STABILOMETER P_H AT 2000 LBS.				
DISPLACEMENT				
R-VALUE BY STABILOMETER				
EXUDATION PRES. P.S.I.				
THICK. BY STAB. FEET				
EXPANSION DIAL READING				
THICK. BY EXP. PRESS. FEET				
R-VALUE BY EXPANSION				

TEST RESULTS	SPEC.
LL P.L P.I.	
CV	
S.E. AS REC'D	
S.E. CRUSHED	
S.E. COMBINED	
LART GRADE 100 REV.	
LART GRADE 500 REV.	
DUR D_f	
DUR D_i	
% CRUSHED PARTICLES	

SP. GR. ☐ BULK (OVEN) ☐ BULK (SSD) ☐ APPARENT

	FINE	CO
AS REC'D.		
CRUSHED		

REL. COMPACTION DA

	IN PLACE	OPT
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATI

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C63+773

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☐ [illegible]

FIELD NO.

DIST. LAB NO. 5186

LOT NO.

SHIPMENT NO.

AUTHORIZATION NO. 163701

5186-98

JUL 25 2008

SAMPLE OF SOIL

FOR USE IN FOUNDATION DESIGN

SAMPLE FROM BORING No. RW8-R3

DEPTH 20-25'

LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R3

AND IS ONE OF A GROUP OF 28

SAMPLES REPRESENTING (TONS, GALS., BBLS., STA. ETC.)

OWNER OR MANUFACTURER CALTRANS

TOTAL QUANTITY AVAILABLE

TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY

DATE NEEDED 08/24/08

REMARKS

CORROSION TEST

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLEED 01/15-17/2008

BY R. NASHED TITLE ENG. GEOLOGIST

DIST., CO., RTE., PM

4-SF-101-8.3/9.4

LIMITS

CONT. NO. 163701

FED. NO. 1-240

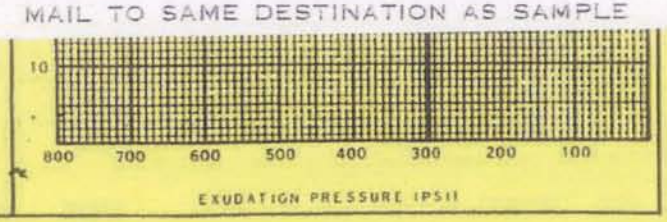
RES. ENGR. OR SUPT. TUNG NGUYEN

ADDRESS 111 GRAND AVE 8TH FL, MS16, OAK(ANT), CA 946

CONTRACTOR PHONE 510-622-1775

FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST 5186 - 10P

DATE RECEIVED JUL 25 2008

CALC. BY _____ APPROVED BY _____

DATE REPORTED NOV 24 2008

BILLED

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECTI
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF. LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30					
50					
100					
200					
5μ					
1μ					

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

RESISTIVITY = 3317
spec: 1000Ω-cm (min)

REMARKS
pH = 8.2
spec: 5.6 (min)

SURFACE

BASE

SUBBASE

GRAVEL EQUIVALENT FACTOR

TRAFFIC INDEX

R VALUE: EXUDATION PRESSURE

EXPANSION PRESSURE

AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - # CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
S.E.	AS REC'D		
	CRUSHED		
	COMBINED		
LART	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN DR ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CAR NUMBER C64774

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☐ DIST. LAB
SUBMITTED BY
AUTHORIZATION NO. 16370

FIELD NO.
DIST. LAB NO. 5186
LOT NO.
P.O. OR REQ. NO.

5186 - 10P

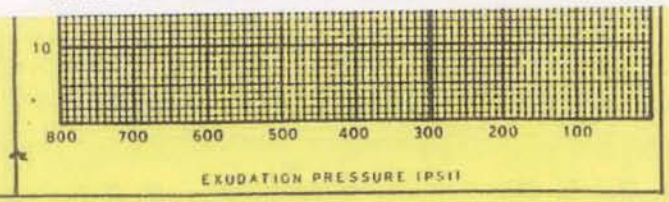
SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN
SAMPLE FROM BORING No. RW8-RA
DEPTH 15 - 20'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-RA
AND IS ONE OF A GROUP OF 2
SAMPLES REPRESENTING (TONS, GALS., BBLS. STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 08/24/08
REMARKS CORROSION TEST

JUL 25 2008

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R. NASHED TITLE ENG. GEOLOGIST
DIST., CO., RTE., PM 4-SF-101-8.3/9.4
LIMITS
CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNE NGUYEN
ADDRESS 111 GRAND AVE 8TH FL. MS16 OAKLAND, CA 946
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



TEST
5186 - 11P
BILLED

DATE RECEIVED JUL 25 2008
CALC. BY _____ APPROVED BY _____
DATE REPORTED NOV 24 2008

☐ DISTRICT ☐ TRANS. LAB.
☐ DIS. MAT ☐ PAV'T. SECTI
☐ RESIDENT ENGINEER ☐ ACCOUNTING
☐ CONSTRUCTION ☐

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	SPECIF LIMITS ☐ SOUGHT ☐
3					
2½					
2					
1½					
1					
¾					
½					
⅜					
4					
8					
16					
30					
50					
100					
200					
5μ					
1μ					

GRADING AS USED WAS OBTAINED AS FOLLOWS:

% BY WT.	% BY VOL.	TEST NO.	DESCRIPTION

RESISTIVITY = 3806
SPECS: 1000 Ω-cm (min)

REMARKS: PH = 8.0
SPECS: 5.6 (min)

SURFACE
BASE
SUBBASE
GRAVEL EQUIVALENT FACTOR
TRAFFIC INDEX

R VALUE
EXUDATION PRESSURE
EXPANSION PRESSURE
AT EQUILIBRUM SPEC.

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS (FEET)

REPORT OF TESTS ON

SOIL

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	AMOUNT

TEST SPECIMEN	A	B	C	D	E
DATE TESTED					
COMPACTOR FOOT PRESSURE P.S.I.					
INITIAL MOISTURE %					
SOAK WATER ML					
WATER ADDED-ML (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET WT. OF BRIQUETTE-GMS					
HEIGHT OF BRIQUETTE-INCHES					
DRY DENSITY OF BRIQ. - 4 CU. FT.					
STABILOMETER P_H AT 2000 LBS.					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. P.S.I.					
THICK. BY STAB. FEET					
EXPANSION DIAL READING					
THICK. BY EXP. PRESS. FEET					
R-VALUE BY EXPANSION					

TEST RESULTS			SPEC.
LL	P.L	P.I.	
CV			
SIEVE	AS REC'D		
	CRUSHED		
	COMBINED		
CURT	GRADE	100 REV.	
		500 REV.	
DUR	D_f		
	D_i		
% CRUSHED PARTICLES			

SP. GR. ☐ BULK (OVEN D ☐ BULK (SSD) ☐ APPARENT

	FINE	COAR
AS REC'D.		
CRUSHED		

REL. COMPACTION DAT

	IN PLACE	OPTIM
DENSITY		
MOISTURE		
% REL. COMP.		
SPEC.		

RICHARD CHAN
DISTRICT MATERIALS ENGINEER
BRANCH CHIEF, MATERIALS B

-TL-361 (Rev. 10/78)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD
TL-0101 (REV. 10/97)
CA[illegible]MBER C6[illegible]775

☐ PRELIMINARY TESTS
☒ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB
SHIPMENT NO.
AUTHORIZATION NO. 163701

FIELD NO.
DIST. LAB NO. 5186
LOT NO.
P.O. OR REQ. NO.

5186-11P

JUL 25 2008

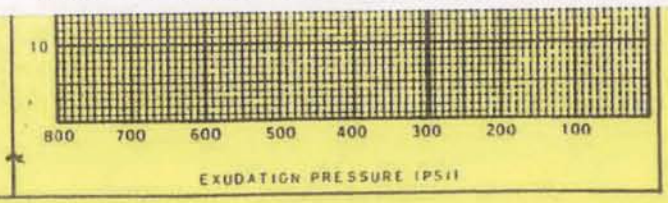
SAMPLE OF SOIL
FOR USE IN FOUNDATION DESIGN
SAMPLE FROM BORING No. RW8-R4
DEPTH 35-40'
LOCATION OF SOURCE DOYLE DRIVE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) RW8-R4
AND IS ONE OF A GROUP OF 28
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA. ETC.)
OWNER OR MANUFACTURER CALTRANS
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☒ NORMAL ☐ PRIORITY
DATE NEEDED 08/24/08
REMARKS CORROSION TEST

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLEED 01/15-17/2008
BY R. NASHED TITLE ENG. GEOLOGIST
DIST, CO, RTE, PM 4-SF-101-8.3/9.4
LIMITS

CONT. NO. 163701
FED. NO. 1-240
RES. ENGR. OR SUPT. TUNG NGUYEN
ADDRESS 111 GRAND AVE 8TH FL MS16 OAK(AND) CA 946[illegible]
CONTRACTOR PHONE 510-622-1775
FAX 510-286-4839

MAIL TO SAME DESTINATION AS SAMPLE



California State Certified Laboratory No.2153

CERCO analytical, inc.
3942-A Valley Avenue
Pleasanton, CA 94566-4715
925.462.2771 • Fax: 925.462.2775
www.cercoanalytical.com

REC'D JUL 23 2008

Client: ARUP
Client's Project No.: 131558
Client's Project Name: Doyle Drive Replacement Project
Date Sampled: Not Indicated
Date Received: 21-May-08
Matrix: Soil
Authorization: Chain of Custody

Corrected
Date of Report: 16-Jul-2008

Job/Sample No.	Sample I.D.	Moisture (%)	pH	Min.Resistivity (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
0805159-016	M-11 #G1	-	7.6	900	-	N.D.	790
0805159-017	M-11 #G2	-	7.6	1,000	-	N.D.	740
0805159-018	BTSB-R2 #9A,9B,10	-	7.2	5,500	-	N.D.	15
0805159-019	M-9/RW7-A1(a) #9A,9B,10	-	7.9	5,300	-	20	15

Method:	226	CT 532/643	CT 532/643	-	CT 422/ASTM D4327	CT 417/ASTM D4327
Detection Limit:	-	-	-	50	15	15
Date Analyzed:	-	29-May-2008	05-Jun-2008 & 6-Jun-2008	-	30-May-2008	30-May-2008

Cheryl McMillen
Laboratory Director

* Results Reported on an "As Received" Basis
N.D. - None Detected

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: **Structure Design**
1. Design
2. R.E. Pending File
3. Specifications & Estimates
4. File

Geotechnical Services
1. GD - North ; South ; West
2 GS File Room

Date: August 24, 2009

Retaining Wall 8
Structure Name

04	SF	101	8.8/9.2
District	County	Route	PM

District Project Development | Hossein Khodabakhsh (District Project Engineer) | 163701 (E.A. Number) | 34E0014 (Structure Number)

Foundation Report By: CALTRANS Dated: 08/18/2009

Reviewed By: _____ (SD) Tung Nguyen/Mahmood Momenzadeh (GS)

General Plan Dated: 08/20/2009 Foundation Plan Dated: 08/20/2009

[ ] No changes. [x] The following changes are necessary.

On Sheet RW8-6, General Notes, Seismic Loading: Please revise to read as following

$k_h = 0.55$ $k_v = 0.15$ Typical UNO
$k_h = 0.275$ $k_v = 0.15$ at Cantilever Retaining Wall

FOUNDATION CHECKLIST

___ Pile Types and Design Loads	___ Footing Elevations, Design Loads, and Locations	___ Effect of Fills on Abutments and Bents
___ Pile Lengths	___ Seismic Data	___ Fill Surcharge
___ Predrilling	___ Location of Adjacent Structures and Utilities	___ Approach Paving Slabs
___ Pile Load Test	___ Stability of Cuts or Fills	___ Scour
___ Substitution of H Piles For Concrete Piles [ ] Yes [ ] No	___ Fill Time Delay	___ Ground Water
	___	___ Tremie Seals/Type D Excavation
		___

M. Momenzadeh 8/24/09

Structure Design | Bridge Design Branch No. | Geotechnical Services

Rev. 06/02

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: **Structure Design**
1. Design
2. R.E. Pending File
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4. File

Geotechnical Services
1. GD - North ; South ; West
2 GS File Room

Date: August 24, 2009

Retaining Wall 8
Structure Name

04	SF	101	8.8/9.2
District	County	Route	PM

District Project Development | Hossein Khodabakhsh (District Project Engineer) | 163701 (E.A. Number) | 34E0014 (Structure Number)

Foundation Report By: CALTRANS Dated: 08/18/2009

Reviewed By: _____ (SD) Tung Nguyen/Mahmood Momenzadeh (GS)

General Plan Dated: 08/20/2009 Foundation Plan Dated: 08/20/2009

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___ Pile Lengths	___ Seismic Data	___ Fill Surcharge
___ Predrilling	___ Location of Adjacent Structures and Utilities	___ Approach Paving Slabs
___ Pile Load Test	___ Stability of Cuts or Fills	___ Scour
___ Substitution of H Piles For Concrete Piles [ ] Yes [ ] No	___ Fill Time Delay	___ Ground Water
	___	___ Tremie Seals/Type D Excavation
		___

M. Momenzadeh 8/24/09

Structure Design | Bridge Design Branch No. | Geotechnical Services

Rev. 06/02

Memorandum

Flex your power!
Be energy efficient!

To: MR. MINH HA
Chief, Structure Design Branch 4
Division of Engineering Services

Attn: Linan Wang

Date: July 13, 2009

File: 04-SF-1,101-PM9.0
04-163701
Presidio Viaduct Substation
Bridge No. 34-0157W

From: CAROLINE CHEN
Transportation Engineer
Office of Geotechnical Design-West
Division of Engineering Services

MAHMOOD MOMENZADEH
Chief, Branch C
Office of Geotechnical Design-West
Division of Engineering Services

Subject: Foundation Recommendations

This report presents the Foundation Recommendations for the proposed Presidio Viaduct Substation (34-0157W) in the city of San Francisco. This structure are part of the overall proposal to replace the existing 70-year-old Doyle Drive, a 1.5 mile stretch of Highway 101 in the northern part of the city extending from Marina Boulevard and Lombard Streets to the southern approach of the Golden Gate Bridge Toll Plaza.

PROJECT DESCRIPTION

The proposed structure is located behind the Abutment 1 of Presidio Viaduct SB, between "SB" Line Stations 86+62 and 87+26, with footprint about 64 ft by 62 ft.

GEOLOGY AND SUBSURFACE CONDITIONS

Regional Geology

The project site location falls in the Coast Range geomorphic province, which is characterized by a series of nearly parallel mountain ranges that trend obliquely to the coast in a northwesterly direction. This trend in direction is emphasized by the alignment of the fault zone, the fold axes and geologic units.

The San Francisco Bay area has long record of seismic activity. The entire project area has also been strongly influenced by changes related to the Pleistocene glaciers and the presence of the San Francisco Bay trough, resulting in variable thickness of recent deposits of soft to medium stiff Holocene clays (Bay Mud), an older stiffer Pleistocene clay (Old Bay Mud) and sand deposits.

Site Specific Geologic Conditions

The varying topography within the project site is the result of a diverse range of geologic conditions. Shallow bedrock of the Franciscan Formation generally dominates at the project location overlain by a relatively thin cover of soil. The Franciscan Formation consists of heavily folded and sheared assemblage of Shale, Sandstone, and Greywacke. The overburden soils are made up of slope debris, dune sand, and/or the Colma sand, which is medium dense to very dense.

Subsurface Conditions

The Office of Geotechnical Design-West conducted subsurface investigations in 2008 and 2009 for the proposed Presidio Viaduct SB and Presidio Viaduct NB, consisting of dozens of mud rotary borings. Three of those borings (34-0157SB-A1, 34-0157SB-B2R, and 34-0157SB-B2L) are near the proposed substation. Boring 34-0157SB-A1 is on the west end of the substation, and Borings 34-0157SB-B2R and 34-0157SB-B2L are approximately 180 ft west to the substation. The elevations at top of the boreholes are 81.2 ft, 63.1 ft, and 62.0 ft for 34-0157SB-A1, 34-0157SB-B2R, and 34-0157SB-B2L, respectively. The deepest boring reached Elevation –61.9 ft, or 125 ft below ground surface.

Base on Boring 34-0157SB-A1, the site is underlain by approximately 20 ft of very dense sand underlain by predominantly sandstone with shale, ranging from slightly weathered to decomposed, from very soft to very hard. The sand layer encountered in Borings 34-0157SB-B2R and 34-0157SB-B2L reaches approximately depth of 60 ft. The first 20 ft underlying the surface consists of medium dense sand, underlain by about 40 ft of dense to very dense sand. Boring 34-0257SB-B2L has a very stiff, high plasticity fat clay layer with sand layer between 18 and 12 feet below grade. Below the sand and clay, the bedrock consists of sandstone, shale, and greywacke.

Ground water was not measured during the drilling of these borings. During the 2008 subsurface investigation for the Presidio Viaduct, piezometers were installed at four locations (Boreholes 34-0157NB-A1-PZ, 34-0157NB-B3R-PZ, 34-0157SB-B3L-PZ, and 34-0157NB-B4R-PZ) along the Presidio Viaduct, which are approximately 30 ft, 400 ft, 400 ft, and 800 ft, away from the proposed structure, respectively. Based on the latest readings dated July and October 2008, the water table is approximately 24 ft below

ground in 34-0157NB-A1-PZ, 20 feet below ground in 34-0157NB-B3R, 10 feet below ground in 34-0157SB-B3L, and 16 feet below ground in 34-0157NB-B4R, or at approximate Elevations 56 ft, 12 ft, 32 ft, and 22 ft, respectively. We recommend design groundwater at approximate Elevation 56 ft. Groundwater elevation is subject to seasonal fluctuations and will be encountered at higher or lower elevations depending on seasonal conditions.

SCOUR POTENTIAL

The structure does not span any watercourse. Therefore, there is no scour potential at the site.

LIQUEFACTION POTENTIAL

The subsurface consists of medium dense well above ground water, very dense sand, and sandstone bedrock. Liquefaction is not anticipated.

CORROSION

Corrosion tests were performed on soil samples collected from the borings. Test results shown on Table 1 indicate the site is considered non-corrosive based on the current Caltrans guidelines.

Table 1 Corrosivity Test Results

Boring No.	Depth (ft)	pH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
34-0157SB-A1	5-6.5	6.32	2886	-	-
34-0157SB- A1	15-16.5	7.41	4171	-	-
34-0157SB-B2R	5-6.5	8.06	11996	-	-
34-0157SB-B2R	15-16.5	7.31	14313	-	-
34-0157SB-B2R	30-31.5	7.39	10049	-	-
34-0157SB-B2L	10-11.5	7.08	13915	-	-
34-0157SB-B2L	20-21.5	6.25	9204	-	-
34-0157SB-B2L	35-36.5	6.92	9086	-	-
34-0157SB-B2L	50-51.5	7.31	2580	-	-

ENVIRONMENTAL/HAZARDOUS CONSIDERATIONS

District 4 Division of Environmental Planning & Engineering completed an extensive soil investigation for the Doyle Drive project. The draft report titled "Soil Investigation Report" is in the process of being finalized and will be available as part of the supplemental handout for the contractor and will include the characterization of the soil and groundwater of the entire Doyle Drive project for potential contaminants and hazardous waste. This includes testing and characterization of project areas subject to both roadway and structure excavation including CIDH pile locations, and the testing of all existing structures within the project for asbestos and lead-based paint.

For further information, please contact Mr. Ray Boyer, District Branch Chief - Hazardous Waste, Office of Environmental Engineering, Division of Environmental Planning & Engineering, Caltrans - District 04, at (510) 286-5668.

FAULT AND SEISMIC DATA

Hossain Salimi of the Office of Geotechnical Design-West will provide seismic recommendations for this structure.

FOUNDATION RECOMMENDATIONS

Based on general Plans, foundation data, and loads provided by structure designer shown on Tables 2 and 3, and the subsurface conditions, Cast-In-Drilled-Hole (CIDH) pile is feasible type of foundation for the proposed structure. Foundation design recommendations are presented on Tables 4 and 5. The CIDH piles are anticipated to tip into the rock. Settlement of CIDH piles under service load is minimal.

Table 2 Foundation Data

Support Location	Design Method	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap (ft)		Permissible Settlement under Service Load (in)	No. of Piles per Support
					B	L		
Abut 1	WSD	24 inch CIDH	71.5	66.75	14	75.5	1	39
Bent 2	LRFD	24 inch CIDH Extension	71.5	71.5	-	-	1	10
Bent 3	LRFD	24 inch CIDH Extension	71.5	71.5	-	-	1	8

Table 3 - Foundation Design Loads Provided by Structure Designer

Support Location	Service 1 Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group) (kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max Per Pile	Per Support	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile
Abut 1	4750	121	4446	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	1031	N/A	557	1584	159	N/A	80	1496	150	N/A	75
Bent 3	740	N/A	332	1176	147	N/A	70	1104	138	N/A	60

Table 4 - Foundation Design Recommendations for Abutment 1

Support Location	Pile Type	Cut-off Elevation (ft)	LRFD Service-I Limit State Load (kips) per Support		LRFD Service-I Limit State Total Load (kips) per Pile (Compression)	Nominal Resistance (kips)	Design Tip Elevations (ft)	Specified Tip Elevation (ft)
			Total	Permanent				
Abut. 1	24 inch CIDH	66.75	4750	4446	121	250	45.0 (1)	45.0

Notes:
1. The design tip elevations are controlled by (1) Compression.
2. Specified pile tip elevations shall not be raised.
3. The structure designer is to provide design tip elevations for lateral loads, if there are any.

The structure designer should show on the plans, in the pile data table, the design pile tip elevation controlled by the lateral load demands. If the design pile tip elevation required to meet lateral load demands exceeds the specified pile tip elevations given within this report, the Office of Geotechnical Design-West shall be contacted for further recommendations.

Table 5 - Foundation Design Recommendations for Bents

Support Location	Pile Type	Cut-Off Elevation (ft)	Service-I Limit State Load per Support (kips)	Total Permissible Support Settlement	Required factored Nominal Resistance (kips)				Design Pile Tip Elevation (ft)	Specified Pile Tip Elevation (ft)
					Strength Limit		Extreme Event			
					Comp. (φ=0.7)	Tension (φ=0.7)	Comp. (φ=1)	Tension (φ=1)		
Bent 2	24 inch CIDH Extension	71.5	1031	1	230	120	150	80	47.5 (1) 54.0 (2)	47.5
Bent 3	24 inch CIDH Extension	71.5	740	1	210	100	140	60	47.5 (1) 55.0 (2)	47.5

Notes:
1. The design tip elevations are controlled by (1) Compression, (2) Tension.
2. Specified pile tip elevations shall not be raised.
3. The structure designer is to provide design tip elevations for lateral loads, if there are any.

CONSTRUCTION CONSIDERATIONS

- Rock is anticipated to be encountered during installation of CIDH piles. The formational rock encountered at the site is extremely variable in hardness, fracturing, and weathering, ranging from very hard to very soft, slightly to very intensely fractured, and slightly weathered to decomposed. Therefore the contractor should anticipate variable drilling conditions in the formational rock similar to the exploratory drilling conditions and the need to alternate from soft and hard rock drilling techniques to drill the holes.

- The contractor should also be prepared for potential caving conditions within the formational unit.

- The drilled shaft shall be drilled and filled with concrete before any adjacent holes are drilled.

- Groundwater is likely to be encountered during drilling to install CIDH piles. Temporary casing may be needed due to cave in potential.

- Contractor should design the shoring appropriately when excavating to install the pile cap.

The recommendations contained in this report are based on specific project information including structure type, support locations, and design loads that have been provided by the Office of Bridge Design-West. If any changes are made during final project design, the Office of Geotechnical Design-West, should review those changes to determine if these foundation recommendations are still applicable

If you have any questions or need additional information, please contact Caroline Chen at 916-227-1066 or Mahmood Momenzadeh at 510-286-5732.

c. TPokrywka, MMomenzadeh, CChen, HSalimi, Daily File, Route File, Translab File
John Mook, PCE-PPRM
Project Manager
District Design Chief

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: Structure Design ✓
1. Preliminary Report
2. R.E. Pending File
3. Specifications & Estimates
4. File

Geotechnical Services
1. GS (Sacramento)
2. GS

District Project Development

Date: 8/5/09

Presidio Viaduct Substation
Structure Name

04 — SF - 1/101 - 9.0
District County Route Post ~~Km~~ M.

District Project Engineer

04-163741 E.A. Number

34-0157W Structure Number

Foundation Report By: C. Chen Dated: 7/13/09

Reviewed By: L. Wang (OSD) R. Price (GS)

General Plan Dated: 7/29/09 Foundation Plan Dated: 7/29/09

☐ No changes. ☒ The following changes are necessary.

Edit "Pile Data Table" on Plans to conform with MTD 3-1 (7/08).

FOUNDATION CHECKLIST

✓ Pile Types and Design Loads	✓ Footing Elevations, Design Loads, and Locations	✓ LQTB's
✓ Pile Lengths	— Seismic Data	✓ Fill Surcharge
✓ Predrilling	✓ Location of Adjacent Structures and Utilities	✓ Approach Paving Slabs
— Pile Load Test	✓ Stability of Cuts or Fills	✓ Scour
— Substitution of H Piles For Concrete Piles ☐ Yes ~~☐ No~~	✓ Fill Time Delay	✓ Ground Water
	— Effect of Fills on Abutments and Bents	✓ Tremie Seals/Type D Excavation

Office of Structure Design 4 Branch No. Geotechnical Services

Rev. 10/02

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: Structure Design
1. Preliminary Report
2. R.E. Pending File
3. Specifications & Estimates
4. File

Geotechnical Services
1. GS (Sacramento)
2. GS

District Project Development
District Project Engineer

Date: 9/1/09

Southbound Buttery Tunnel
Structure Name

04 - SF - 101 - 9.0/9.2
District County Route Post ~~Km~~ M.

04-163741 34-0161L
E.A. Number Structure Number

Foundation Report By: F. Gragura (ARUP) Dated: 7/20/09

Reviewed By: B. Anderson (OSD) R. Price (GS)

General Plan Dated: 8/26/09 Foundation Plan Dated: 7/31/09

☐ No changes. ☒ The following changes are necessary.

① Sheet SBBT - ST7, "Excavation & Backfill Pay Limits". Show Backfill details (Legend)

FOUNDATION CHECKLIST

___ Pile Types and Design Loads	✓ Footing Elevations, Design Loads, and Locations	✓ LOTB's
___ Pile Lengths	✓ Seismic Data	___ Fill Surcharge
___ Predrilling	✓ Location of Adjacent Structures and Utilities	___ Approach Paving Slabs
___ Pile Load Test	✓ Stability of Cuts or Fills	✓ Scour
___ Substitution of H Piles For Concrete Piles ☐ Yes ☐ No	✓ Fill Time Delay	___ Ground Water
	✓ Effect of Fills on Abutments and Bents	___ Tremie Seals/Type D Excavation

Paul R. Cook 8 [signature]
Office of Structure Design Branch No. Geotechnical Services

Rev. 10/02

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: Structure Design
1. Preliminary Report
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4. File

Geotechnical Services
1. GS (Sacramento)
2. GS

Date: 9/1/09

Retaining Wall A & B
Structure Name

04 - SF - 101 - 9.0/9.2
District County Route Post ~~Km~~

District Project Development
District Project Engineer

04 - 163741
E.A. Number

34 - 0161L
Structure Number

Foundation Report By: F. Gragusas (Arup) Dated: 7/20/09

Reviewed By: R. Anderson (OSD) R. Price (GS)

General Plan Dated: 8/26/04 Foundation Plan Dated: 7/31/09

☐ No changes. ☒ The following changes are necessary.

Refer to Southbound Battery Tunnel LOTB's

FOUNDATION CHECKLIST

- ___ Pile Types and Design Loads
- ___ Pile Lengths
- ___ Predrilling
- ___ Pile Load Test
- ___ Substitution of H Piles For Concrete Piles ☐ Yes ☐ No
- ___ Footing Elevations, Design Loads, and Locations
- ___ Seismic Data
- ___ Location of Adjacent Structures and Utilities
- ___ Stability of Cuts or Fills
- ___ Fill Time Delay
- ___ Effect of Fills on Abutments and Bents
- ___ LOTB's
- ___ Fill Surcharge
- ___ Approach Paving Slabs
- ___ Scour
- ___ Ground Water
- ___ Tremie Seals/Type D Excavation

Office of Structure Design 8 Branch No. Geotechnical Services

Rev. 10/02

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

FOUNDATION REPORT

Southbound Battery Tunnel (Bridge No. 34-0161L)

August 2009

Prepared By:

Caltrans and Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Foundation Report

Southbound Battery Tunnel (Bridge No. 34 0161L)

August 2009

ARUP PB joint venture

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job number 131558-00.

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Appendices

Appendix A

Geotechnical Exploration Program

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Appendix B

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1 Introduction

This Foundation Report provides foundation recommendations for the Southbound Battery Tunnel structure, a cut-and-cover tunnel located in San Francisco, California. The proposed structure is part of the Doyle Drive Replacement Project which will replace the freeway that stretches from the west end of Lombard Street, through the Presidio of San Francisco, ending at the Golden Gate Bridge toll plaza. The cut-and-cover tunnel will be landscaped above to restore some of the natural beauty of the Presidio, which is now part of the United States National Park System. The Southbound Battery Tunnel will be located in the west portion of the project in a bluff adjacent to a reclaimed tidal marsh as shown on Figure 1.

Two tunnels (the Southbound and Northbound Battery Tunnels) are proposed to replace the existing at-grade portion of Doyle Drive in approximately the same location. The underground structures are comprised of an approximately 56-foot-wide, 800-foot-long Northbound Tunnel and an approximately 66-foot-wide, 1,000-foot-long Southbound Tunnel. The two tunnels will be constructed separately in different stages in order to maintain normal traffic flow during construction. The Southbound Tunnel will be constructed first and after completion will accommodate traffic flow in both directions while existing Doyle Drive is taken out of service for construction of the Northbound Tunnel. The Southbound Tunnel is considered a shallow tunnel and will be constructed with conventional cut-and-cover methods. The Southbound Tunnel begins at Station 75+80 (The East Portal) and extends to Station 86+14 (The West Portal). The Southbound Tunnel transitions to permanent retaining walls beyond both portals. Retaining Wall 8 is located adjacent to the East Portal and Retaining Wall 6, which is part of the substation located in the abutment of the Southbound Presidio Viaduct (Bridge No. 34-157L), is located adjacent to West Portal. Foundation Reports for both Retaining Wall 8 and Retaining Wall 6 will be provided by the Department.

Construction of the Battery Tunnels will require excavations up to approximately 43 feet deep. In order to support excavations of this depth, temporary retaining structures will need to be constructed along the north and south sides of the excavation. Retaining Wall A will be installed on the south side of the tunnel and Retaining Wall B will be installed on the north side. Retaining Walls A and B will remain in place after tunnel construction, but are considered temporary.

A Preliminary Foundation Report for collective Battery Tunnels was issued to the Caltrans office of Geotechnical Design – West for their review and comments. A draft of the Preliminary Foundation Report was submitted on April 15, 2008. We received comments back from the Department via email on May 13, 2008. The comments were addressed and incorporated in the Preliminary Foundation Report Battery Tunnels dated January 2009. This Foundation Report serves to update the Preliminary Foundation Report, incorporating the latest structural design elements. A draft of this Foundation Report was issued on June 4, 2009 and we received comments from the Department on June 24, 2009 and August 5, 2009. The comments have been addressed and incorporated into this Foundation Report.

2 Site Exploration Program

The site exploration program for the Battery Tunnels included the following: 1) exploratory soil and rock boreholes; 2) a comprehensive laboratory testing program; 3) in-situ geophysical tests; 4) oriented rock coring; 5) in-situ permeability (packer) testing; and 6) installation of standpipe piezometers at selected locations to monitor groundwater levels and periodic readings of groundwater levels in the piezometers.

The exploratory programs for both the Northbound and Southbound Tunnels were performed concurrently and as such, much of the data collected pertains to the design of both structures. All data collected during the exploratory programs is presented in this Foundation Report and where appropriate, data related specifically to the design of the Southbound Tunnel has been highlighted.

2.1 Exploratory Boreholes

The Arup/PB Joint Venture (Arup/PB) drilled exploratory boreholes in 18 locations in the vicinity of the Battery Tunnels. Boreholes were drilled in 3 of the locations specifically for the foundation design of the Southbound Battery Tunnel. Boreholes were drilled in 3 of the locations for the design of adjacent Retaining Wall 6 and Retaining Wall 8. Boreholes were drilled in 3 of the locations by hand auger at the base of the Battery bluff for the purpose of monitoring groundwater. Logs of Test Borings (LOTBs) are included in Appendix A.1 and Boring Records are included in Appendix A.2. The locations of boreholes drilled by Arup/PB are shown on Figure 2 and summarized on Table 1 including installation and survey data.

The Department drilled 3 boreholes for the design of adjacent structures that were used as part of this report (RW8-R2, 34-0157NB-A1-PZ, and 34-0157SB-A1). These boreholes will be included in Caltrans Foundation Reports, but draft copies of the field logs are also included in Appendix A.3 of this report and shown on Figure 2.

Two adjacent boreholes that were drilled as part of a previous investigation are also included in Appendix A.3 and are shown on Figure 2.

2.2 Laboratory Testing

A comprehensive laboratory testing program was undertaken to evaluate the physical and engineering characteristics of the major soil and rock strata of interest and to determine appropriate parameters for design. In order to better determine average values for design, test results for both the Southbound and Northbound tunnel alignments were considered. The results of the laboratory testing program are presented in Appendix B. Summaries of the laboratory test results on soil and rock are presented on Tables 2 and 3, respectively. All of the test reports received from the testing laboratories are included in a CD in Appendix B.

The laboratory testing program included the following types of tests:

- Index tests such as moisture content, total unit weight, gradation, organic content, and Atterberg (plasticity) limits. The primary purpose of these tests is for soil classification and for correlation with the engineering properties of the respective soils.
- Consolidation tests were performed on samples of the stiff Sandy Clay layer that is present above and below the Colma Sand layer to evaluate the stress history and compressibility characteristics of cohesive soils. Consolidation tests were performed using the incremental loading (IL) procedure in accordance with the American Society for Testing and Materials (ASTM) D2435-96 test method. The incremental loading procedure was modified from the ASTM specifications, by using very small load increments in the recompression zone so as to better define the compression curve and the maximum past pressure of the soil.
- Direct shear tests were performed on samples of Colma Sand, sandy Fill, and sandy Buried Soil Horizon to evaluate the strength characteristics of cohesionless soils.
- Unconsolidated Undrained Triaxial Compression (TXUU) tests were performed on samples of the Sandy Clay, Buried Soil Horizon, and also Colma Sand samples with appreciable amounts of clay or silt. Additionally, TXUU tests were performed on

samples of very intensely weathered or decomposed sandstone, serpentinite, Mélange Matrix, and gabbro to evaluate their undrained shear strength.

- Isotropically Consolidated Undrained Triaxial (TXICU) tests were performed on samples of the Colma Sand layer to provide information on the effective-stress-strength and deformation characteristics of the Colma Sand. The tests were performed in general accordance with the ASTM D4767-95 test method. The ASTM test method was developed for cohesive soils, but in practice the same general procedures and test equipment can be used to perform undrained, or drained triaxial tests on cohesionless soils as well. The information generated from the TXICU tests is required to develop input parameters in terms of strength and stiffness of the Colma Sand for the analyses of the excavations and for other evaluations as well.
- Point Load Index (PLI) tests were performed on intact rock cores for evaluation of the uniaxial compressive strength of rock. The point load index strength also provides information that can be used in combination with fracture frequency information to evaluate the excavatability of rock. Point Load Index tests are particularly useful because they can be performed on relatively small test specimens, as opposed to uniaxial compression tests that require specimens 6 inches long or longer for the test. A large number of PLI tests should be performed in order to representative values for the PLI. Because the Franciscan Complex is highly sheared and weathered, invalid tests were common, typically when the break occurred not through the rock mass, but through pre-existing fractures. The PLI tests were performed primarily on samples of sandstone.
- Uniaxial Compression (UCS) tests were performed on intact rock cores for determination of the strength, Young's Modulus (modulus of elasticity), and Poisson's ratio of the rock. The tests were performed on rock core, including sandstone, gabbro, and serpentinite. The test requires a minimum length of core of twice the diameter, but in some cases shorter samples were used and the values corrected to account for the short sample.
- Splitting (Indirect) Tensile Tests (Brazilian) were performed on cores of sandstone and gabbro. The tests were performed in accordance with the ASTM D3967-95 test method. The tensile strength of rock is used as one of the index parameters for boreability evaluations. The results of these tests can be used to evaluate the level of difficulty of drilling into rock and wear on equipment.
- Slake Durability Tests were performed on samples of serpentinite. The tests were performed in accordance with the ASTM D4644-98 test method. The purpose of these tests was to evaluate the tendency for deterioration of the rock when it becomes exposed to air, humidity, and/or seepage, as well as to construction activities after excavation.
- Other tests were performed to evaluate the boreability of the rock. This category includes Punch Penetration tests and Cerchar Abrasivity tests. These are specialized index tests performed to qualitatively evaluate the boreability of the rock.
- Petrographic Analysis Tests were performed to identify the mineral composition of the rocks tested. The tests were performed in accordance with the ASTM C295 test method.

2.3 Geophysical Testing

Suspension P-S velocity logging was performed in boreholes BTSB-R2, BTSB-R3-PZ-D, RW6-R1-PZ, RW6-R2-PZ-D, and RW8-R1-PZ to obtain information about the stiffness characteristics of the soil and rock below the tunnel and adjacent retaining walls. GEOVision Inc. (GEOVision) of Corona, California performed the logging. Suspension velocity logging was also performed in boreholes BTNB-R4-PZ, BTNB-R5-PZ-D, and BTNB-R7-PZ-D for design of the Northbound Battery Tunnel. The velocity results for all boreholes are presented in the GEOVision Report, which is attached in Appendix C of this report on a CD.

The measured shear wave velocity of the Fill ranged from 450 feet per second (fps) to 820 fps. The shear wave velocity of the Colma Sand ranged from 950 fps to 1,750 fps. The shear wave velocity of the serpentinite ranged from 1,780 fps to 4,860 fps. The shear wave velocity of the sandstone typically ranged from 1,470 fps to 7,020 fps, however, the shear wave velocity of the sandstone in BTSB-R3-PZ-D was as high as 8,750 fps indicating a block of very hard sandstone with a low degree of fracturing.

GEOVision also performed acoustic televiewer testing in boreholes BTSB-R3-PZ-D, RW6-R2-PZ-D, and RW8-R1-PZ adjacent to the Southbound Tunnel and boreholes BTNB-R4-PZ, BTNB-R5-PZ-D, BTNB-R7-PZ-D adjacent to the Northbound Tunnel. All acoustic televiewer test results are presented on the CD in Appendix C.

The purpose of the acoustic televiewer tests was to determine if a repeatable joint orientation exists and if groundwater could be conveyed from the south side of the tunnels into the corresponding bedrock fractures on the north side of the tunnels recreating the groundwater flow as if the tunnel structures were not present. The acoustic televiewer results were very good in locations of harder rock, such as sandstone, but degraded in sections of Mélange Matrix or soft serpentinite. In order to evaluate if repeatable joint orientations exist through which groundwater flows, the test results from the Southbound Tunnel and the Northbound Tunnel must be compared and all results are evaluated in this report.

Several mean fracture sets are present in each borehole and are summarized on Table 4. No mean fracture sets are presented for borehole BTNB-R4-PZ because only a limited number of fractures were observed. No consistent fracture sets were obtained in borehole RW8-R1-PZ as the bedrock encountered was predominantly serpentinite.

2.4 Oriented Rock Coring

Oriented rock coring was performed in boreholes BTNB-R5-PZ-D, BTNB-R6-PZ-D, BTNB-R7-PZ-D, BTSB-R3-PZ-D, and RW6-R2-PZ-D to supplement the acoustic televiewer results and attempt to determine potentially repeatable joint orientations that could convey groundwater.

The oriented core was obtained using the EZY-MARK Core Orientation System. The EZY-MARK system works by drilling the borehole at a slight incline (approximately 5°) and inserting the EZY-MARK tool into the core barrel. The tool will mark the top of the core stub in the ground with a pencil and a series of pins as well as orienting itself with the “downside” of the inclined borehole. After completion of the core run, the top of the obtained core and the tool are aligned and the relation of the obtained core to the borehole orientation is determined.

The mean fracture sets determined from the oriented rock coring are summarized on Table 5. The strike and dip data is presented on the Boring Records in Appendix A.2.

2.5 Packer Testing

Packer tests were performed at 6 locations to measure the hydraulic conductivity of the bedrock below the Battery Tunnels. The hydraulic conductivity in the serpentinite bedrock ranged from $1.3x10^{-7}$ cm/s to $1.5x10^{-4}$ cm/s and in the sandstone ranged from very small (test interval did not take any water) to $1.6x10^{-4}$ cm/s. The results of the packer tests are summarized on Table 6 and presented in detail in Appendix D.

2.6 Piezometer Installation and Groundwater Readings

Seven standpipe piezometers were installed in 5 locations below the Southbound Battery Tunnel and adjacent retaining walls in permeable soil and rock strata to verify the groundwater conditions. Where multiple piezometers were installed at the same location, the screened interval was changed to evaluate conditions in different soil and rock strata.

Piezometer RW8-R1-PZ was not installed properly and was abandoned per the Presidio Trust Environmental Standard Operating Procedure for Well Maintenance and Abandonment, SOP No. 006, Revision No. 00. The abandoned piezometer was replaced with piezometer RW8-R1A-PZ.

All piezometers were developed by Gregg Drilling and Testing, typically by pumping 10 times the well volume of water out of the well and measuring the turbidity of the pumped water. The results of our well development program are summarized on Table 7. The results of our groundwater monitoring, including piezometer screen intervals, and screened materials, are presented on Table 8.

3 Site Geology and Subsurface Conditions

3.1 General Site Geology

The regional topography of the San Francisco peninsula is characterized by relatively rugged hills formed by Jurassic- to Cretaceous-aged bedrock surrounded by low flat-lying areas which are underlain by Quaternary sedimentary deposits. Bedrock consists of highly deformed and fractured rocks of the Franciscan assemblage. Locally, the Franciscan Complex contains large through-going shear zones such as the City College and Fort Point-Potrero Hill-Hunters Point shear zones. The Fort Point-Potrero Hill-Hunters Point shear zone traverses the study area as may be seen on Figure 3. It should therefore be expected that the Franciscan Complex would be intensely fractured, containing moderately weathered to decomposed (soil-like) inclusions.

In the Peninsula area, Quaternary sediments lie unconformably on the eroded bedrock surface and consist of an alternating sequence of terrestrial and estuarine deposits that reflect major sea level fluctuations during the Pleistocene and Holocene epochs. Low stands of sea level are recorded by the deposition of terrestrial sediments, such as Colma Sand, whereas estuarine sediments such as the Yerba Buena Mud (also known locally as Old Bay Mud) and Bay Mud were deposited during high sea-level stands (Sloan, 1992). The Colma Sand is deposited in coastal and estuarine environments during the last interglacial period. It is typically composed of fine to medium sand and it commonly contains Sandy Clay and Sandy Silt layers. The Old Bay Mud was deposited in an estuarine environment similar to that which presently exists in San Francisco Bay, and therefore has a lateral distribution similar to that of the younger estuarine Bay Mud. Historical development of the San Francisco Bay area has resulted in placement of artificial fill material over substantial portions of modern estuaries, marshlands and creek beds in an effort to reclaim land.

The Tunnel is located on a raised bluff in the western portion of the project where estuarine Bay Mud, Old Bay Mud, and marshland deposits do not exist.

3.2 Site Specific Subsurface Conditions

Figures 4 and 5 present generalized subsurface cross sections, showing the soils encountered below the Northbound and Southbound Battery Tunnels. Transverse cross sections at the East Portal, and Stations 78+00, 81+00, and 85+00 are presented on Figures 6, 7, 8, and 9, respectively.

The depth of the bedrock is variable along the alignment of the tunnels. At the east end of the tunnel, about 60 feet of soils exist over bedrock whereas, near the west end, about 12 feet of soils exist above bedrock.

The surficial soil unit is a medium dense sandy Fill that is present along the entire alignment. The Fill is related to site grading performed while the Presidio was used for military activities and ranges between 3 and 23 feet thick. Much of the Fill appears to have been derived from Dune Sand. Verification of large amounts of Fill was given by overlaying ground surface elevations from 1871 and 2000 which indicate that the ground surface has risen due to site grading and filling (Barnaal, The Presidio Trust, 2008). Figure 10 presents approximate changes in the site grading in the area of the Battery Tunnels. This figure is provided solely to show that fill has been placed in this area and should not be used for any other purpose.

The Fill is underlain at some locations by a thin Buried Soil Horizon. When present, this unit ranges from 3.5 to 5 feet thick and is characterized by soft, dark brown silts with sand and a strong organic odor.

At the east end, below the Buried Soil Horizon is a layer of medium stiff Sandy Silts and Sandy Clays ranging up to 16 feet thick. The Sandy Silt and Sandy Clay layer is underlain by up to 19 feet of Colma Sand. The Colma Sand is dense to very dense with typically a trace of fines (about 5 percent) to about 20 percent fines. A second layer of Sandy Clay exists below the Colma Sand, which in turn is underlain by Residual Soil over bedrock, although Colluvium or Residual Soil was not encountered in all boreholes composed of stiff gravelly and sandy clay.

At the east end Colluvium was encountered within the slope of the bluff. At the west end, the Fill is underlain by Residual Soil over bedrock.

Bedrock beneath the Battery Tunnels is of the Franciscan Complex. This formation consists of a variety of heavily folded and sheared assemblages of sandstone, siltstone, serpentinite, Mélange Matrix (a plastic bedrock unit which is similar to a gravelly clay), shale, gabbro, greenstone, granulite and claystone. The hardness of these bedrock units typically ranges from very soft to hard and may vary in short distances, but large blocks (on the order of hundreds of feet) of very hard rock may be encountered. Fracture frequency typically ranged from very intensely fractured to moderately fractured. Because of the pervasive fracturing, distinct joint sets could not be determined during the field investigation. Photographs of typical geologic features within the bedrock are shown on Figure 11. The types and nature of bedrock encountered can also vary over short distances within the Franciscan Complex. Below the east portion of the tunnels, bedrock was typically comprised of serpentinite, whereas to towards the west portion, of the tunnel, a large block of sandstone was encountered. Mélange Matrix was encountered between the serpentinite and sandstone. The results of petrographic analyses are presented in Appendix B.

3.3 Groundwater Conditions

Groundwater was encountered at various elevations across the tunnel alignments, increasing in elevation from east to west. At the east portion, groundwater was encountered in the Colma Sand between elevations 40 feet and 50 feet. To the west, as the bedrock surface rises in elevation, a seasonal groundwater layer was typically encountered perched on the soil-rock interface and was encountered as high as elevation 88 feet.

Average groundwater readings and piezometer screen intervals are shown on the longitudinal and transverse Cross Sections (Figures 4 through 9) and Table 8.

BASELINE Environmental Inc. (BASELINE) is performing a comprehensive groundwater monitoring program for the bluff. The program involves quarterly readings of all of the piezometers and installation of leveloggers at several critical locations along the tunnel alignment. Leveloggers were installed in piezometers BTNB-R7-PZ-D, BTNB-R7A-PZ-S, BTNB-R5-PZ-D, BTNB-R5A-PZ-S, BTSB-R3-PZ-D, BTSB-R3A-PZ-S, RW6-R2-PZ-D and RW8-R1A-PZ. A levelogger is essentially a vibrating wire piezometer that is programmed to take water level readings at set intervals. The results of the work done by BASELINE will be submitted separately.

The results of the Packer tests were submitted to the Department for evaluation of flow rates into the excavation.

Construction dewatering and a long-term groundwater management plans are required and are discussed further in the Section 9, Construction Concerns.

4 Scour

Scour will not be a concern on this portion of the project because water is not flowing in contact with the structure. However, surface runoff flowing over sloping surfaces may cause erosion if engineered fill and native soils are not properly compacted, covered with vegetation, or covered by a low permeability material. Appropriate erosion control measures should be provided by the landscape architect.

5 Corrosivity

Five soil samples were collected for corrosion testing. Sampling and testing of the site soils were in conformance with the Corrosion Guidelines for Foundation Investigations (Caltrans, 2003). The results of the corrosion testing are presented on Table 9.

Caltrans (2003) considers a site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

- Chloride concentration is greater than or equal to 500 ppm;
- Sulfate concentration is greater than or equal to 2,000 ppm; or
- The pH is 5.5 or less.

Based on the results of the corrosion analyses and the Caltrans criteria, the site is considered non-corrosive.

6 Seismicity

Structural design criteria has been proposed in the report titled *Structural Design Criteria: Cut-and-Cover Tunnels and Non-Standard Retaining Walls, Draft-Revision 4,* dated March 2009 prepared by Arup/PB. This document summarizes the seismic demand placed on the

structure. In addition, Amec Geomatrix, in conjunction with Dr. Norm Abrahamson, were retained to provide the following services:

- Perform a site-specific seismic hazard assessment and develop rock response spectra for Functional Evaluation Earthquake (FEE) and Safety Evaluation Earthquake (SEE) events;
- Develop three independent sets of spectrum-compatible rock motions for each of the FEE and SEE events; and
- Perform 1-Dimensional site response analyses for both fault-normal and fault-parallel components and for all three sets of time histories.

The results of the AMEC Geomatrix study are presented in their report: Seismic Hazard Assessment and Site Response Analysis Prepared for the Doyle Drive Replacement Project, Parts 1 and 2, dated May 2009 and Part 3, dated July 2009. The complete report is attached in Appendix E of this report on a CD.

For the Battery Tunnels, two soil and rock profiles were considered for the site response analyses: a shallow profile and a deep profile. The shallow profile refers to the west end of the tunnels where the depth to bedrock is shallow and the tunnels will be founded in the rock. The deep profile refers to the east end of the tunnels where the depth to bedrock is deeper and the tunnels will be founded on soil.

6.1 Liquefaction

The results of the site response analyses by AMEC Geomatrix were used to evaluate the potential for liquefaction triggering below the Tunnel. The site response analyses calculated the shear stresses at depth for both the shallow and deep soil and rock profiles. The shear stresses were then used to evaluate the potential for soil liquefaction triggering for the SEE.

The liquefaction analysis was performed following the procedure proposed by Seed, et al. (2003) using the results of standard penetration tests. Blowcounts from the Modified California (MC) sampler were converted to equivalent Standard Penetration Test (SPT) blowcounts by multiplying by 0.75 for sandy soils, 0.71 for silts, and 0.52 for clays. The correlations were determined from approximately 150 sets of consecutively driven MC and SPT samplers that were conducted during the geotechnical exploration program for the Doyle Drive Replacement Project.

Soils susceptible to liquefaction do not exist in the Battery Tunnels area because of the low water table and the typically medium dense to dense soil. The medium dense sandy Fill is typically not saturated. In areas where the water table is located within the overburden soils, it is typically found within the dense Colma Sand layer. Additionally, significant amounts of soil will be excavated in order to reach the bottom grade of the tunnel and as such, some of the loose soils will be removed and replaced either with the tunnel structure or engineered backfill.

Figures 12 and 13 show the probability of liquefaction triggering in the Fill and Colma Sand from the SPT correlations, respectively. The analyses indicate that the likelihood of liquefaction triggering is small below or adjacent to the Battery Tunnels.

The liquefaction triggering evaluation procedure is addressed in detail in the Liquefaction Triggering from Standard Penetration Tests calculation package attached in Appendix F.1. The calculation package also includes information regarding the blowcount correction applied to the Modified California sampler.

6.2 Seismic Earth Pressures

The results of the site response analyses were also used to evaluate seismic earth pressures on the temporary and permanent walls for the Southbound Battery Tunnel using the Mononabe-Okabe method as modified by Lam and Martin (1986). The results of the analyses are incorporated into Section 8 and the procedure is addressed in detail in the Lateral Earth Pressure calculation package attached in Appendix F.2.

7 Foundation Type Recommendations

7.1 Tunnel Foundations

The Southbound Battery Tunnel structure should be founded on a reinforced mat foundation. For design, a spring constant approach may be used.

Spring constants in the Preliminary Foundation Report have been revised for the Foundation Report. The spring constants for design of the Southbound Tunnel have been separated into three portions; from the East Portal to Station 78+50 where bedrock is not anticipated to be exposed when excavating for the structure, from Station 78+50 to Station 81+50 where moderately hard, moderately fractured sandstone is expected to be encountered, and from Station 81+50 to the West Portal where moderately hard, intensely fractured sandstone is expected to be encountered. Small amounts of other soil or rock types (such as serpentinite) may be encountered at the base of the excavation, but they are not anticipated to affect the design.

The spring constants for this foundation report have been estimated using typical values presented in the Naval Facilities Engineering Command Design Manual 7 (NAVFAC DM7) and are presented using a pseudo-coupled analysis. In a pseudo-coupled analysis, varying spring constants are applied to the mat such that the value in the center of the mat is less than those computed for the perimeter of the mat while maintaining the weighted average of the spring constants by area equal to the average spring constant for the entire mat. The mat was divided into three equal, concentric areas. The perimeter values are equal to two times the central values with one intermediate value.

The estimated spring constants are shown on Figure 14 and detailed below:

- From the southbound East Portal to southbound Station 78+50, the average spring constant is 360 ksf/ft. The spring constant for the outer zone of the tunnel is k_s = 485 ksf/ft. For the intermediate zone k_s = 364 ksf/ft and for the inner zone k_s = 243 ksf/ft
- From southbound Station 78+50 to southbound Station 81+50, the average spring constant is 700 ksf/ft. The spring constant for the outer zone of the tunnel is k_s = 1,018 ksf/ft. For the intermediate zone k_s = 764 ksf/ft and for the inner zone k_s = 509 ksf/ft.
- From southbound Station 81+50 to the southbound West Portal, the average spring constant is 500 ksf/ft. The spring constant for the outer zone of the tunnel is k_s = 674 ksf/ft. For the intermediate zone k_s = 505 ksf/ft and for the inner zone k_s = 337 ksf/ft.

These spring constants assume that all soft or loose materials are removed prior to the construction of the mat foundation. If soft materials, especially clays, are encountered below the base of the mat, these materials will need to be excavated and replaced with

compacted structural backfill. The method of estimation of the spring constants is presented in the calculation package in Appendix F.3.

Because of the excavation depths required to reach the final grade of the Battery Tunnels, the net load on the supporting soil and rock is small and in many locations negative. The small to negative final loading conditions and the lack of compressible soils anticipated beneath the Battery Tunnels indicate that total and differential settlements are expected to be less than ½ inch. A check of the bearing capacity indicates that the factor of safety against bearing failure is greater than 3.0. Calculations are presented in Appendix F.4.

7.2 Portal Foundations

The East and West Portals for the Southbound Tunnels may be supported at grade. The East Portal for the Southbound Tunnel is expected to be supported on Colma Sand. The Southbound West Portal is anticipated to be supported on sandstone.

For design, a spring constant approach may be used. For this report, an average spring constant was calculated for the portal structures. The East Portal, which will be supported on Colma Sand, may be designed using an average spring constant of $k_{s,avg}$ = 360 ksf/ft. The West Portal, which will be supported on sandstone, may be designed using an average spring constant of $k_{s,avg}$ = 500 ksf/ft. The method of estimation of the spring constants is presented in the calculation package in Appendix F.3.

7.3 Retaining Walls

Lateral design of the temporary retaining walls can be performed using a horizontal spring constant approach. An average horizontal spring constant of $k_{h,avg}$ = 200 ksf/ft may be used. The method of estimation of the spring constants is presented in the calculation package in Appendix F.3. Additional parameters for design are discussed in Section 8.

8 Earth Pressures on the Tunnel Structure

8.1 Vertical Earth Pressures

Soil cover over the top of the tunnel structure will exert a distributed vertical load on the roof of the structures. This dead load pressure will be equal to 140 pcf times the depth of the compacted fill. For example, if there is 5 feet of fill material placed over the structures, the applied distributed load from this material will be 700 psf.

We understand that between Station 76+05 and Station 79+99, up to 6 feet of light weight aggregate fill will be used to reduce the vertical earth pressures on the tunnel structure. Lightweight aggregate, such as Expanded Shale, Clay and Slate, will exert a vertical dead load pressure of approximately 40 to 65 pcf times the depth of fill.

8.2 At-Rest Earth Pressures

Static design of the tunnel shall be based on the calculated at-rest earth pressures. Figures 15 through 17 present the results of at-rest (long-term static) earth pressure calculations at Stations 78+00, 81+00, and 85+00, respectively, along the Southbound Battery Tunnel. These three stations represent the three typical conditions that are expected to be encountered: deep, intermediate, and shallow bedrock.

Drainage panels will be installed on the temporary retaining walls in order to relieve hydrostatic pressures that would act on the tunnel walls.

Over the side of the tunnel walls, the earth pressure will be a triangular or trapezoidal distributed force. Resultants may be easily determined using standard methods. For estimation of the at-rest earth pressures at a given depth below the top of the tunnel wall, z, the following equations can be used at the each of the typical sections:

- Station 78+00: 425+60*z, psf/ft
- Station 81+00: 760+56*z in soil, 430+30*z, in rock, psf/ft
- Station 85+00: 200+55*z in soil, 400+30*z in rock, psf/ft

Alternatively, and for non-typical locations, the pressures can be designed using equivalent fluid weight values for each of the different soils layers expected to be encountered. Equivalent fluid weight values for each of the soil types, as well as the earth pressure coefficients and the soil parameters used to develop them are summarized on Table 10.

8.3 Seismic Earth Pressures

Lateral earth pressures as a result of seismic loading have been evaluated using the results of the site response analyses. During an earthquake, the walls move and the active condition occurs, with at-rest pressures no longer being applicable. Therefore, for the long-term seismic loading condition, the seismic pressure as a result of the SEE earthquake is applied on top of active pressures. The results are presented on Figures 18 through 20 corresponding to Stations 78+00, 81+00, and 85+00, respectively. The anticipated lateral seismic earth pressures, in psf, range from 9 times the height of the wall (9H) at Stations 81+00 and 85+00 to 11 times the height of the wall (11H) at Station 78+00 and are summarized on Table 11.

For estimation of the long-term seismic earth pressures at a given depth below the top of the tunnel wall, z, the following equations can be used at the each of the typical sections:

- Station 78+00: 250+35*z + 11*H, psf/ft
- Station 81+00: 450+33*z in soil, 230+16*z, in rock +9*H, psf/ft
- Station 85+00: 120+33*z in soil, 220+16*z in rock +9*H, psf/ft

Alternatively, and for non-typical locations, the active pressures can be determined using equivalent fluid weight values for each of the different soils layers expected to be encountered as presented in Table 10. A calculation package is included as Appendix F.2.

8.4 Lateral Resistance

In their final configurations, the Southbound and Northbound Tunnels will be embedded into the Bluff soils on both the south and north sides of the tunnels, providing equal and opposite lateral soil pressures on the sides of the Tunnels. However, the Southbound Tunnel is longer than the Northbound Tunnel and beyond approximately Southbound Station 83+90, the Northbound alignment will be constructed at-grade and as such, cannot resist the lateral pressures on the Southbound Tunnel. In order to resist these loads, the soldier piles for Retaining Wall B will be extended deeper into the bedrock and become part of the permanent design. Recommended pile tip elevations for Retaining Wall B are summarized on Table 13.

Calculations to support the required installation depths are presented in Appendix F.6.

9 Construction Concerns

9.1 Environmental Considerations

Caltrans District 4 Division of Environmental Planning & Engineering completed an extensive environmental soil investigation for the Doyle Drive Project. The draft report titled "Soil Investigation Report for Contract No. 4," is in the process of being finalized and will be available as part of the supplemental handout for the contractor. The report will include a characterization of the soil and groundwater for the entire Doyle Drive project for potential contaminants and hazardous waste. This includes testing and characterization of the soils to be excavated for construction of the Southbound Battery Tunnel.

For further information, please contact Mr. Ray Boyer, District Branch Chief – Hazardous Waste, Office of Environmental Engineering, Division of Environmental Planning & Engineering, Caltrans – District 04, at 510.286.5668.

9.2 Temporary Retaining Structures

In concurrence with the Department, the shoring wall will be designed by Arup/PB. Construction of the Battery Tunnels will require excavations up to approximately 43 feet deep. In order to support excavations of this depth, temporary retaining structures will need to be constructed along the north and south sides of the excavation. Retaining Wall A will be installed on the south side of the tunnel and Retaining Wall B will be installed on the north side.

We recommend Retaining Walls A and B constructed using soldier piles and lagging for soil support as presented in our Type Selection Report dated January 15, 2009. Lagging will be only taken down to the top of the bedrock. The rock formation may be shored with lagging or shotcrete.

Ground anchors will not be allowed below the National Cemetery and can only be used in limited areas. Where ground anchors cannot be used, the temporary soldier pile and lagging wall will require internal bracing to limit deflections.

Table 11 summarizes the recommended earth pressure conditions for each of the stages of construction.

Tables 12 and 13 present the sizes, pile tips, and pile tops of the soldier piles for Retaining Walls A and B, respectively.

9.2.1 Apparent Pressures

Internal bracing and ground anchors will be used to support Retaining Walls A and B and as a result, apparent earth pressures will develop on the temporary retaining walls. Figures 21 through 23 present the results of apparent pressure calculations at Stations 78+00, 81+00, and 85+00, respectively, along the Southbound Battery Tunnel. The apparent pressures are based on the Terzaghi and Peck, 1969 method as presented in Fang (1991).

For estimation of the apparent earth pressures acting on the retaining walls, the following equations can be used at the each of the typical sections:

- Station 78+00: 965 psf/ft
- Station 81+00: 680 psf/ft in soil, 345 psf/ft, in rock
- Station 85+00: 735 psf/ft in soil, 345 psf/ft in rock

Over the sides of the walls, the apparent earth pressures will be a rectangular distributed force. Resultants may be easily determined using standard methods.

Prior to the installation of the first row of struts, the cantilevered wall may be design with active earth pressures using the equivalent fluid weight values presented on Table 10.

Drainage will be provided behind the retaining walls to relieve hydrostatic pressure.

During the construction of the Southbound Battery Tunnel, the existing Doyle Drive will remain open to traffic and will impose an additional surcharge on Retaining Wall B, which should be applied in addition to the recommended apparent pressures. The recommended surcharge pressures are shown on Figure 24.

Details regarding the calculation of the apparent pressures are attached in Appendix F.2 and are summarized on Table 10.

9.2.2 Construction Earthquake Event

Retaining Walls A and B should also be designed for a Construction Earthquake Event. According to the Caltrans Memo to Designers 20-12, the construction earthquake event should be equal to the earthquake corresponding to a 10% probability of exceedance in 10 years or twice the expected construction time, whichever is larger. Construction of the Southbound Battery Tunnel is expected to take 2 years and as such the Construction Earthquake Event is defined as a 10% probability of exceedance in 10 years or an approximately 100-year return period. However, as part of the site response analyses, AMEC Geomatrix evaluated a Functional Evaluation Earthquake (FEE) which corresponded to a 108-year return period. For convenience and conservatism, the FEE was used as the Construction Earthquake Event.

The Construction Earthquake Event should be applied in addition to the apparent pressures or active earth pressures and ranges from 1H to 2H as indicated on Table 11.

9.2.3 Wall Deflections and Soil Settlement

The temporary retaining walls for support of excavation should be constructed to limit lateral deflections to less than 1 inch. If wall deflections are limited to 1 inch, vertical settlements behind the wall will be less than 1 inch. The vertical settlement will be at a maximum directly behind the wall and is anticipated to reduce to zero at a distance behind the wall of approximately twice the height of the wall, or a maximum of 80 feet behind the wall. Calculations showing the anticipated wall deflections and vertical settlements are attached in Appendix F.5 and summarized on Tables 12 and 13. The calculations show that as designed, the retaining walls are expected to deflect less than ½ inch, with vertical settlements also being less than ½ inch.

9.2.4 External Rakers

Beyond approximately Station 84+00, the ground surface behind Retaining Wall B slopes down reducing the passive resistance capacity to the wall. Without full passive resistance behind the wall for support, the strut loads from the internally braced excavation will cause large displacements in both Retaining Walls A and B.

In order to provide lateral support to limit wall deflections, external rakers will be installed at the location of each strut. The rakers will connect from the backside of Retaining Wall B to drilled piers embedded into the bedrock.

The drilled piers will consist of a W14x99 steel beam encased in concrete in a 30-inch diameter hole. The drilled piers should be a minimum of 10 feet long and embedded at least 5 feet into bedrock to limit deflections to less than 1 inch. Table 14 presents a

summary of the rakers and the expected settlements and lateral deflection. Calculations to support the required raker installation depths are presented in Appendix F.6.

Additionally, the use of the rakers causes an uplift on the adjacent solider piles. The embedment of the soldier piles should be increased in order resist this uplift. We recommend that the solider piles be embedded at least 10 feet below the base of the excavation with a minimum embedment of 5 feet into the sandstone. The required pile tip elevations are presented on Table 14 and the calculations are presented in Appendix F.8.

9.2.5 Passive Arching Factor

The temporary retaining walls for support of excavation will be designed using 30 inch diameter soldier piles with typically 6-foot center to center spacings. For this configuration a passive arching factor of 3.0 may be used without overlapping stresses.

There are five wall niches in the tunnel that will require the soldier spacing between piles to be 9 feet center to center, although the pile remain 30 inches in diameter. At these locations, the passive arching factor should be 3.25.

9.2.6 Lagging Arching Factor

An arching factor may be applied to the lagging. Per the Caltrans Trenching and Shoring Manual, the lagging design load may be taken to be 0.6 times the shoring design load with a maximum lagging load of 400 psf.

9.2.7 Ground Anchors

Temporary ground anchors will be required at the east ends of Retaining Walls A and B. The ground anchors will be required between Station 76+32 (Solider Pile PA-25) and Station 76+62 (Solider Pile PA-30) for Retaining Wall A and Station 75+71 (Solider Pile PB-15) and Station 76+55 (Solider Pile PB-30) for Retaining Wall B, as internal bracing cannot be used at these locations. Ground anchors for Retaining Wall B will have to extend below the existing Doyle Drive and would be removed during construction of the Northbound Tunnel. Ground anchors for Retaining Wall A will extend to the limits of the National Cemetery and would remain in place after construction, but will not be considered for permanent design. The ground anchors are anticipated to be founded in Colma Sand. Ground anchors should be installed no steeper than 15° to minimize vertical loads on the wall. Apparent pressures should be used for the design of the ground anchors.

The temporary walls are 40 feet high where the ground anchors are required and 3 rows of ground anchors will be required. Table 15 presents the depths of the ground anchors and the required unbonded lengths. The ground anchor design calculations are attached as Appendix F.7.

9.2.8 Axial Loads

The ground anchors will cause an axial (downward) force on the solider piles. The solider pile should be embedded a minimum of 8 feet below the excavation (into the Colma Sand) to resist these loads. The required pile tip elevations are presented on Tables 12 and 13 for Retaining Walls A and B, respectively. The calculations are presented in Appendix F.8.

9.3 Additional Surcharges

Surcharges adjacent to the excavation and tunnel limits will add increased lateral earth pressures to the temporary shoring and the permanent tunnel. Different surcharge conditions exist on the south and north sides of the Southbound Battery Tunnel. On the south side, the National Cemetery limits the placements of loads and on the north side, the in service Doyle Drive will increase the lateral loads for design.

9.3.1 South Side of the Southbound Battery Tunnel and Retaining Wall A

The temporary braced excavation will be designed using apparent pressures. The apparent pressure diagrams used for design of the temporary braced excavation include typical construction loads and additional surcharge loads are not required for design of Retaining Wall A provided surcharge loads are limited to less than 150 psf

After completion of the Southbound Battery Tunnel, construction activities will begin for the construction of the adjacent Northbound Battery Tunnel and the area above and around the Southbound Tunnel will be used for construction activities. Therefore, the effect of an additional vertical surcharge pressure of 250 psf should be applied to the long-term static and long-term seismic conditions to account for these loads being applied to the permanent structure.

A uniform vertical surcharge will produce a non-uniform horizontal pressure on the wall. For simplification, the horizontal pressure was converted to uniform pressures applied on the wall, such that the same moment is imposed on the base of the tunnel wall from the non-uniform pressures and the equivalent uniform pressures. The recommended surcharge pressures are shown on Figure 24.

9.3.2 North Side of the Southbound Battery Tunnel and Retaining Wall B

During construction of the Southbound Battery Tunnel and prior to construction of the Northbound Battery Tunnel, the existing Doyle Drive will remain in service adjacent to the north side of the excavation. The traffic loads from the Doyle Drive roadway will impose lateral pressures on Retaining Wall B and the permanent structure. A uniform vertical surcharge of 250 psf can be used to account for the active roadway loads and any typical construction loads that may be present between the edge of the excavation and the roadway. These loads should be applied to the braced excavation in addition to the apparent pressures and to the permanent structure in addition to the long-term static and long-term seismic pressures.

A uniform vertical surcharge will produce a non-uniform horizontal pressure on the wall. For simplification, the horizontal pressure was converted to uniform pressures applied on the wall, such that the same moment is imposed on the base of the wall from the non-uniform pressures and the equivalent uniform pressures. The recommended surcharge pressures are shown on Figure 24.

9.4 Excavatability

In order to reach final grade, approximately 26,000 yd^3 of rock will need to be excavated for the Southbound Battery Tunnel. Much of the rock to be excavated is rippable to marginally rippable sandstone and rippable Mélange Matrix and serpentinite (additional comments regarding the excavation of serpentine are presented in Section 9.5). However, it should be anticipated that there will be blocks of moderately hard to hard, moderately fractured sandstone that must be excavated, particularly in the vicinity of borehole BTSB-R3-PZ-D.

Mechanical means beyond ripping may be required to excavate the moderately hard to hard, moderately fractured sandstone, such as controlled blasting, use of a hoe-ram, or one of several low-vibration techniques.

Controlled blasting may be the most cost-effective, but will generate potentially large vibrations and noise that will need to be monitored. Use of a hoe-ram produces lower vibrations and noises, but, over a longer period of time compared to the short blast durations of controlled blasting. There are several low-vibration techniques available such as expansive grout or plasma rock splitting, but they may be more expensive than controlled blasting or hoe-ramming. Also, these methods may require closer spaced drillholes than controlled blasting.

Potential vibrations and noise associated with the chosen excavation technique must be carefully considered because construction will be taking place in the sensitive environment of a National Park.

Figure 25 shows empirical correlations of excavatability with compression wave velocity and point load strength. Measurements of compression wave velocities can be affected by the presence of groundwater. Compression waves travel through water at a speed of approximately 6,000 ft/sec creating a lower bound of the measurements. Rock with compression wave velocities less than 6,000 ft/sec may not be detected. Additionally plots of RQD are shown on Figures 4 through 9 and also on the LOTBs. Laboratory test results that can be used to further evaluate the excavatability of the rock, such as Uniaxial Compression Tests, Indirect Tensile (Brazillian) Tests, Punch Penetration Tests, and Cerchar Abrasivity Tests are presented in Appendix B.

9.5 Excavation of Serpentinite

Excavation to the final grade for the Southbound Tunnel may require excavation of serpentinite bedrock. The predominate bedrock anticipated within the excavation for the Southbound Tunnel is sandstone, however, serpentinite is present in the area and it is likely that serpentinite will be encountered during the excavation. We estimate that approximately 6,000 cubic yards of serpentinite will need to be excavated. Serpentinite may contain naturally occurring asbestos, which presents a potential health concern. Testing to determine the presence of asbestos has indicated that the serpentinite contains elevated levels of asbestos and Nickel and will be considered California Hazardous Waste. Proper procedures must be followed as detailed in the Design Documents.

For further information, please contact Mr. Ray Boyer, District Branch Chief – Hazardous Waste, Office of Environmental Engineering, Division of Environmental Planning & Engineering, Caltrans – District 04, at 510.286.5668.

9.6 Groundwater Control

Groundwater control consists of two phases: construction dewatering and a long-term water management plan.

9.6.1 Construction Dewatering

The invert of the Southbound Tunnel will be constructed from 30 to 43 feet below the existing grade. Groundwater conditions will be encountered during excavation that will require construction dewatering to facilitate the installation of the solider pile and lagging walls. If construction dewatering is not performed, a blowout of the soils could occur during installation of the lagging. A blowout occurs when water flows through a gap in the wall such as after excavation, but prior to installation of lagging, and carries soil with it, creating a void behind the wall. A system of well-points installed south of Retaining Wall A is anticipated to be adequate to drawdown perched water flowing on top of the bedrock so that the wall lagging can be installed. Sumps and pumps are anticipated to be adequate to drawdown the water level during excavation of the tunnel after the shoring is constructed.

After installation of the temporary retaining walls a drainage panel will be installed on the face of the solider pile and lagging walls. The drainage panel will collect water in a pipe at the base of the south wall. The water will be conveyed below the tunnel in a sub-drain system to the north side of the excavation. The sub-drain system will consist of perforated High Density Polyethylene (HDPE) pipes encased in Class 1, Type B Permeable Material (as per Caltrans Standard Specification Section 68-1.025) and wrapped in a geotextile. The 1-foot high by 4-foot wide sub-drains will be installed transverse to the alignment at 24-foot

center to center spacing. Groundwater collected from the drainage panel and sub-drains will temporarily be collected in an outlet pipe aligned along the north side of the Southbound Battery Tunnel excavation, at the base of Retaining Wall B. The collected water can be temporarily discharged to the San Francisco Public Utility Commission sewer system or re-applied to the Battery Bluff through a drip system. Pre-treatment of construction dewatering may be required before the collected water can be discharged to the sewer system or re-applied to the bluff.

9.6.2 Long-Term Groundwater Management Plan

A small wetlands area exists at the base of the bluff, offset approximately 300 feet from the Southbound Tunnel alignment, extending from approximate Station 77+00 to Station 82+00. A large effort was undertaken to understand the groundwater regime in the bluff area, particularly with respect to the wetlands. The effort included a monitoring program by BASELINE, as well as acoustic televiewer tests and oriented rock coring during this investigation in order to determine the flow path of the groundwater.

Televiewer tests and oriented coring were performed in an attempt to determine if a there was a repeatable joint orientation that may act as a flow path for the groundwater through the bedrock from the hillside south of the Battery Tunnels to the wetlands at the base of the bluff to the north. The results of the acoustic televiewer tests and the oriented rock coring are compared on Figure 26. The results indicate that the fractures are randomly oriented and that the bedrock is highly fractured and sheared and as a result many groundwater flow paths are present. Fracture frequency typically ranged from very intensely fractured to moderately fractured. Because of the pervasive fracturing, distinct joint sets could not be determined during the field investigation.

Because of the highly fractured nature of the bedrock, the long-term groundwater management plan conveys the groundwater from the south side of the tunnel structures to the north side and allows it to percolate back into fractured rock and reach the wetlands in a manner similar to the existing, pre-construction condition. This long-term groundwater management plan will also provide a pressure relief system below the tunnel structures to prevent unfavorable hydrostatic uplift pressures from occurring.

The transverse perforated pipe installed for the construction dewatering phase will be connected to the drainage of the Northbound Tunnel and will become part of the long-term groundwater management plan. The groundwater will be collected from the drainage panels and conveyed through the sub-drain system and delivered to a series of “drywells” on the north side of the tunnels which will allow the water to percolate back into the ground. The final design of the long-term groundwater management plan will be incorporated into the design of the Northbound Tunnel.

9.7 Seepage

The bottom of the excavation is anticipated to extend below the initial groundwater level. Analyses were performed by the Department to estimate the flow rate of groundwater into the excavation. The analyses were based on the results of the Packer Tests presented in Section 2.5 in the rock units and slug tests performed in the Colma Sand and presented in the Final Report Aquifer Testing by BASELINE Environmental Consulting.

The analyses indicate that groundwater may flow into the excavation through the Colma Sand and rock at an average rate of 2 gallons/day/ft^2 of excavation surface area below the initial groundwater level.

The analysis was based on the procedure presented in the Federal Highway Administration (1990) publication.

The seepage analyses do not address the storativity of the groundwater.

9.8 Soil to Rock Bearing Transition

At approximately Station 78+50 the tunnel will transition from bearing on Colma Sand to bearing on sandstone. This transition represents an abrupt change in the stiffness of the bearing strata and as such may affect the performance of the tunnel, particularly during an earthquake event. In order to "soften" this transition, a two-foot-thick granular mat should be constructed below the tunnel structure. The granular mat should consist of 3/4–inch maximum, Class 2 Aggregate Base (as per Caltrans Standard Specification Section 26-1.02A) compacted in accordance with Caltrans standard specification. The tunnel response to this transition will also be modeled with the Soil-Structure Interaction software SASSI.

9.9 Stability at West Portal

At the West Portal, the existing slope will be cut and re-graded around the portal structure as part of the landscaping. The proposed slope was evaluated for static and dynamic (pseudo-static) stability. As currently detailed, the re-graded slope should not pose a stability concern. Figure 27 shows the results of the stability analyses for the two steepest sections of the re-grading. Additionally, the West Portal will be founded on sandstone and is not susceptible to being undermined by a slope failure. The analyses are presented in Appendix F.9.

9.10 Light Pole Foundations

Six light pole will be installed over the Southbound Battery Tunnel. Wherever possible, the light pole will be supported using the Caltrans standard detail consisting of a 5-foot-long, 30-inch-diameter CIDH pile. However, in some areas above the Southbound Battery Tunnel, there is less than 5 feet of soil cover over the tunnel structure. In these locations, the light pole will be supported on shallow spread footings. The spread footings will be 6 feet by 6 feet square.

In order to provide sufficient resistance to sliding forces and overturning moments, the CIDH piles and spread footings should be surrounded by at least 7 feet of structure backfill, from the centerline of the light pole. Where it is necessary for other reasons, lightweight fill may be used in lieu of the structure backfill. Additionally, any topsoil should be limited to a maximum of 6 inches thick within this 7-foot zone.

The analyses are presented in Appendix F.10.

10 Conclusion

Any questions regarding the above recommendations should be directed to the attention of Francis R. Greguras at 415-946-0255 or Terrence Carroll at 415-946-1659.

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TABLES

TABLE 1 SUMMARY OF SURVEYED BOREHOLE LOCATIONS			
Borehole ID	**Northing**	**Easting**	**Elevation**
34-0157NB-A1-PZ	2120509.438	5993931.703	80.911
34-0157SB-A1	**2120481.342**	**5993926.250**	**81.209**
BTNB-R1	2120470.078	5994297.737	91.378
BTNB-R2	2120407.628	5994505.431	89.420
BTNB-R3	2120351.985	5994725.980	86.286
BTNB-R4-PZ	2120366.979	5994998.299	70.422
BTNB-R5A-PZ-S	2120582.620	5994169.980	79.370
BTNB-R5-PZ-D	2120581.324	5994178.193	79.635
BTNB-R6A-PZ-S	2120558.479	5994527.552	83.531
BTNB-R6-PZ-D	2120559.949	5994521.542	83.591
BTNB-R7A-PZ-S	2120461.975	5994829.468	78.961
BTNB-R7-PZ-D	2120459.851	5994825.735	79.353
BTSB-R1-PZ	**2120323.729**	**5994396.263**	**101.030**
BTSB-R2	**2120218.262**	**5994858.344**	**92.121**
BTSB-R3A-PZ-S	**2120227.544**	**5994550.875**	**98.049**
BTSB-R3-PZ-D	**2120225.975**	**5994556.115**	**97.900**
M-9/RW7-A1A	2120378.671	5995179.887	17.928
M-10	2120511.047	5995523.129	11.908
M-11	2120559.565	5995764.236	12.472
RW5-R1	2120520.291	5994131.737	93.094
RW6-R1-PZ	**2120380.700**	**5994104.938**	**108.507**
RW6-R2A-PZ-S	**2120266.257**	**5993963.449**	**108.315**
RW6-R2-PZ-D	**2120270.083**	**5993967.843**	**108.659**
RW8-R1A-PZ	**2120200.018**	**5995013.992**	**90.063**
RW8-R1-PZ	**2120199.669**	**5995008.466**	**90.616**
RW8-R2	2120192.938	5995167.458	82.348
HA-1-PZ	2120752.489	5994220.945	27.802
HA-2-PZ	2120690.897	5994579.932	25.348
HA-3-PZ	2120613.038	5994884.724	22.315

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel. All collected data is presented for completeness.

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TABLE 2
SUMMARY OF LABORATORY TEST RESULTS ON SOIL

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)	Type of Test	Normal or Confining Stress (psf)	Shear Strength[1] (psf)	Friction Angle at 10% Strain[2] (degrees)	Over Consolidation Ratio, OCR	Compression/ Recompression Ratio, CR/RR
BTNB-R3	11.6	74.7	Sandy Clay	18.9	130.0	41	17	24	0.08	109.4							
BTNB-R3	18.3	68.0	Colma Sand	18.2													
BTNB-R3	31.7	54.6	Colma Sand	23.1	125.6					102.1	12.6						
BTNB-R4-PZ	8.3	62.2	Sandy Clay	13.7	130.7	32	16	16	-0.14	114.9	81.1						
BTNB-R4-PZ	13.4	57.1	Sandy Silt	14.1	136.8					119.8	54.4						
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.5	131.9					110.4	14.3	DS	2,700	2,640			
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.4	129.0					108.0		DS	3,300	3,336			
BTNB-R4-PZ	23.5	47.0	Colma Sand	18.8	127.8					107.6		DS	4,000	4,020			
BTNB-R4-PZ	33.1	37.4	Colma Sand	20.1	132.9					110.7	9.5						
BTNB-R4-PZ	48.1	22.4	Colma Sand	21.2	134.2					110.8	14.2						
BTNB-R6-PZ-D	8.2	75.4	Fill	14.7	124.3					108.3	9.5						
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	34	17	17	0.21	107.3		TXUU	2,250	2,442			
BTNB-R6-PZ-D	18.3	65.3	Sandy Silt	18.0	134.0					113.5	59.1						
BTNB-R6-PZ-D	23.6	60.0	Colma Sand	15.7	136.3					117.8	17.9						
BTNB-R6-PZ-D	27.6	56.0	Colma Sand	14.9	124.4					108.3	10.9	TXICU	4,650		39.0		
BTNB-R7A-PZ-S	9.8	69.2	Buried Soil Horizon	20.4		30	15	15	0.36								
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1					107.7	52.5	TXUU	3,100	1,240			
BTNB-R7A-PZ-S	19.8	59.2	Sandy Clay	23.6		30	14	16	0.60								
BTNB-R7A-PZ-S	23.1	55.9	Colma Sand	19.9	133.6					111.5	17.6						
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand	20.9	132.1					109.3	18.2	TXICU	5,800		38.4		
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	23	15	8	0.23	115.1		TXUU	2,250	1,740			
BTSB-R1-PZ	**13.3**	**87.8**	**Fill**	**15.0**	**121.7**					**105.8**	**3.3**						
BTSB-R1-PZ	**22.8**	**78.3**	**Fill**	**26.4**	**127.0**					**100.5**	**2.1**	**DS**	**2,650**	**2,208**			
BTSB-R1-PZ	**22.8**	**78.3**	**Fill**	**25.3**	**126.2**					**100.7**		**DS**	**3,300**	**2,508**			
BTSB-R1-PZ	**22.8**	**78.3**	**Fill**	**30.8**	**125.4**					**95.9**		**DS**	**4,000**	**3,012**			
BTSB-R1-PZ	**27.5**	**73.5**	**Sandy Clay**	**22.0**	**129.9**					**106.5**		**TXUU**	**5,200**	**1,480**			
BTSB-R1-PZ	**28.8**	**72.3**	**Sandy Clay**	**22.8**	**123.5**					**100.6**						**4.1**	**0.124/ 0.006**
BTSB-R1-PZ	**28.8**	**72.3**	**Sandy Clay**			**37**	**16**	**21**									
BTSB-R1-PZ	**28.8**	**72.3**	**Sandy Clay**			**39**	**18**	**21**									
BTSB-R2	**3.3**	**88.9**	**Fill**	**5.3**	**118.8**					**112.9**							
BTSB-R2	**12.8**	**79.3**	**Sandy Clay**	**22.5**	**128.2**	**38**	**18**	**20**	**0.23**	**104.6**		**TXUU**	**2,250**	**1,854**			
BTSB-R2	**17.8**	**74.3**	**Colma Sand**	**19.1**	**135.8**					**114.0**	**48.3**	**TXUU**	**3,100**	**1,854**			
BTSB-R2	**28.3**	**63.9**	**Colma Sand**	**21.8**	**130.1**					**106.8**	**11.4**	**DS**	**3,200**	**3,120**			
BTSB-R2	**28.3**	**63.9**	**Colma Sand**	**20.7**	**129.9**					**107.6**		**DS**	**4,000**	**3,744**			
BTSB-R2	**28.3**	**63.9**	**Colma Sand**	**20.6**	**130.0**					**107.8**		**DS**	**4,800**	**4,404**			
BTSB-R2	**33.6**	**58.6**	**Colma Sand**	**21.2**	**128.5**					**106.0**	**13.0**	**TXICU**	**5,700**		**34.6**		

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TABLE 2
SUMMARY OF LABORATORY TEST RESULTS ON SOIL

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines	Type of Test	Normal or Confining Stress	Shear Strength[1]	Friction Angle at 10% Strain[2]	Over Consolidation Ratio, OCR	Compression/ Recompression Ratio, CR/RR
BTSB-R2	**37.8**	**54.3**	**Sandy Clay**	**20.7**	**130.4**	**30**	**17**	**13**	**0.28**	**108.1**		**TXUU**	**6,550**	**2,296**			
BTSB-R2	**38.3**	**53.8**	**Sandy Clay**	**22.3**	**127.6**	**45**	**21**	**24**	**0.05**	**104.3**		**TXUU**	**6,550**	**3,675**			
BTSB-R2	**42.8**	**49.3**	**Sandy Clay**	**19.4**	**132.4**	**40**	**20**	**20**	**-0.03**	**110.9**		**TXUU**	**7,400**	**6,274**			
BTSB-R3A-PZ-S	**3.1**	**95.0**	**Fill**	**6.7**	**115.6**					**108.4**	**1.8**						
BTSB-R3A-PZ-S	**9.3**	**88.8**	**Fill**	**9.2**	**109.1**					**99.9**	**1.4**	**DS**	**1,000**	**936**			
BTSB-R3A-PZ-S	**9.3**	**88.8**	**Fill**	**10.4**	**112.9**					**102.3**		**DS**	**1,300**	**1,044**			
BTSB-R3A-PZ-S	**9.3**	**88.8**	**Fill**	**9.3**	**109.7**					**100.4**		**DS**	**1,600**	**1,500**			
BTSB-R3A-PZ-S	**12.8**	**85.2**	**Buried Soil Horizon**	**18.6**	**131.8**	**23**	**16**	**7**	**0.37**	**111.2**		**TXUU**	**2,250**	**775**			
M-9/RW7-A1A	6.3	11.7	Hydraulic Fill	39.7	113.5					81.3	31.2						
M-9/RW7-A1A	12.8	5.2	Hydraulic Fill	22.0							25.5	DS	1,275	1,152			
M-9/RW7-A1A	17.3	0.7	Marine Sand	24.8							45.5	DS	1,600	1,248			
M-9/RW7-A1A	26.1	-8.1	Colluvium								50.9	DS	1,900	1,452			
M-9/RW7-A1A	30.8	-12.8	Colluvium								58.4						
M-9/RW7-A1A	35.3	-17.3	Colluvium								24.1						
M-10	4.8	7.2	Hydraulic Fill	22.7							4.6	DS	2,800	2,112			
M-10	10.8	1.2	Hydraulic Fill	28.3	121.4					94.6	4.2						
M-10	10.8	1.2	Hydraulic Fill	26.5	123.1					97.3							
M-10	10.8	1.2	Hydraulic Fill	27.2	124.5					97.9							
M-10	14.6	-2.6	Colma Sand	19.3	133.9					112.2							
M-10	24.6	-12.6	Colma Sand	23.7	130.6					105.5	7.6						
M-10	41.3	-29.3	Colma Sand	20.6							15.3						
M-11	16.1	-3.6	Hydraulic Fill	23.9	129.4					104.4	1.4						
M-11	16.1	-3.6	Hydraulic Fill	26.6	130.3					102.9							
M-11	16.1	-3.6	Hydraulic Fill	24.9	127.9					102.4							
M-11	21.2	-8.7	Hydraulic Fill	19.6	132.2					110.6	2.8						
RW5-R1	3.3	89.8	Colma Sand	13.8	134.0					117.7	49.9						
RW6-R1-PZ	**3.1**	**105.5**	**Fill**	**15.4**	**124.3**					**107.7**	**49.5**						
RW6-R1-PZ	**7.9**	**100.7**	**Sandy Clay**	**15.7**		**28**	**15**	**13**	**0.05**		**75.6**						
RW6-R1-PZ	**12.9**	**95.7**	**Colma Sand**	**16.6**	**128.7**					**110.4**	**21.5**	**DS**	**1,000**	**1,236**			
RW6-R1-PZ	**12.9**	**95.7**	**Colma Sand**	**16.8**	**127.2**					**108.9**		**DS**	**1,200**	**1,320**			
RW6-R1-PZ	**12.9**	**95.7**	**Colma Sand**	**16.3**	**129.1**					**111.0**		**DS**	**1,400**	**1,764**			
RW6-R1-PZ	**17.3**	**91.3**	**Colma Sand**	**21.2**	**131.1**					**108.2**	**27.4**	**DS**	**2,000**	**1,884**			
RW6-R1-PZ	**17.3**	**91.3**	**Colma Sand**	**22.1**	**131.0**					**107.3**		**DS**	**2,500**	**2,100**			
RW6-R1-PZ	**17.3**	**91.3**	**Colma Sand**	**18.7**	**134.1**					**113.0**		**DS**	**3,000**	**2,652**			
RW6-R2A-PZ-S	**3.8**	**104.6**	**Fill**	**4.5**	**104.2**					**99.7**	**4.5**						
RW6-R2A-PZ-S	**8.1**	**100.3**	**Fill**	**24.3**	**126.3**					**101.6**	**2.7**	**DS**	**1,000**	**972**			
RW6-R2A-PZ-S	**8.1**	**100.3**	**Fill**	**21.7**	**131.2**					**107.8**		**DS**	**1,200**	**1,092**			

TABLE 2
SUMMARY OF LABORATORY TEST RESULTS ON SOIL

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines	Type of Test	Normal or Confining Stress	Shear Strength[1]	Friction Angle at 10% Strain[2]	Over Consolidation Ratio, OCR	Compression/ Recompression Ratio, CR/RR
RW6-R2A-PZ-S	**8.1**	**100.3**	**Fill**	**18.2**	**124.7**					**105.5**		**DS**	**1,400**	**1,200**			
RW6-R2A-PZ-S	**18.6**	**89.8**	**Colma Sand**	**13.2**	**129.6**					**114.5**	**16.4**						
RW6-R2-PZ-D	**31.0**	**77.7**	**Sandstone**		**160.5**												
RW8-R1-PZ	**8.8**	**81.9**	**Fill**	**9.6**	**109.0**					**99.5**							
RW8-R1-PZ	**13.3**	**77.4**	**Sandy Clay**	**22.4**	**127.3**	**24**	**17**	**7**	**0.77**	**104.0**	**83.4**						
RW8-R1-PZ	**18.8**	**71.9**	**Sandy Clay**	**19.0**	**131.3**	**29**	**19**	**10**	**-0.004**	**110.4**							
RW8-R1-PZ	**23.1**	**67.5**	**Sandy Clay**	**19.6**	**126.4**	**25**	**13**	**12**	**0.55**	**105.7**	**60.1**	**TXUU**	**4,200**	**1,457**		**4.7**	**0.126/0.007**
RW8-R1-PZ	**24.4**	**66.2**	**Colma Sand**	**18.2**	**131.0**	**23**	**16**	**7**	**0.31**	**110.8**	**47.2**	**TXICU**	**4,650**		**34.6**		
RW8-R1-PZ	**29.8**	**60.9**	**Colma Sand**	**15.3**							**20.4**						
RW8-R1-PZ	**33.3**	**57.4**	**Colma Sand**	**19.6**	**130.3**					**108.9**	**21.3**	**DS**	**4,150**	**3,852**			
RW8-R1-PZ	**33.3**	**57.4**	**Colma Sand**	**20.0**	**130.3**					**108.6**		**DS**	**5,200**	**4,476**			
RW8-R1-PZ	**33.3**	**57.4**	**Colma Sand**	**19.5**	**133.2**					**111.5**		**DS**	**6,225**	**5,124**			
RW8-R1-PZ	**43.3**	**47.4**	**Sandy Clay**	**23.1**	**126.9**	**29**	**16**	**13**	**0.55**	**103.1**		**TXUU**	**8,175**	**1,282**			
RW8-R1-PZ	**43.8**	**46.9**	**Sandy Clay**	**21.1**	**124.0**	**29**	**18**	**11**	**0.28**	**102.4**						**0.8**	**0.094/0.007**

[1]Shear strength values represent peak or undrained shear strength
[2]Friction angle at 10% strain calculated assuming c = 0

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

TABLE 3
SUMMARY OF LABORATORY TEST RESULTS ON ROCK

Borehole ID	Depth (ft)	Elevation (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)	Type of Test	Confining Stress (psf)	Shear Strength (psf)	Compressive Strength (psi)	Other Tests
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	22	15	7	-0.67	135.6		TXUU	9,500	935		
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	Non-Plastic	Non-Plastic	Non-Plastic		119.7		TXUU	10,500	729		
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.2												Slake Durability Index = 94.2
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.03												Slake Durability Index = 65.2
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	Non-Plastic	Non-Plastic	Non-Plastic		118.6		TXUU	16,000	832		
BTNB-R4-PZ	96.48	-26.1	Serpentinite		142.4										1,280	
BTNB-R5A-PZ-S	25.1	54.3	Sandstone		167.5											Splitting Tensile Strength = 690 psi
BTNB-R5A-PZ-S	25.1	54.3	Sandstone													Cerchar Abrasivity Index = 1.2
BTNB-R5A-PZ-S	25.45	53.9	Sandstone		165.6										9,800	
BTNB-R5-PZ-D	54.5	25.1	Mélange Matrix	9.3	158.6	27	16	11	-0.61	145.1						
BTNB-R5-PZ-D	88.35	-8.7	Sandstone		163.8										8,810	
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8					73.1	31.8	TXUU	4,850	1,487		
BTNB-R6-PZ-D	47.7	35.9	Serpentinite		132.1										400	
BTNB-R6-PZ-D	83.8	-0.2	Serpentinite		151.1										3,650	
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	39	33	6	-3.02	122.2		TXUU	17,000	875		
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	30	28	2	-6.60	122.2		TXUU	16,000	570		
BTSB-R1-PZ	**36.25**	**64.8**	**Sandstone**		**164.6**										**10,840**	
BTSB-R1-PZ	**36.625**	**64.4**	**Sandstone**		**165.3**											**Splitting Tensile Strength = 610 psi**
BTSB-R1-PZ	**45.175**	**55.9**	**Sandstone, Shale**		**166.4**										**12,610**	
BTSB-R3A-PZ-S	**17.8**	**80.2**	**Sandstone**	**10.5**	**142.2**					**128.7**	**33.1**	**TXUU**	**3,100**	**2,561**		
BTSB-R3-PZ-D	**24.775**	**73.1**	**Sandstone**													**Cerchar Abrasivity Index = 1.0**
BTSB-R3-PZ-D	**25.075**	**72.8**	**Sandstone**		**158.2**										**4,870**	
BTSB-R3-PZ-D	**25.45**	**72.5**	**Sandstone**													**Peak Slope (Punch Test) = 61 kips/in**
BTSB-R3-PZ-D	**30.2**	**67.7**	**Sandstone**		**159.5**										**3,350**	
BTSB-R3-PZ-D	**44.45**	**53.5**	**Sandstone**		**161.3**										**9,430**	
BTSB-R3-PZ-D	**44.85**	**53.1**	**Sandstone**		**166.7**											**Splitting Tensile Strength = 790 psi**
BTSB-R3-PZ-D	**50.4**	**47.5**	**Sandstone**		**164.9**										**16,800**	
BTSB-R3-PZ-D	**81.65**	**16.3**	**Sandstone**		**166.2**										**3,510**	
M-9/RW7-A1A	41.1	-23.1	Serpentinite			44	23	21								
M-9/RW7-A1A	46.925	-29.0	Gabbro		162.9										7,850	
M-9/RW7-A1A	47.275	-29.3	Gabbro		160											Splitting Tensile Strength = 630 psi
RW6-R1-PZ	**26.575**	**81.9**	**Sandstone**													**Cerchar Abrasivity Index = 0.4**
RW6-R1-PZ	**26.9**	**81.6**	**Sandstone**		**152.6**										**3,090**	
RW6-R1-PZ	**45.325**	**63.2**	**Sandstone**		**163.4**										**14,480**	
RW6-R1-PZ	**49.85**	**58.7**	**Sandstone**		**166.5**											**Splitting Tensile Strength = 1,090 psi**
RW6-R2-PZ-D	**30.95**	**77.7**	**Sandstone**		**160.5**										**3,770**	
RW8-R1-PZ	**76.475**	**14.1**	**Serpentinite**	**7.69**												**Slake Durability Index = 61.8**
RW8-R1-PZ	**121.9**	**-31.3**	**Serpentinite**		**150.5**										**1,770**	

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

TABLE 4 SUMMARY OF ACOUSTIC TELEVIEWER TEST RESULTS		
Borehole ID	**Dip Azimuth**	**Mean Dip**
BTNB-R5-PZ-D	147	51
	71	54
	220	39
	290	47
BTNB-R7-PZ-D	252	15
	22	32
	181	57
BTSB-R3-PZ-D	**209**	**38**
	323	**31**
	324	**65**
	4	**64**
	93	**46**
RW6-R1-PZ	**286**	**65**
	154	**64**
	87	**50**
RW6-R2-PZ-D	**221**	**75**
	249	**79**
	315	**74**
	284	**41**
	358	**34**
	76	**62**
	117	**47**

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel. All collected data is presented for completeness.

TABLE 5 SUMMARY OF ORIENTED ROCK CORING RESULTS		
Borehole ID	**Dip Azimuth**	**Mean Dip**
BTNB-R5-PZ-D	186	55
	255	44
	36	53
	336	17
BTNB-R6-PZ-D	299	29
	208	25
BTNB-R7-PZ-D	128	52
	209	29
	320	40
	358	12
BTSB-R3-PZ-D	**1**	**38**
	270	**79**
	172	**50**
	107	**37**
RW6-R2-PZ-D	**120**	**44**
	38	**53**
	217	**89**
	349	**25**
	244	**22**

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel. All collected data is presented for completeness.

TABLE 6
SUMMARY OF PACKER TEST RESULTS

Borehole ID	Depth Interval (ft)	Elevation Interval (NAVD88) (ft)	Rock Type(s)	Hydraulic Conductivity	
				Royle [1] (cm/s)	Bureau of Reclamation [2] (cm/s)
BTNB-R4-PZ	55 to 66	15 to 26	Serpentinite	1.31E-07	1.37E-07
	63 to 74	7 to 18	Serpentinite	1.15E-06	1.05E-06
	73 to 84	-3 to 8.4	Serpentinite	2.06E-04	2.15E-04
	83 to 94	-13 to -1.6	Serpentinite	1.50E-04	1.62E-04
BTNB-R5-PZ-D	89 to 100	-9 to 1.6	Sandstone	2.05E-04	2.14E-04
	99 to 110	-19 to -8.4	Sandstone	1.66E-04	1.73E-04
BTNB-R7-PZ-D	53 to 64	26 to 37	Greenstone	4.84E-04	3.87E-04
	67 to 78	12 to 23	Greenstone	8.30E-05	8.64E-05
	77 to 88	2 to 13	Greenstone, Gabbro	8.23E-06	8.58E-06
	87 to 98	-8 to 3.4	Gabbro, Serpentinite	6.04E-05	6.29E-05
BTSB-R3-PZ-D	**24 to 35**	**74 to 85**	**Sandstone**	**No Take**	**No Take**
	35 to 46	**63 to 74**	**Sandstone**	**8.36E-05**	**8.71E-05**
	46 to 57	**52 to 63**	**Sandstone**	**1.56E-04**	**1.63E-04**
	57 to 68	**41 to 52**	**Sandstone**	**4.61E-04**	**4.79E-04**
	68 to 79	**30 to 41**	**Sandstone, Shale**	**2.71E-05**	**2.83E-05**
	82 to 93	**16 to 27**	**Sandstone, Shale**	**9.49E-06**	**9.89E-06**
RW6-R1-PZ	**30 to 41**	**79 to 90**	**Sandstone**	**1.17E-05**	**1.21E-05**
	40 to 51	**69 to 80**	**Sandstone**	**9.27E-04**	**9.98E-04**
RW6-R2-PZ-D	**32 to 43**	**77 to 88**	**Sandstone**	**2.31E-04**	**2.42E-04**
	41 to 52	**68 to 79**	**Sandstone**	**2.99E-04**	**3.12E-04**
	54 to 65	**55 to 66**	**Sandstone**	**7.16E-06**	**7.46E-06**
	65 to 76	**44 to 55**	**Sandstone**	**9.47E-06**	**9.86E-06**
	76 to 87	**33 to 44**	**Sandstone**	**2.98E-06**	**3.11E-06**
	87 to 98	**22 to 33**	**Sandstone, Shale**	**2.85E-06**	**3.00E-06**

[1] Royle, Michael (October, 2006) Standard Operating Procedures for Borehole Packer Testing, SRK Consulting
[2] United States Department of the Interior, Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes, USBR 7310-89

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

TABLE 7
SUMMARY OF WELL DEVELOPMENT DATA

Piezometer ID	Installed By	Date of Installation	Northing (ft)	Easting (ft)	Elevation (NAVD88) (ft)	Slotted Interval Depth (ft)	Sand Interval Depth (ft)	Date of Development	Time Start	Time Completed	Duration of Development (min)	Initial Water Depth from Ground Surface (ft)	Pumped (Y/N)	Surged (Y/N)	Pumping Rate (gpm)	Average Water Depth from Ground Surface During Pumping (ft)	Water Collected (gal)	Water Quality at Last Reading				Remarks
																		pH	Electrical Conductivity (mS/cm)	Turbidity (NTU)	Temperature (°C)	
34-0157NB-A1-PZ	Caltrans	2/26/2008	2120509.438	5993931.703	80.911	15.0 to 25.0	14.0 to 25.0	6/11/2008	14:05	14:40	35	Dry	N	N	N/A	N/A	0.5	N/A	N/A	N/A	N/A	1.5" diameter well
BTNB-R4-PZ	Pitcher Drilling	2/18/2008	2120366.979	5994998.299	70.422	49.5 to 69.5	47.0 to 69.5	6/9/2008	15:55	18:19	144	25.15	Y	Y	1 to 0.5	Varied	50	6.99	0.456	5	17.4	Well pumped dry. Pumping continued after allowing it to recharge.
BTNB-R5A-PZ-S	Pitcher Drilling	4/11/2008	2120582.620	5994169.980	79.370	15.0 to 35.0	14.0 to 36.0	6/13/2008	10:05	11:55	110	3.07	Y	Y	1.0	5.17	55	7.31	1.03	-5	15.2	
BTNB-R5-PZ-D	Pitcher Drilling	4/10/2008	2120581.324	5994178.193	79.635	78.0 to 98.0	77.0 to 99.0	6/13/2008	7:40	10:00	140	53.84	Y	Y	1.0	Not Measured	75	7.31	1.01	-5	15.2	Unable to measure water level during pumping because well is inclined.
BTNB-R6A-PZ-S	Pitcher Drilling	3/27/2008	2120558.479	5994527.552	83.531	17.0 to 32.0	15.0 to 32.0	6/13/2008	14:25	15:30	65	27.46	N	N	N/A	N/A	2	N/A	N/A	N/A	N/A	After bailing, well was dry and did not recharge.
BTNB-R6-PZ-D	Pitcher Drilling	3/28/2008	2120559.949	5994521.542	83.591	60.0 to 80.0	58.5 to 80.5	6/13/2008	12:05	14:10	125	26.78	Y	Y	1.0	Not Measured	91	8.27	6.97	10	16.5	Unable to measure water level during pumping because well is inclined.
BTNB-R7A-PZ-S	Pitcher Drilling	4/1/2008	2120461.975	5994829.468	78.961	28.5 to 43.5	26.5 to 43.5	6/10/2008	8:20	10:25	125	28.45	Y	Y	0.5	Not Measured	25	6.60	0.586	1	18.7	
BTNB-R7-PZ-D	Pitcher Drilling	4/3/2008	2120459.851	5994825.735	79.353	50.0 to 70.0	47.0 to 70.0	6/10/2008	10:30	15:50	320	11.84	Y	Y	0.5	Not Measured	100	8.51	0.687	140	19.7	Unable to measure water level during pumping because well is inclined.
BTSB-R1-PZ	**Pitcher Drilling**	**1/23/2008**	**2120323.729**	**5994396.263**	**101.030**	**23.5 to 33.5**	**21.5 to 33.5**	**6/12/2008**	**8:25**	**10:45**	**140**	**18.48**	**Y**	**Y**	**<0.01**	**Varied**	**26**	**6.89**	**0.599**	**94**	**20.7**	**Well pumped dry. Pumping continued after allowing it to recharge.**
BTSB-R3A-PZ-S	**Pitcher Drilling**	**4/23/2008**	**2120227.544**	**5994550.875**	**98.049**	**9.0 to 18.0**	**7.0 to 19.3**	**6/12/2008**	**11:00**	**11:35**	**35**	**15.00**	**N**	**N**	**N/A**	**N/A**	**1**	**N/A**	**N/A**	**N/A**	**N/A**	**After bailing, well was dry and did not recharge.**
BTSB-R3-PZ-D	**Pitcher Drilling**	**4/23/2008**	**2120225.975**	**5994556.115**	**97.900**	**50.0 to 70.0**	**48.5 to 71.0**	**6/12/2008**	**11:45**	**14:55**	**190**	**11.85**	**Y**	**Y**	**1.0**	**33.30**	**100**	**7.19**	**0.617**	**10**	**19.1**	
RW6-R1-PZ	**Pitcher Drilling**	**2/28/2008**	**2120380.700**	**5994104.938**	**108.507**	**12.0 to 22.0**	**10.0 to 22.0**	**6/9/2008**	**9:00**	**9:45**	**45**	**19.87**	**N**	**N**	**N/A**	**N/A**	**0.25**	**N/A**	**N/A**	**N/A**	**N/A**	**After bailing, well was dry and did not recharge.**
RW6-R2A-PZ-S	**Pitcher Drilling**	**4/17/2008**	**2120266.257**	**5993963.449**	**108.315**	**12.0 to 29.0**	**13.0 to 28.0**	**6/9/2008**	**9:50**	**10:15**	**25**	**Dry**	**N**	**N**	**N/A**	**N/A**	**0.25**	**N/A**	**N/A**	**N/A**	**N/A**	**Well was dry prior to bailing.**
RW6-R2-PZ-D	**Pitcher Drilling**	**4/17/2008**	**2120270.083**	**5993967.843**	**108.659**	**76.0 to 98.0**	**77.0 to 97.0**	**6/9/2008**	**10:20**	**15:05**	**285**	**41.70**	**Y**	**Y**	**1**	**Varied**	**94**	**7.35**	**1.37**	**209**	**17.9**	**Well pumped dry. Pumping continued after allowing it to recharge.**
RW8-R1-PZ	**Pitcher Drilling**	**1/17/2008**	**2120199.669**	**5995008.466**	**90.616**	**25.0 to 45.0**	**20.0 to 46.0**	**6/11/2008**	**12:30**	**13:30**	**60**	**39.45**	**N**	**Y**	**N/A**	**N/A**	**5**	**N/A**	**N/A**	**N/A**	**N/A**	

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

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TABLE 8
SUMMARY OF GROUNDWATER MONITORING RESULTS

Borehole ID	34-0157NB-A1-PZ	BTNB-R4-PZ	BTNB-R5-PZ-D	BTNB-R5A-PZ-S	BTNB-R6-PZ-D	BTNB-R6A-PZ-S	BTNB-R7-PZ-D	BTNB-R7A-PZ-S	BTSB-R1-PZ	BTSB-R3-PZ-D	BTSB-R3A-PZ-S	RW6-R1-PZ	RW6-R2-PZ-D	RW6-R2A-PZ-S	RW8-R1A-PZ
Piezometer ID			**Deep**	**Shallow**	**Deep**	**Shallow**	**Deep**	**Shallow**		**Deep**	**Shallow**		**Deep**	**Shallow**	
Elevation, NAVD88 (ft)	**80.911**	**70.422**	**79.635**	**79.37**	**83.591**	**83.531**	**79.353**	**78.961**	**101.03**	**97.9**	**98.049**	**108.507**	**108.659**	**108.315**	**90.063**
Screen Depth Inverval (ft)	**15.0 to 25.0**	**49.5 to 69.5**	**78.0 to 98.0**	**15.0 to 35.0**	**60.0 to 80.0**	**17.0 to 32.0**	**50.0 to 70.0**	**28.5 to 43.5**	**23.5 to 33.5**	**50.0 to 70.0**	**8.0 to 18.0**	**12.0 to 22.0**	**76.0 to 98.0**	**12.0 to 29.0**	**25.0 to 45.0**
Screened Material	**Colma Sand**	**Colma Sand**	**Mélange Matrix, Sandstone**	**Sandstone**	**Greenstone, Sandstone, Serpentinite**	**Sandy Silt, Colma Sand**	**Greenstone**	**Colma Sand, Greenstone**	**Buried Soil Horizon, Sandstone**	**Sandstone**	**Fill, Buried Soil Horizon, Sandy Clay, Sandstone**	**Colma Sand, Sandstone**	**Sandstone, Shale**	**Colma Sand, Sandstone**	**Colma Sand, Sandy Clay, Residual Soil**
Pipe Inside Diameter (in)	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
Date Installed	**2/28/2008**	**2/18/2008**	**4/10/2008**	**4/11/2008**	**3/28/2008**	**3/27/2008**	**4/3/2008**	**4/1/2008**	**1/23/2008**	**4/23/2008**	**4/23/2008**	**2/28/2008**	**4/17/2008**	**4/17/2008**	**6/5/2008**
Date Developed	**6/11/2008**	**6/9/2008**	**6/13/2008**	**6/13/2008**	**6/13/2008**	**6/13/2008**	**6/10/2008**	**6/10/2008**	**6/12/2008**	**6/12/2008**	**6/12/2008**	**6/9/2008**	**6/9/2008**	**6/9/2008**	**6/11/2008**
Date Read															
03/04/08															
03/28/08									**17.15**						
06/09/08		25.15										**19.87**	**41.70**	**Dry**	
06/10/08							11.84	28.45							
06/11/08	Dry														**39.45**
06/12/08									**18.48**	**11.85**	**15.00**				
06/13/08			53.84	3.07	26.78	27.46									
07/18/08	24.03	29.69	51.64	3.37	27.58	29.04	30.31	29.81	**20.20**	**17.18**	**17.79**	**20.21**	**50.41**	**28.20**	**38.73**
08/29/08	24.46	30.02	51.44	4.01	27.68	29.58	30.43	30.04	**21.48**	**17.42**	**14.80**	**20.60**	**52.20**	**28.55**	**38.80**
Average	24.2	29.9	51.5	3.7	27.6	29.3	30.4	29.9	**20.8**	**17.3**	**16.3**	**20.4**	**51.3**	**28.4**	**38.8**

Reading taken before piezometer was developed.

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

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TABLE 9
SUMMARY OF CORROSIVITY ANALYSIS

Borehole ID	Depth (ft)	Soil Unit	pH*	Resistivity (ohms-cm)	Chloride** (mg/kg)	Sulfate*** (mg/kg)
BTSB-R2	22.8 - 24.0	Colma Sand	7.2	5,500	--	15
BTSB-R3A-PZ-S	**0 - 2.5**	**Fill**	**7.2**	**5,100**	**--**	**--**
BTSB-R3A-PZ-S	**0 - 2.5**	**Fill**	**7.1**	**25,000**	**--**	**--**
BTSB-R1-PZ	**8.0 - 9.0**	**Fill**	**7.0**	**6,100**	**--**	**19**
		Method:	CT 532/643	CT 532/643	CT 422/ASTM D4327	CT 417/ASTM D4327

Note: Table entries denoted in bold face type are specifically for the Southbound Battery Tunnel.
All collected data is presented for completeness.

* The pH of the soils range from 7.0 to 7.9 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

** The chloride iron concentrations range from zero to 20 mg/kg. Since these concentrations are below 300 mg/kg, they are determined to be insufficient to attack embedded steel in a concrete mortar coating.

***The sulfate ion concentrations range from zero to 23 mg/kg. Since these concentrations are below 2,000 mg/kg, they are determined to be insufficient to be potentially deterimental to reinforced concrete structures and cement mortar-coated steel.

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TABLE 10
Earth Pressure Coefficients and Equivalent Fluid Weight Values

Station Limits	Depth (ft)	Expected Soil Unit	γ	ϕ	c'	δ	Active Pressures		At Rest Pressures		Passive Resistance	
							K_a	Equivalent Fluid Pressure (pcf)	K_0	Equivalent Fluid Pressure (pcf)	K_p	Equivalent Fluid Pressure (pcf)
75+80 to 78+50	0 to17	Sandy Fill/Sandy Silts and Sandy Clays	120	32	0	16	0.28	33	0.47	56	5.8	693
	17 to 36.5	Colma Sand	130	38	0	19	0.22	28	0.38	50	9.6	1253
	36.5 to 45	Sandy Silts and Sandy Clays	120	32	0	16	0.28	33	0.47	56	5.8	693
	Below 45	Serpentinite (srp)/ Mélange Matrix (mg)	150	0	1400	0	1.00	0	1.00	0	1.0	2950
78+50 to 82+50	0 to 20	Sandy Fill/Sandy Silts and Sandy Clays	120	32	0	16	0.28	33	0.47	56	5.8	693
	Below 20	Sandstone (ss)	165	55	0	28	0.10	16	0.18	30	12.0	1980
82+50 to 86+14	0 to 8.5	Sandy Fill/Sandy Silts and Sandy Clays	120	32	0	16	0.28	33	0.47	56	5.8	693
	8.5 to 18	Colma Sand	130	38	0	19	0.22	28	0.38	50	9.6	1253
	Below 18	Sandstone (ss)	165	55	0	28	0.10	16	0.18	30	12.0	1980

Notes:

1) The wall friction angle, δ, is taken to be one-half of the soil friction angle, φ. No wall friction is considered for the at-rest case.
2) No factor of safety has been applied to the passive pressures. We recommend a minimum factor of safety of 2.5.
3) The value of K_p for the sandstone was capped at 12.
4) The ground surface behind the walls is typically level.
1) Typically c' values for Mélange Matrix are higher than for the serpentinite however, we do not have site specific data to determine separate values.

TABLE 11
Summary of Loading Conditions

Structure	Station Limits	Active Pressures	At Rest Pressures	Apparent Pressures	Safety Evaluation Earthquake	Construction Evaluation Earthquake	Surcharges
Retaining Walls	75+80 to 78+50	May be used prior to installation of 1st Strut: Use equivalent fluid weights presented on Table 10	-	965, psf/ft	-	2H	Retaining Wall A: 300 psf/ft 0'-10' below top of wall 150 psf/ft 10'-20' below top of wall Retaining Wall B: 350 psf/ft 0'-10' below top of wall 175 psf/ft 10'-20' below top of wall
	78+50 to 82+50		-	680, psf/ft (soil) 345, psf/ft (rock)	-	1H	
	82+50 to 86+14		-	735, psf/ft (soil) 345, psf/ft (rock)	-	1H	
Tunnel Structure	75+80 to 78+50	250+35*z, psf/ft	425+60*z, psf/ft	-	11H	-	South Wall: 300 psf/ft 0'-10' below top of wall 150 psf/ft 10'-20' below top of wall North Wall: 350 psf/ft 0'-10' below top of wall 175 psf/ft 10'-20' below top of wall
	78+50 to 82+50	450+33*z, psf/ft (soil) 230+16*z, psf/ft (rock)	760+56*z, psf/ft (soil) 430+30*z, psf/ft (rock)	-	9H	-	
	82+50 to 86+14	120+33*z, psf/ft (soil) 220+16*z, psf/ft (rock)	200+55*z, psf/ft (soil) 400+30*z, psf/ft (rock)	-	9H	-	

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Table 12
Soldier Pile Schedule - Retaining Wall A

Pile No.	Size	Hole Diameter	Pile Top Elevation	Pile Tip Elevation	Design Loads Provided by Structural Engineer[1]						Foundation Design Recommendations									
					Service 1 - Limit State		Strength Limit State		Extreme Event Limit State		Expected Movements		Minimum Required Tip Elevation for Considered Loadings							
					Compression (a)	Tension (b)	Compression©	Tension (d)	Compression (e)	Tension (f)	Settlement	Deflection	(a)	(b)	(c)	(d)	(e)	(f)	(g)	Controlling Load
		(ft)	(ft)	(ft)	(kips)	(kips)	(kips)	(kips)	(kips)	(kips)	(in)	(in)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
PA1-PA24	Not Used	2.5	N/A	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PA25-PA30	2 - MC18x42.7	2.5	92.00	37.52	70	0	Self Weight	0	Self Weight	0	<0.5	<1.0	42.52	N/A	42.52	N/A	42.52	N/A	37.52	(g)
PA31-PA34	W18x65	2.5	92.00	37.52	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	43.60	N/A	43.60	N/A	43.60	N/A	38.60	(g)
PA35-PA40	W18x65	2.5	93.50	39.31	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	44.31	N/A	44.31	N/A	44.31	N/A	39.31	(g)
PA41-PA46	W18x65	2.5	93.00	40.43	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	45.43	N/A	45.43	N/A	45.43	N/A	40.43	(g)
PA47-PA52	W18x65	2.5	93.50	41.46	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	46.46	N/A	46.46	N/A	46.46	N/A	41.46	(g)
PA53-PA58	W18x65	2.5	94.50	42.54	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	47.54	N/A	47.54	N/A	47.54	N/A	42.54	(g)
PA59-PA64	W18x65	2.5	94.90	43.61	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	48.61	N/A	48.61	N/A	48.61	N/A	43.61	(g)
PA65-PA70	W18x65	2.5	95.80	44.68	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	49.68	N/A	49.68	N/A	49.68	N/A	44.68	(g)
PA71-PA76	W18x65	2.5	96.60	45.73	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	50.73	N/A	50.73	N/A	50.73	N/A	45.73	(g)
PA77-PA82	W18x65	2.5	96.80	51.51	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	51.51	N/A	51.51	N/A	51.51	N/A	51.51	(g)
PA83-PA88	W18x65	2.5	96.60	52.33	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	52.33	N/A	52.33	N/A	52.33	N/A	52.33	(g)
PA89-PA94	W18x65	2.5	102.00	53.23	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	53.23	N/A	53.23	N/A	53.23	N/A	53.23	(g)
PA95-PA100	W18x65	2.5	103.00	53.99	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	53.99	N/A	53.99	N/A	53.99	N/A	53.99	(g)
PA101-PA106	W18x65	2.5	97.80	54.88	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	54.88	N/A	54.88	N/A	54.88	N/A	54.88	(g)
PA107-PA112	W18x65	2.5	99.30	55.79	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	55.79	N/A	55.79	N/A	55.79	N/A	55.79	(g)
PA113-PA118	W18x65	2.5	100.30	56.72	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	56.88	N/A	56.88	N/A	56.88	N/A	56.88	(g)
PA119-PA124	W18x65	2.5	101.40	57.69	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	57.89	N/A	57.89	N/A	57.89	N/A	57.89	(g)
PA125-PA130	W18x65	2.5	103.30	58.89	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	59.10	N/A	59.10	N/A	59.10	N/A	59.10	(g)
PA131-PA136	W18x65	2.5	104.90	61.15	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	60.37	N/A	60.37	N/A	60.37	N/A	60.37	(g)
PA137-PA142	W18x65	2.5	106.00	62.44	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	61.66	N/A	61.66	N/A	61.66	N/A	61.66	(g)
PA143-PA146	W18x65	2.5	106.80	63.76	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	62.98	N/A	62.98	N/A	62.98	N/A	62.98	(g)
PA147-PA184	W18x65	2.5	106.80	64.64	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	65.00	N/A	65.00	N/A	65.00	N/A	65.00	(g)
PA185-PA190	W18x65	2.5	110.70	66.91	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	65.91	N/A	65.91	N/A	65.91	N/A	66.91	(g)
PA191-PA195	W18x65	2.5	110.70	68.30	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	67.30	N/A	67.30	N/A	67.30	N/A	68.30	(g)
PA196-PA201	W18x65	2.5	108.30	69.72	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	68.48	N/A	68.48	N/A	68.48	N/A	69.48	(g)
PA202-PA212	W18x86	2.5	108.30	69.16	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	69.92	N/A	69.92	N/A	69.92	N/A	70.92	(g)

Notes:
1) Loads provided by structural Engineer are per pile location
2) For applied lateral loads, see Figures 15 through 24 in Foundation Design Report
3) The design tip elevations are controlled by (a) Compression (Service 1 - Limit), (b) Tension (Service 1 - Limit) (c) Compression (Strength Limit), (d) Tension (Strength Limit), (e) Compression (Extreme Event), (f) Tension (Extreme Event), (g) Lateral Loads

ARUP PB joint venture

Table 13
Soldier Pile Schedule - Retaining Wall B

Pile No.	Size	Hole Diameter	Pile Top Elevation	Pile Tip Elevation	Design Loads Provided by Structural Engineer [1]						Foundation Design Recommendations									
					Service 1 - Limit State		Strength Limit State		Extreme Event Limit State		Expected Movements		Minimum Required Tip Elevation for Considered Loadings							
					Compression (a)	Tension (b)	Compression©	Tension (d)	Compression (e)	Tension (f)	Settlement	Deflection	(a)	(b)	(c)	(d)	(e)	(f)	(g)	Controlling Load
		(ft)	(ft)	(ft)	(kips)	(kips)	(kips)	(kips)	(kips)	(kips)	(in)	(in)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
PB1-PB9	Not Used	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PB10-PB14	W18x65	2.5	77.58	32.28	42	0	42	0	31	0	<0.5	<1.0	33.89	N/A	33.89	N/A	33.89	N/A	31.89	(g)
PB15-PB23	2 - MC18x42.7	2.5	77.58	32.28	112	0	112	0	83	0	<0.5	<1.0	33.89	N/A	33.89	N/A	33.89	N/A	31.89	(g)
PB24-PB30	2 - MC18x42.7	2.5	78.82	33.67	70	0	70	0	52	0	<0.5	<1.0	35.57	N/A	35.57	N/A	35.57	N/A	33.57	(g)
PB31	W14x99	2.5	85.20	33.67	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	39.87	N/A	39.87	N/A	39.87	N/A	34.87	(g)
PB32	W14x99	2.5	85.20	33.67	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	40.06	N/A	40.06	N/A	40.06	N/A	35.06	(g)
PB33	W18x65	2.5	85.20	36.06	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	40.24	N/A	40.24	N/A	40.24	N/A	35.24	(g)
PB34	W18x65	2.5	85.20	36.23	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	40.43	N/A	40.43	N/A	40.43	N/A	35.43	(g)
PB35-PB40	W18x65	2.5	88.36	35.61	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	40.61	N/A	40.61	N/A	40.61	N/A	35.61	(g)
PB41-PB46	W18x65	2.5	89.34	36.71	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	41.71	N/A	41.71	N/A	41.71	N/A	36.71	(g)
PB47-PB52	W18x65	2.5	90.32	37.81	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	42.81	N/A	42.81	N/A	42.81	N/A	37.81	(g)
PB53-PB58	W18x65	2.5	91.25	38.91	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	43.91	N/A	43.91	N/A	43.91	N/A	38.91	(g)
PB59-PB64	W18x65	2.5	92.23	40.00	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	45.00	N/A	45.00	N/A	45.00	N/A	40.00	(g)
PB65-PB70	W18x65	2.5	93.17	41.11	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	51.00	N/A	51.00	N/A	51.00	N/A	46.00	(g)
PB71-PB76	W18x65	2.5	94.16	42.21	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	53.80	N/A	53.80	N/A	53.80	N/A	48.80	(g)
PB77-PB82	W18x65	2.5	95.49	48.33	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	57.50	N/A	57.50	N/A	57.50	N/A	52.50	(g)
PB83-PB88	W18x65	2.5	96.08	49.44	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	61.30	N/A	61.30	N/A	61.30	N/A	56.30	(g)
PB89-PB94	W18x65	2.5	101.10	50.55	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	64.30	N/A	64.30	N/A	64.30	N/A	59.30	(g)
PB95-PB100	W18x119	2.5	102.15	51.66	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	68.50	N/A	68.50	N/A	68.50	N/A	63.50	(g)
PB101-PB106	W18x119	2.5	102.91	52.85	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	72.50	N/A	72.50	N/A	72.50	N/A	67.50	(g)
PB107-PB112	W18x119	2.5	100.00	54.03	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	69.40	N/A	69.40	N/A	69.40	N/A	64.40	(g)
PB113-PB118	W18x119	2.5	101.07	55.23	Self Weight	0	Self Weight	0	Self Weight	0	<0.5	<1.0	64.90	N/A	64.90	N/A	64.90	N/A	59.90	(g)
PB119-PB124	W18x65	2.5	102.08	46.46	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	62.30	46.67	62.30	46.67	62.30	46.67	57.30	(b), (d), (f)
PB125-PB130	W18x65	2.5	103.91	47.71	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	65.50	47.92	65.50	47.92	65.50	47.92	60.50	(b), (d), (f)
PB131-PB136	W18x65	2.5	104.80	49.97	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	70.70	49.19	70.70	49.19	70.70	49.19	65.70	(b), (d), (f)
PB137-PB142	W18x65	2.5	106.46	51.26	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	76.70	50.48	76.70	50.48	76.70	50.48	71.70	(b), (d), (f)
PB143-PB146	W18x65	2.5	107.45	52.57	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	81.20	51.80	81.20	51.80	81.20	51.80	76.20	(b), (d), (f)
PB147-PB152	W18x65	2.5	108.66	53.46	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	85.00	52.69	85.00	52.69	85.00	52.69	80.00	(b), (d), (f)
PB153-PB156	W18x65	2.5	109.69	53.81	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	86.00	54.04	86.00	54.04	86.00	54.04	81.00	(b), (d), (f)
PB157-PB162	W18x65	2.5	111.08	54.73	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	86.60	54.96	86.60	54.96	86.60	54.96	81.60	(b), (d), (f)
PB163-PB168	W18x65	2.5	112.48	56.12	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	86.30	56.36	86.30	56.36	86.30	56.36	81.30	(b), (d), (f)
PB169-PB174	W18x65	2.5	116.94	57.54	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	85.30	57.78	85.30	57.78	85.30	57.78	80.30	(b), (d), (f)
PB175-PB180	W18x65	2.5	118.38	58.97	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	84.70	59.22	84.70	59.22	84.70	59.22	79.70	(b), (d), (f)
PB181-PB183	W18x65	2.5	124.33	60.44	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	84.20	60.68	84.20	60.68	84.20	60.68	79.20	(b), (d), (f)
PB184-PB187	W18x65	2.5	124.33	61.18	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	84.00	61.18	84.00	61.18	84.00	61.18	79.00	(b), (d), (f)
PB188-PB191	W18x119	2.5	97.30	61.50	Self Weight	150	Self Weight	150	Self Weight	150	<0.5	<1.0	83.00	62.40	83.00	62.40	83.00	62.40	78.00	(b), (d), (f)

Notes:
1) Loads provided by structural Engineer are per pile location
2) For applied lateral loads, see Figures 15 through 24 in Foundation Design Report
3) The design tip elevations are controlled by (a) Compression (Service 1 - Limit), (b) Tension (Service 1 - Limit) (c) Compression (Strength Limit), (d) Tension (Strength Limit), (e) Compression (Extreme Event), (f) Tension (Extreme Event), (g) Lateral Loads

Table 14
Raker Schedule

Adjacent Pile No.	Size	Hole Diameter	Pile Top Elevation	Pile Tip Elevation	Design Loads Provided by Structural Engineer [1]						Foundation Design Recommendations								
					Service 1 - Limit State		Strength Limit State		Extreme Event Limit State		Expected Movements		Minimum Required Tip Elevation for Considered Loading						
					Compression (a)	Lateral @ Top (b)	Compression ©	Lateral @ Top (d)	Compression (e)	Lateral @ Top (f)	Settlement	Deflection	(a)	(b)	(c)	(d)	(e)	(f)	Controlling Load
		(ft)	(ft)	(ft)	(kips)	(kips)	(kips)	(kips)	(kips)	(kips)	(in)	(in)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
PR1-PR9	Not Used	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PR10	W14x99	30	92.00	61.28	140	140	140	140	140	140	<0.5"	<1.0"	77.00	84.00	77.00	84.00	77.00	84.00	(b), (d), (f)
PR11	W14x99	30	93.20	62.99	140	140	140	140	140	140	<0.5"	<1.0"	78.20	85.20	78.20	85.20	78.20	85.20	(b), (d), (f)
PR12	W14x99	30	93.30	63.84	140	140	140	140	140	140	<0.5"	<1.0"	78.30	85.30	78.30	85.30	78.30	85.30	(b), (d), (f)
PR13	W14x99	30	93.49	65.56	140	140	140	140	140	140	<0.5"	<1.0"	78.49	85.49	78.49	85.49	78.49	85.49	(b), (d), (f)
PR14	W14x99	30	93.58	66.41	140	140	140	140	140	140	<0.5"	<1.0"	78.58	85.58	78.58	85.58	78.58	85.58	(b), (d), (f)
PR15	W14x99	30	93.76	68.12	140	140	140	140	140	140	<0.5"	<1.0"	78.76	85.76	78.76	85.76	78.76	85.76	(b), (d), (f)
PR16	W14x99	30	93.85	68.98	140	140	140	140	140	140	<0.5"	<1.0"	78.85	85.85	78.85	85.85	78.85	85.85	(b), (d), (f)
PR17	W14x99	30	94.03	70.69	140	140	140	140	140	140	<0.5"	<1.0"	79.03	86.03	79.03	86.03	79.03	86.03	(b), (d), (f)
PR18	W14x99	30	94.10	71.55	140	140	140	140	140	140	<0.5"	<1.0"	79.10	86.10	79.10	86.10	79.10	86.10	(b), (d), (f)
PR19	W14x99	30	94.14	73.26	140	140	140	140	140	140	<0.5"	<1.0"	79.14	86.14	79.14	86.14	79.14	86.14	(b), (d), (f)
PR20	W14x99	30	94.16	74.12	140	140	140	140	140	140	<0.5"	<1.0"	79.16	86.16	79.16	86.16	79.16	86.16	(b), (d), (f)
PR21	W14x99	30	94.20	75.83	140	140	140	140	140	140	<0.5"	<1.0"	79.20	86.20	79.20	86.20	79.20	86.20	(b), (d), (f)
PR22	W14x99	30	94.22	76.68	140	140	140	140	140	140	<0.5"	<1.0"	79.22	86.22	79.22	86.22	79.22	86.22	(b), (d), (f)
PR23	W14x99	30	94.26	78.40	140	140	140	140	140	140	<0.5"	<1.0"	79.26	86.26	79.26	86.26	79.26	86.26	(b), (d), (f)
PR24	W14x99	30	94.30	79.25	140	140	140	140	140	140	<0.5"	<1.0"	79.30	86.30	79.30	86.30	79.30	86.30	(b), (d), (f)
PR25	W14x99	30	94.42	79.42	140	140	140	140	140	140	<0.5"	<1.0"	79.42	86.42	79.42	86.42	79.42	86.42	(b), (d), (f)
PR26	W14x99	30	94.48	79.48	140	140	140	140	140	140	<0.5"	<1.0"	79.48	86.48	79.48	86.48	79.48	86.48	(b), (d), (f)
PR27	W14x99	30	94.54	79.54	140	140	140	140	140	140	<0.5"	<1.0"	79.54	86.54	79.54	86.54	79.54	86.54	(b), (d), (f)
PR28	W14x99	30	94.60	79.60	140	140	140	140	140	140	<0.5"	<1.0"	79.60	86.60	79.60	86.60	79.60	86.60	(b), (d), (f)
PR29	W14x99	30	94.66	79.66	140	140	140	140	140	140	<0.5"	<1.0"	79.66	86.66	79.66	86.66	79.66	86.66	(b), (d), (f)
PR30	W14x99	30	94.72	79.72	140	140	140	140	140	140	<0.5"	<1.0"	79.72	86.72	79.72	86.72	79.72	86.72	(b), (d), (f)
PR31	W14x99	30	94.80	79.80	140	140	140	140	140	140	<0.5"	<1.0"	79.80	86.80	79.80	86.80	79.80	86.80	(b), (d), (f)
PR32	W14x99	30	94.85	79.85	140	140	140	140	140	140	<0.5"	<1.0"	79.85	86.85	79.85	86.85	79.85	86.85	(b), (d), (f)
PR33	W14x99	30	94.90	79.90	140	140	140	140	140	140	<0.5"	<1.0"	79.90	86.90	79.90	86.90	79.90	86.90	(b), (d), (f)
PR34	W14x99	30	94.95	79.95	140	140	140	140	140	140	<0.5"	<1.0"	79.95	86.95	79.95	86.95	79.95	86.95	(b), (d), (f)
PR35	W14x99	30	95.00	80.00	140	140	140	140	140	140	<0.5"	<1.0"	80.00	87.00	80.00	87.00	80.00	87.00	(b), (d), (f)
PR36	W14x99	30	95.05	80.05	140	140	140	140	140	140	<0.5"	<1.0"	80.05	87.05	80.05	87.05	80.05	87.05	(b), (d), (f)
PR37	W14x99	30	95.10	80.10	140	140	140	140	140	140	<0.5"	<1.0"	80.10	87.10	80.10	87.10	80.10	87.10	(b), (d), (f)
PR38	W14x99	30	95.15	80.15	140	140	140	140	140	140	<0.5"	<1.0"	80.15	87.15	80.15	87.15	80.15	87.15	(b), (d), (f)
PR39	W14x99	30	95.20	80.20	140	140	140	140	140	140	<0.5"	<1.0"	80.20	87.20	80.20	87.20	80.20	87.20	(b), (d), (f)
PR40	W14x99	30	95.32	80.32	140	140	140	140	140	140	<0.5"	<1.0"	80.32	87.32	80.32	87.32	80.32	87.32	(b), (d), (f)
PR41	W14x99	30	95.44	80.44	140	140	140	140	140	140	<0.5"	<1.0"	80.44	87.44	80.44	87.44	80.44	87.44	(b), (d), (f)
PR42	W14x99	30	95.56	80.56	140	140	140	140	140	140	<0.5"	<1.0"	80.56	87.56	80.56	87.56	80.56	87.56	(b), (d), (f)
PR43	W14x99	30	95.68	80.68	140	140	140	140	140	140	<0.5"	<1.0"	80.68	87.68	80.68	87.68	80.68	87.68	(b), (d), (f)
PR44	W14x99	30	95.80	80.80	140	140	140	140	140	140	<0.5"	<1.0"	80.80	87.80	80.80	87.80	80.80	87.80	(b), (d), (f)
PR45	W14x99	30	95.92	80.92	140	140	140	140	140	140	<0.5"	<1.0"	80.92	87.92	80.92	87.92	80.92	87.92	(b), (d), (f)
PR46	W14x99	30	96.04	81.04	140	140	140	140	140	140	<0.5"	<1.0"	81.04	88.04	81.04	88.04	81.04	88.04	(b), (d), (f)
PR47	W14x99	30	96.10	81.10	140	140	140	140	140	140	<0.5"	<1.0"	81.10	88.10	81.10	88.10	81.10	88.10	(b), (d), (f)
PR48	W14x99	30	96.22	81.22	140	140	140	140	140	140	<0.5"	<1.0"	81.22	88.22	81.22	88.22	81.22	88.22	(b), (d), (f)
PR49	W14x99	30	96.34	81.34	140	140	140	140	140	140	<0.5"	<1.0"	81.34	88.34	81.34	88.34	81.34	88.34	(b), (d), (f)
PR50	W14x99	30	96.46	81.46	140	140	140	140	140	140	<0.5"	<1.0"	81.46	88.46	81.46	88.46	81.46	88.46	(b), (d), (f)
PR51	W14x99	30	96.58	81.58	140	140	140	140	140	140	<0.5"	<1.0"	81.58	88.58	81.58	88.58	81.58	88.58	(b), (d), (f)

1) Loads provided by structural Engineer are per pile location
2) No tensile (uplift) loads are expected on the rakers.

3) The design tip elevations are controlled by (a) Compression (Service 1 - Limit), (b) Lateral (Service 1 - Limit) (c) Compression (Strength Limit), (d) Lateral (Strength Limit), (e) Compression (Extreme Event), (f) Lateral (Extreme Event).

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Table 15 Summary of Ground Anchor Requirements		
Ground Anchor Level	**Depth Below Top of Wall (ft)**	**Required Unbonded Length (ft)**
1	6	27
2	14	20
3	34	14

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FIGURES

Source: USGS, San Francisco North Quadrangle, California, 7.5-Minute Series (Topographic), 1996

SCALE: 1:24,000
Contour Interval 25 feet
(National Geographic Vertical Datum of 1929)

N

SITE VICINITY MAP

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August 2009 San Francisco, California

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Q:\131558\4a Arup Internal Project Data\4a-15 Geotech\4a-015-006 Drawings\Site Vicinity Map.ai

FIGURE 1

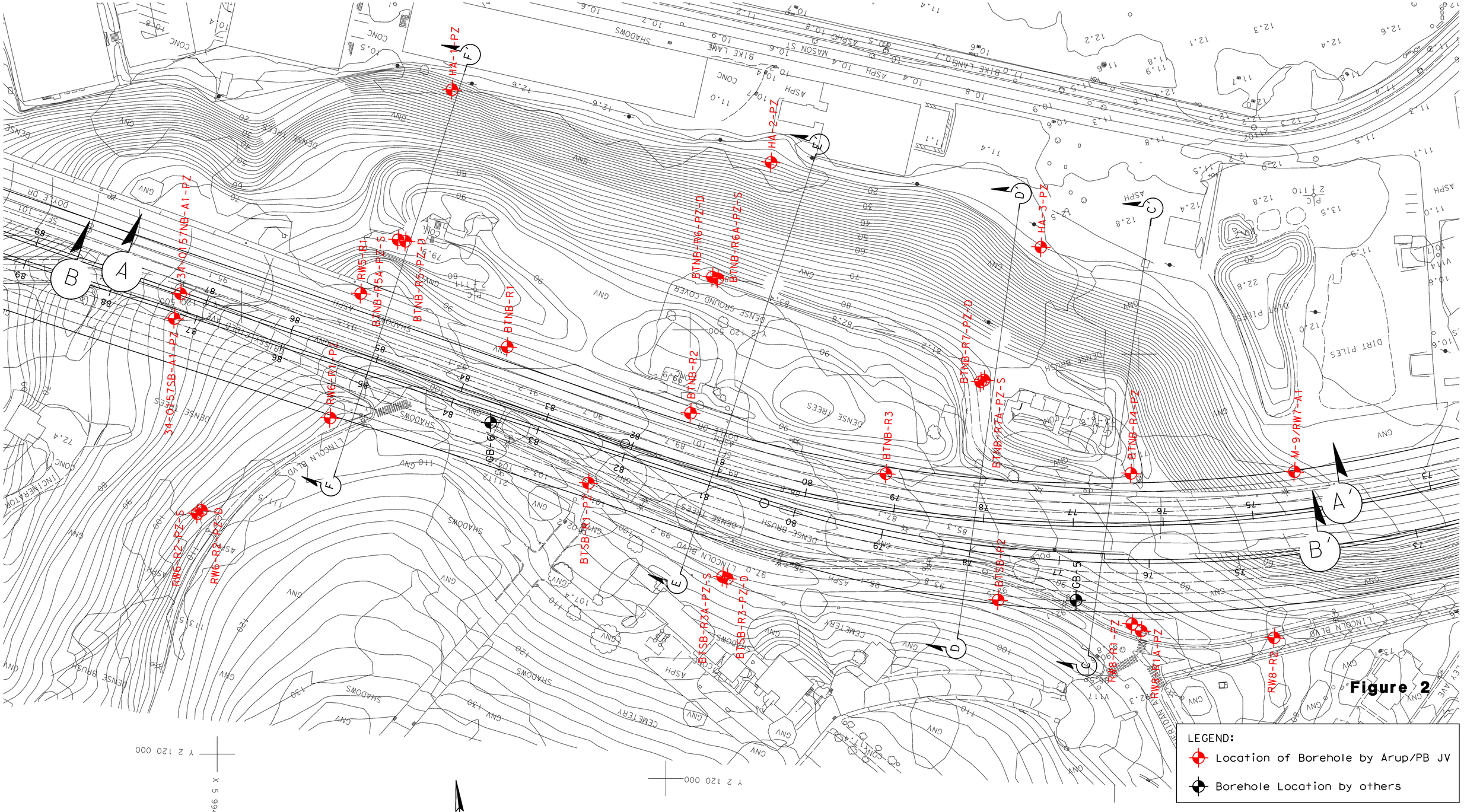

Figure 2

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

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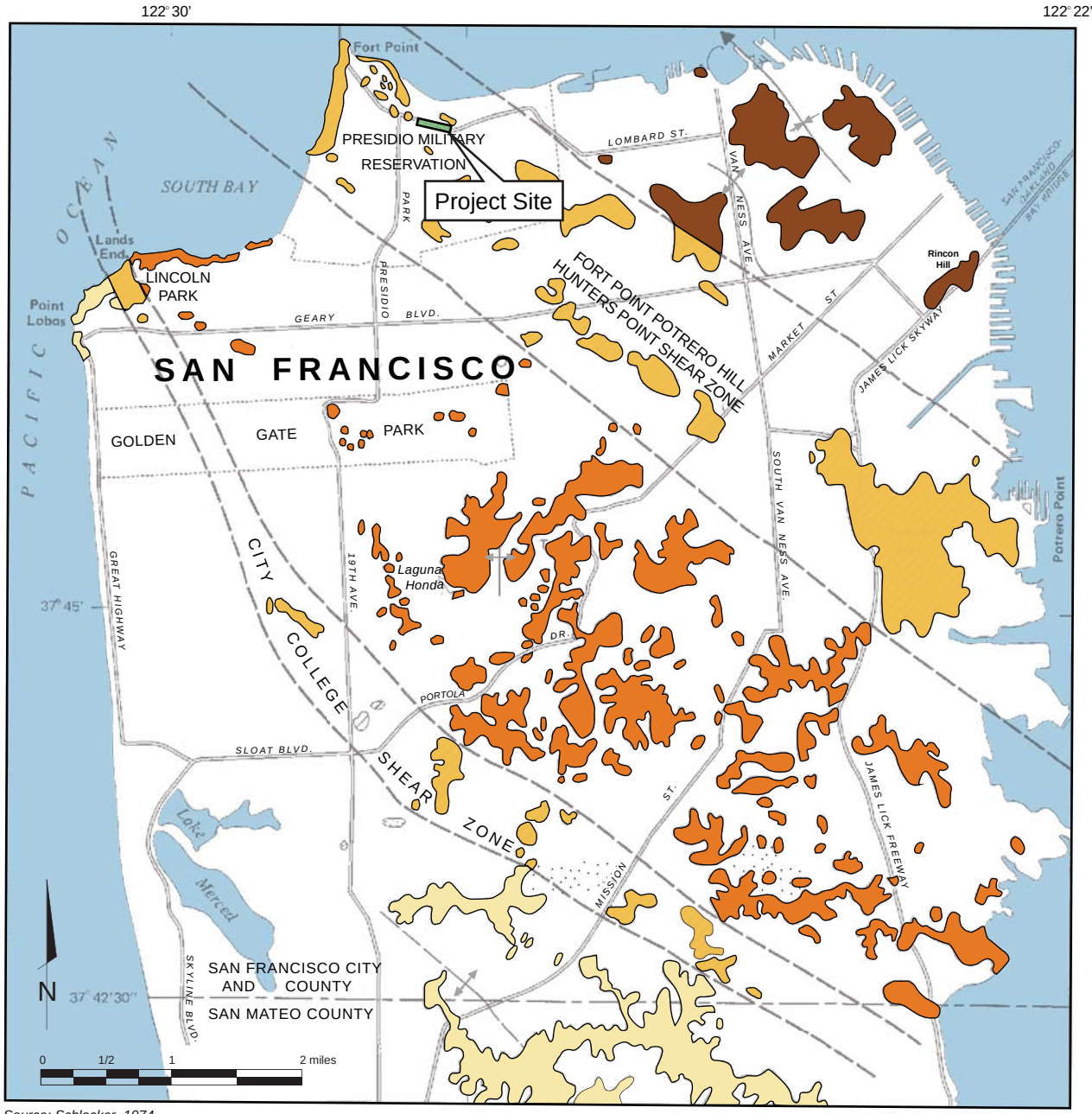

Source: Schlocker, 1974

Geology in San Francisco South quadrangle modified after Bonilla (1965)

QUATERNARY

Surficial deposits

CRETACEOUS AND JURASSIC (?)

Great Valley Sequence

Sandstone and shale Rocks in the Point Lobos area, west at the City College shear zone are tentatively assigned to the Great Valley sequence

Franciscan Formation

Radiolarian Chert, greenstone, and some sandstone and shale

Sandstone and shale

Sheared rocks Includes fragments of Franciscan Formation, Great Valley sequence, and serpentine

Contact

Anticline

Syncline

GENERALIZED GEOLOGY OF SAN FRANCISCO

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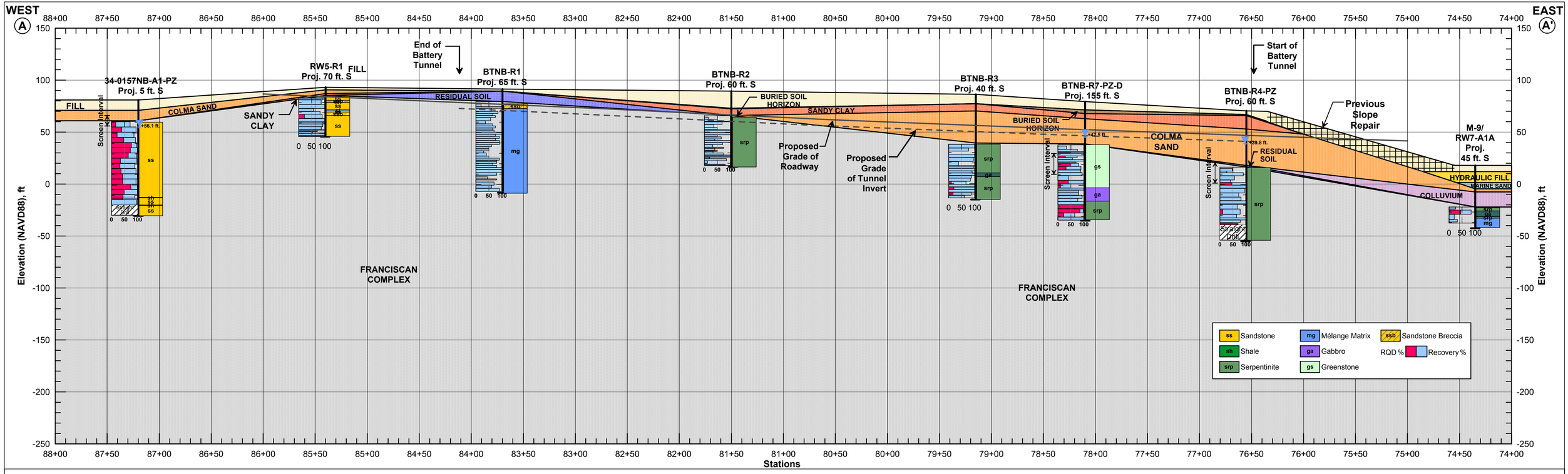
Q:\131558\4a Arup Internal Project Data\4a-15 Geotech\4a-015-006 Drawings\Generalized Geology.ai

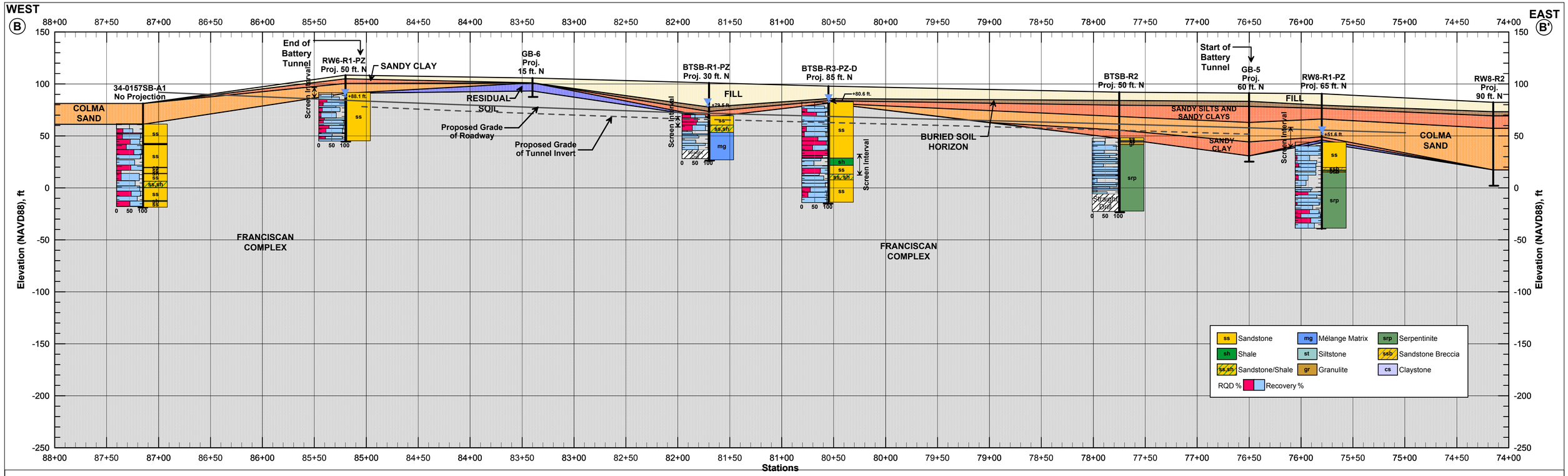
FIGURE 3



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section A-A'
Along Northbound Battery Tunnel (Bridge No. 34-0161R)

Figure 4

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\BTNB Longitudinal.grf



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section B-B'
Along Southbound Battery Tunnel (Bridge No. 34-0161L)

ARUP PB joint venture

Figure 5

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\BTSB Longitudinal.grf

SOUTH
C

NORTH
C'

SB Profile Grade Line

Existing Doyle Drive

RW8-R1-PZ
Proj. 35 ft. West

BTNB-R4-PZ
Proj. 25 ft. West

HA-3-PZ
Proj. 95 ft. East

FILL

ENGINEERED FILL

BURIED SOIL HORIZON

Proposed Battery Tunnel Southbound

Future Battery Tunnel Northbound

Original Grade

FILL

SANDY CLAY

COLMA SAND

RESIDUAL SOIL

Screen Interval

+51.6

+39.8

ss

ssb

srp

Straight Drilled

Note: Serpentinite bedrock encountered in HA-3-PZ

FRANCISCAN COMPLEX

FRANCISCAN COMPLEX

ss Sandstone

ssb Sandstone Breccia

srp Serpentinite

RQD %

Recovery %

Elevation (NAVD88), ft

Distance Left of SB Profile Grade Line (ft)

Distance Right of SB Profile Grade Line (ft)

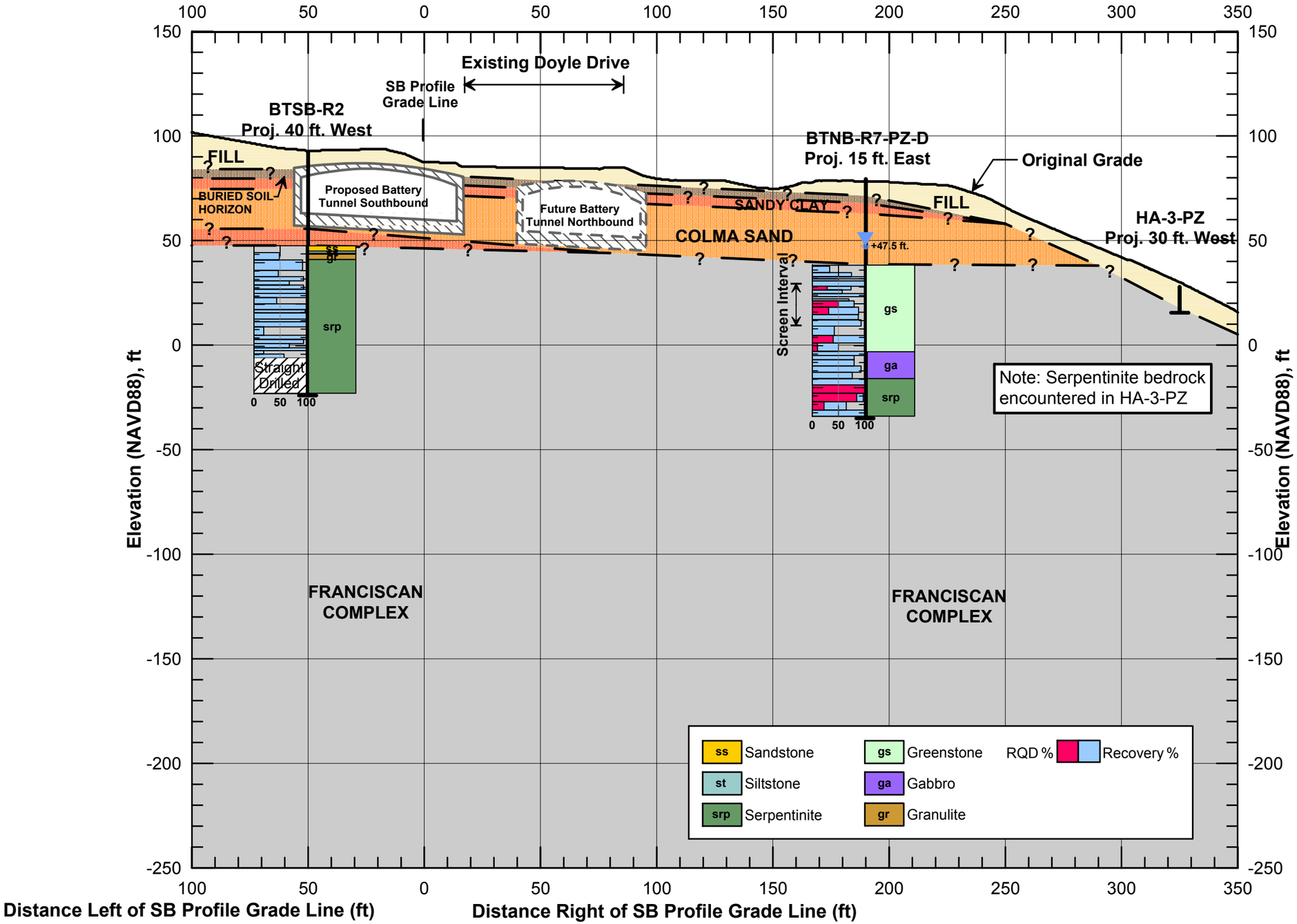
DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Cross Section C-C'
Transverse Cross Section at Station Southbound East Portal
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 6

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\BT East Portal Transverse.grf

SOUTH
D

NORTH
D'



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Cross Section D-D'
Transverse Cross Section at Station 78+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 7

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\78+00 BT Transverse.grf

SOUTH
E

NORTH
E'

SB Profile Grade Line

Existing Doyle Drive

BTSB-R3-PZ-D
Proj. 50 ft. West

BTNB-R2
Proj. 45 ft. East

BTNB-R6-PZ-D
Proj. 70 ft. East

HA-2-PZ
Proj. 40 ft. East

ENGINEERED FILL

BURIED SOIL HORIZON

Proposed Battery Tunnel Southbound

Future Battery Tunnel Northbound

FILL

SANDY CLAY

COLMA SAND

FILL

Original Grade

Screen Interval

Screen Interval

FRANCISCAN COMPLEX

FRANCISCAN COMPLEX

Elevation (NAVD88), ft

Elevation (NAVD88), ft

Distance Left of SB Profile Grade Line (ft)

Distance Right of SB Profile Grade Line (ft)

ss Sandstone
ss, sh Sandstone/Shale
sh Shale
gs Greenstone
srp Serpentinite
RQD %
Recovery %

DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section E-E'
Transverse Cross Section at Station 81+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 8

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\81+00 BT Transverse.grf

SOUTH
F

NORTH
F'

RW6-R1-PZ
Proj. 25 ft. E

SB Profile
Grade Line

Existing Doyle Drive

Battery Blaney Road

ENGINEERED FILL

RW5-R1
Proj. 35 ft. E

BTNB-R5-PZ-D
Proj. 10 ft. E

FILL
SANDY CLAY

Screen Interval

Proposed Battery
Tunnel Southbound
+88.1 ft.

Future Doyle
Drive Northbound

COLMA
SAND

Original Grade

?FILL

HA-1-PZ
No Projection

+28.8 ft.

Screen Interval

Note: Serpentinite bedrock
encountered in HA-1-PZ

FRANCISCAN
COMPLEX

FRANCISCAN
COMPLEX

ss Sandstone
mg Mélange Matrix
RQD % Recovery %

Elevation (NAVD88), ft

Distance Left of SB Profile Grade Line (ft)

Distance Right of SB Profile Grade Line (ft)

DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy, Section F-F'
Transverse Cross Section at Station 85+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 9

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\85+00 BT Transverse.grf

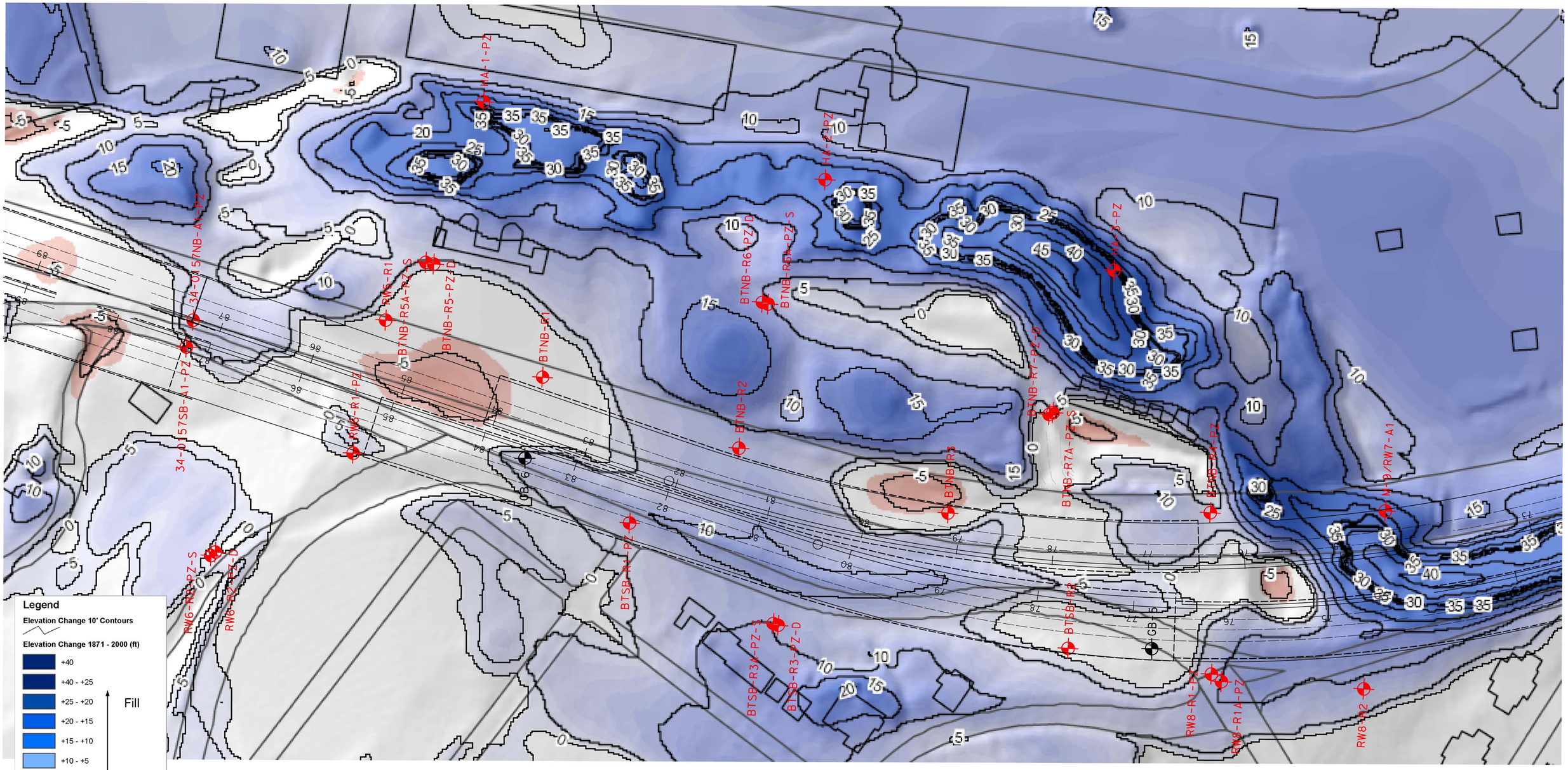


FIGURE 10

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

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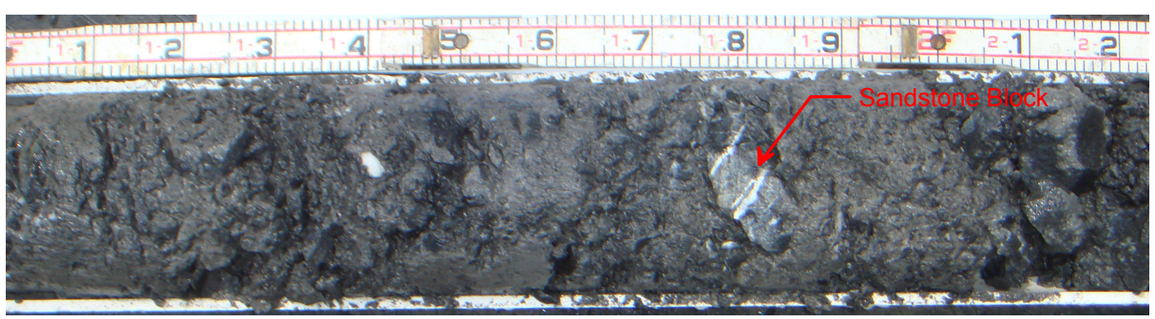
Caltrans

SAN FRANCISCO COUNTY TRANSPORTATION AUTHORITY

DOYLE DRIVE REPLACEMENT PROJECT

Map of Presidio Showing Comparison Between 1871- and 2000-year Contours

Brecciated Sandstone: Small blocks of sandstone filled around by soft white clay.
(Borehole: RW8-R1-PZ, Depth: 51.2 to 51.95 feet)



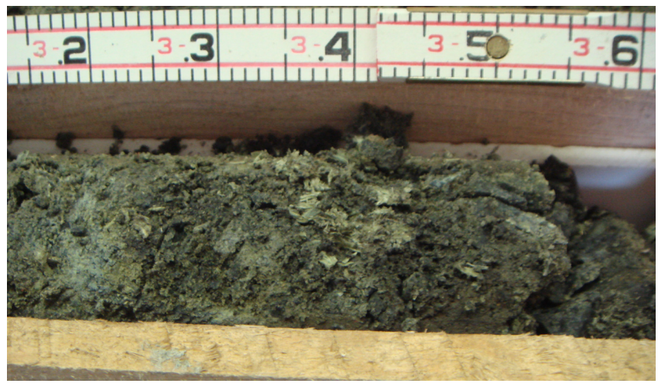
Mélange Matrix: Sandstone blocks within a Sheared Shale Matrix.
(Borehole: BTNB-R5-PZ-D, Depth: 49.5 to 50.5 feet)

Slickensides: Evidence of shearing
on fracture surface in sandstone.
(Borehole: BTSB-R1, Depth: 35.9 feet)

Slickensides: Evidence of shearing on
fracture surface in serpentinite. Secondary
white mineral deposit on fracture surface.
(Borehole: BTNB-R2, Depth: 61.8 feet)

Mylonized Sandstone: Very intensely weathered and sheared. Comprised of up to 50% clay.
(Borehole: RW6-R2-PZ-D, Depth: 45.0 to 45.9 feet)

Sandstone and Shale: Bedding distorted by soft sediment deformation and micro-faulting.
Surface of core is pitted.
(Borehole: BTSB-R1, Depth: 45.5 to 46.3 feet)



Fibrous Texture: Fibers (asbestos?) present in serpentinite.
(Borehole: BTNB-R2, Depth: 37.5 to 37.9 feet)

PHOTOGRAPHS OF TYPICAL GEOLOGIC FEATURES

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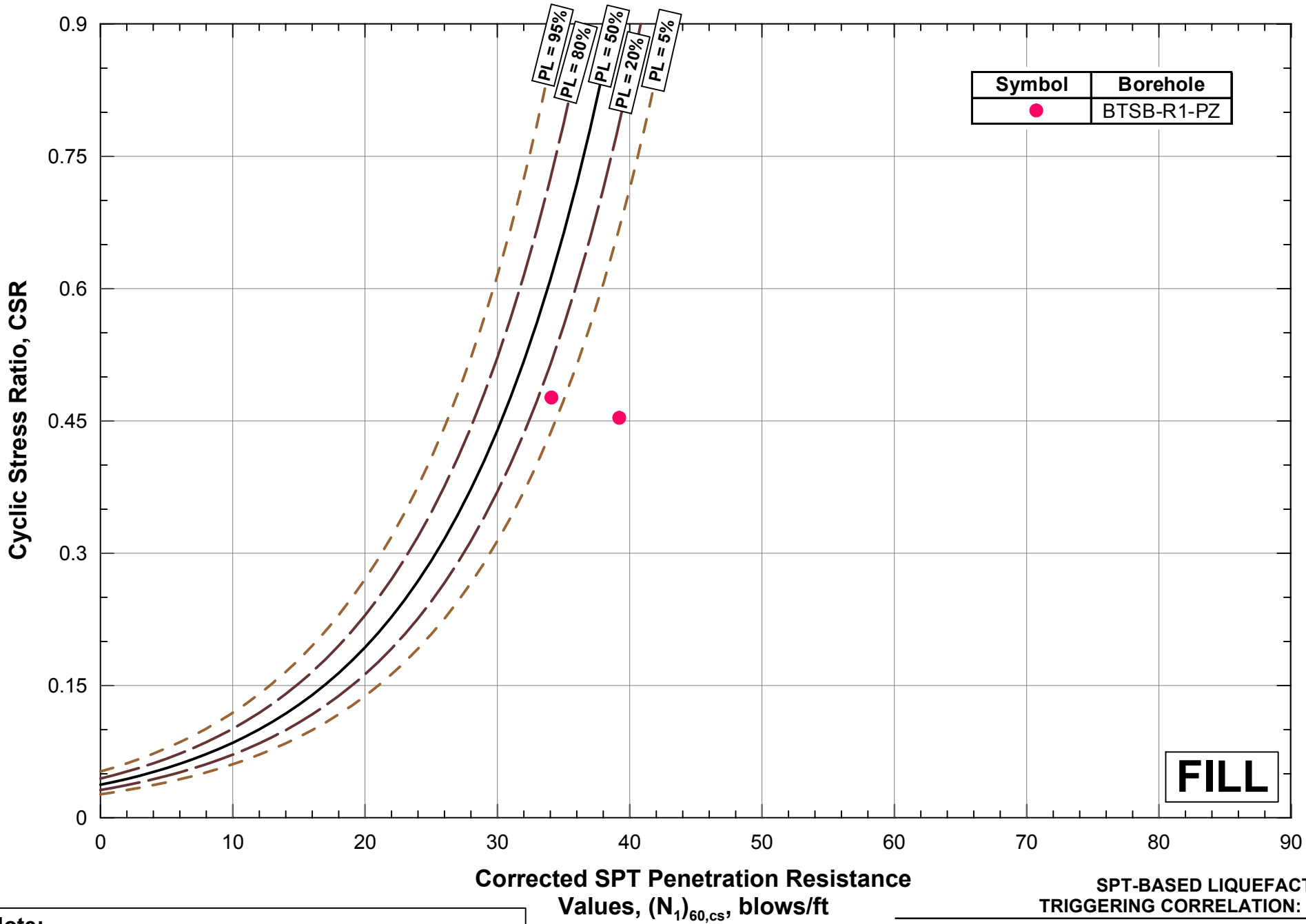
FIGURE 11



Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: FILL

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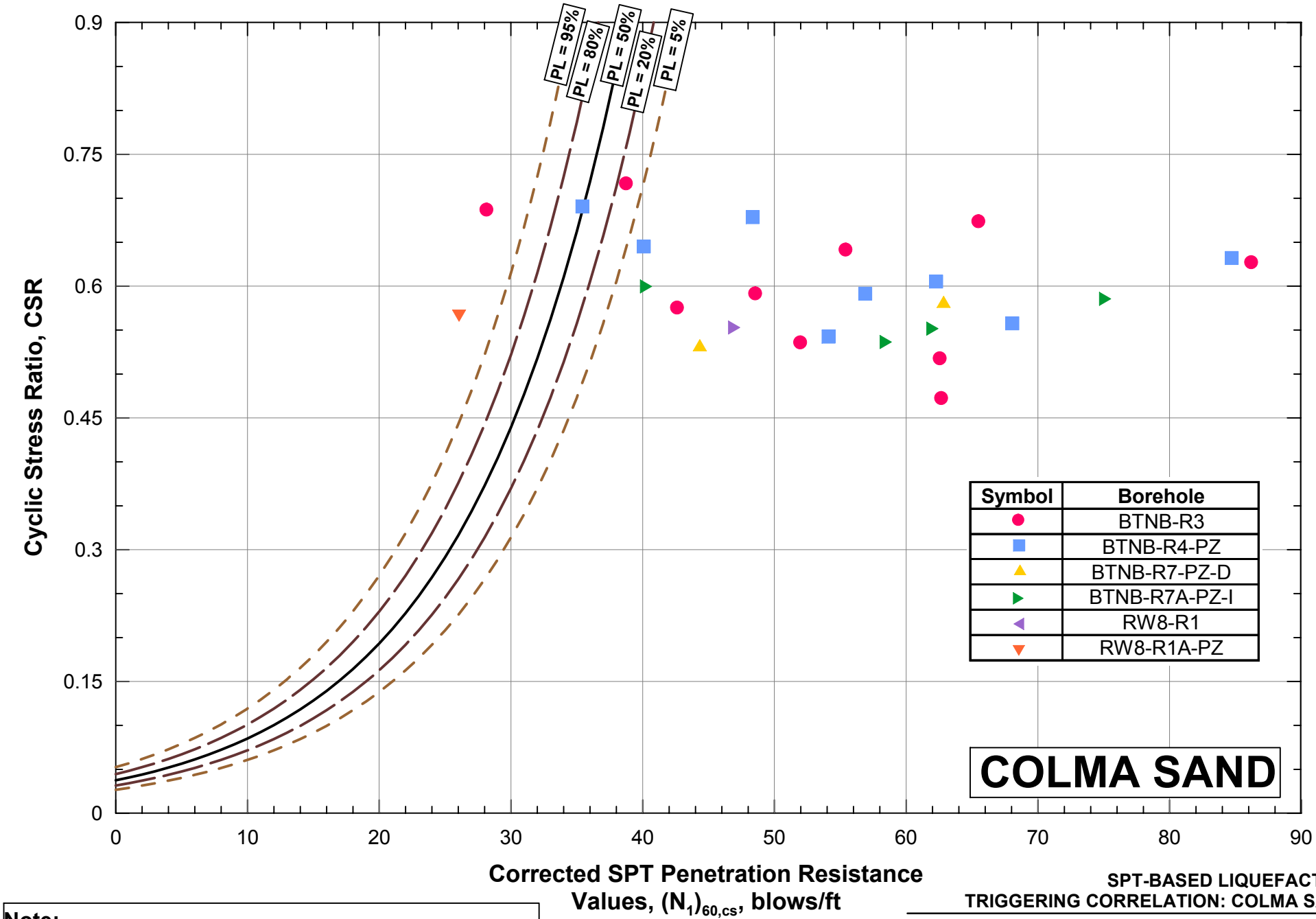
FIGURE 12

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationFILL Battery.grf



Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: COLMA SAND

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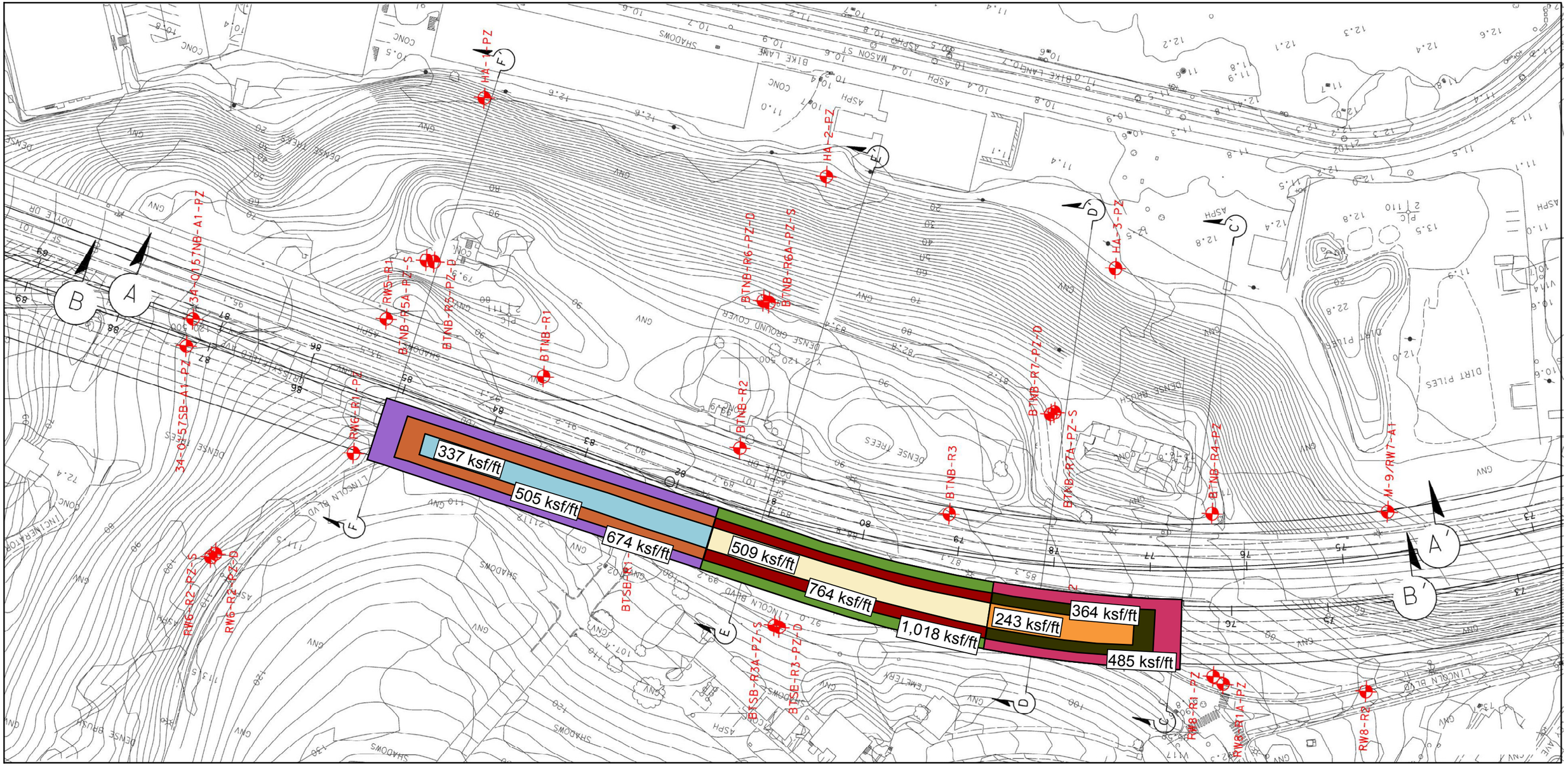
FIGURE 13

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationCOLMA Battery.grf



k_S = 674 ksf/ft	k_S = 1,018 ksf/ft	k_S = 485 ksf/ft
k_S = 505 ksf/ft	k_S = 764 ksf/ft	k_S = 364 ksf/ft
k_S = 337 ksf/ft	k_S = 509 ksf/ft	k_S = 243 ksf/ft

ESTIMATED VERTICAL SPRING CONSTANTS

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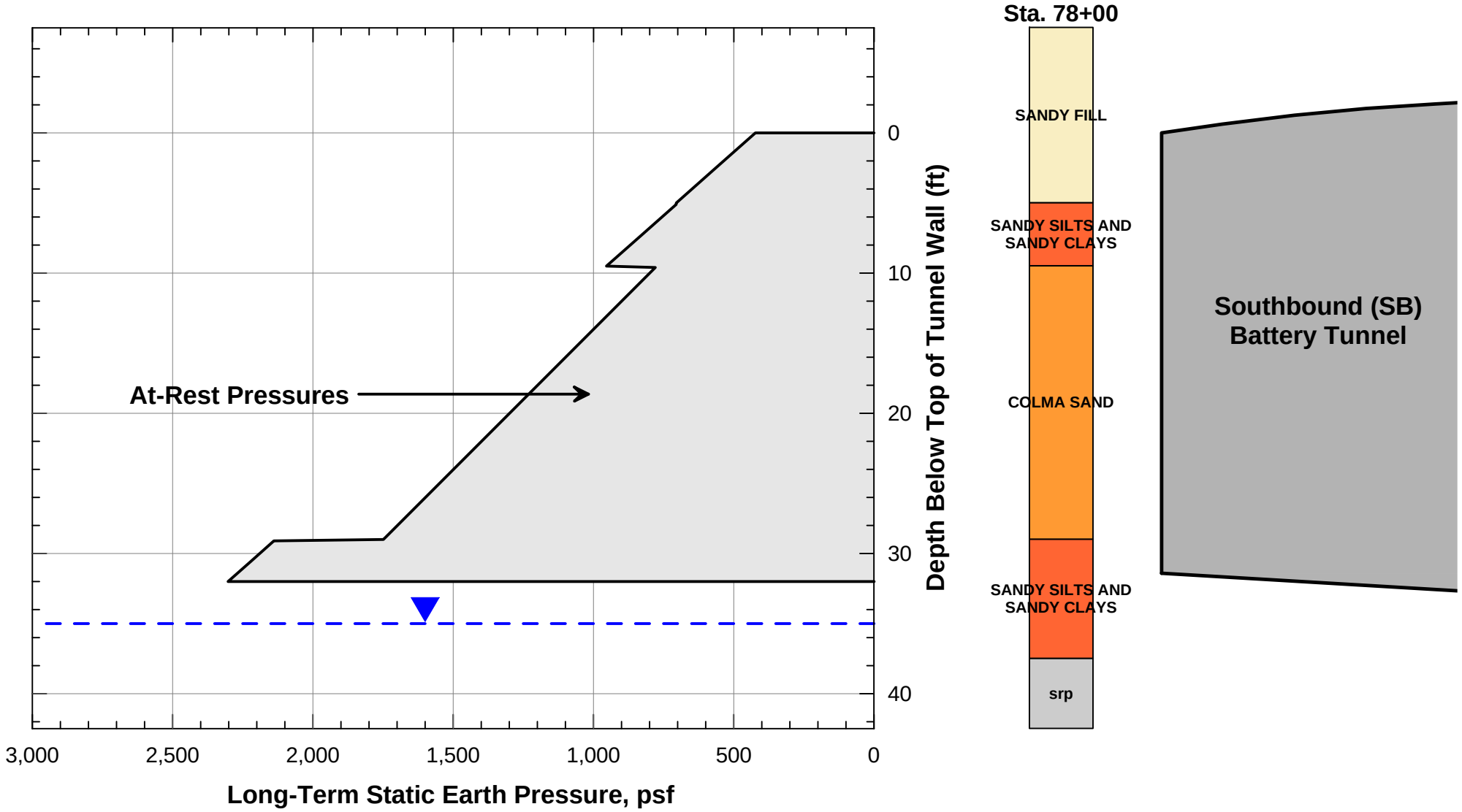
FIGURE 14

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Soil Springs\Spring ConstantsSouthbound.grf



LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

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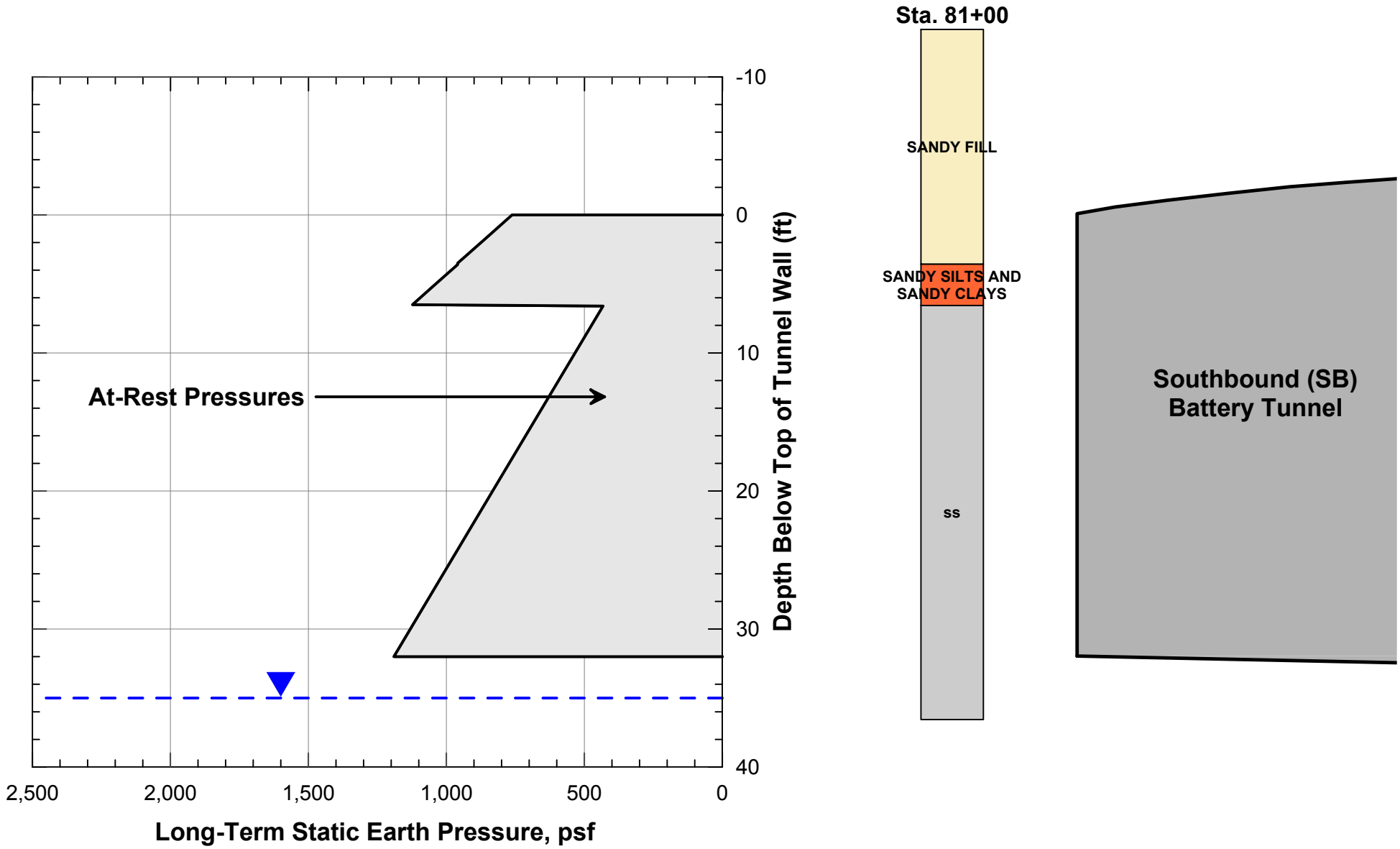
FIGURE 15

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 78SB-S.grf



LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

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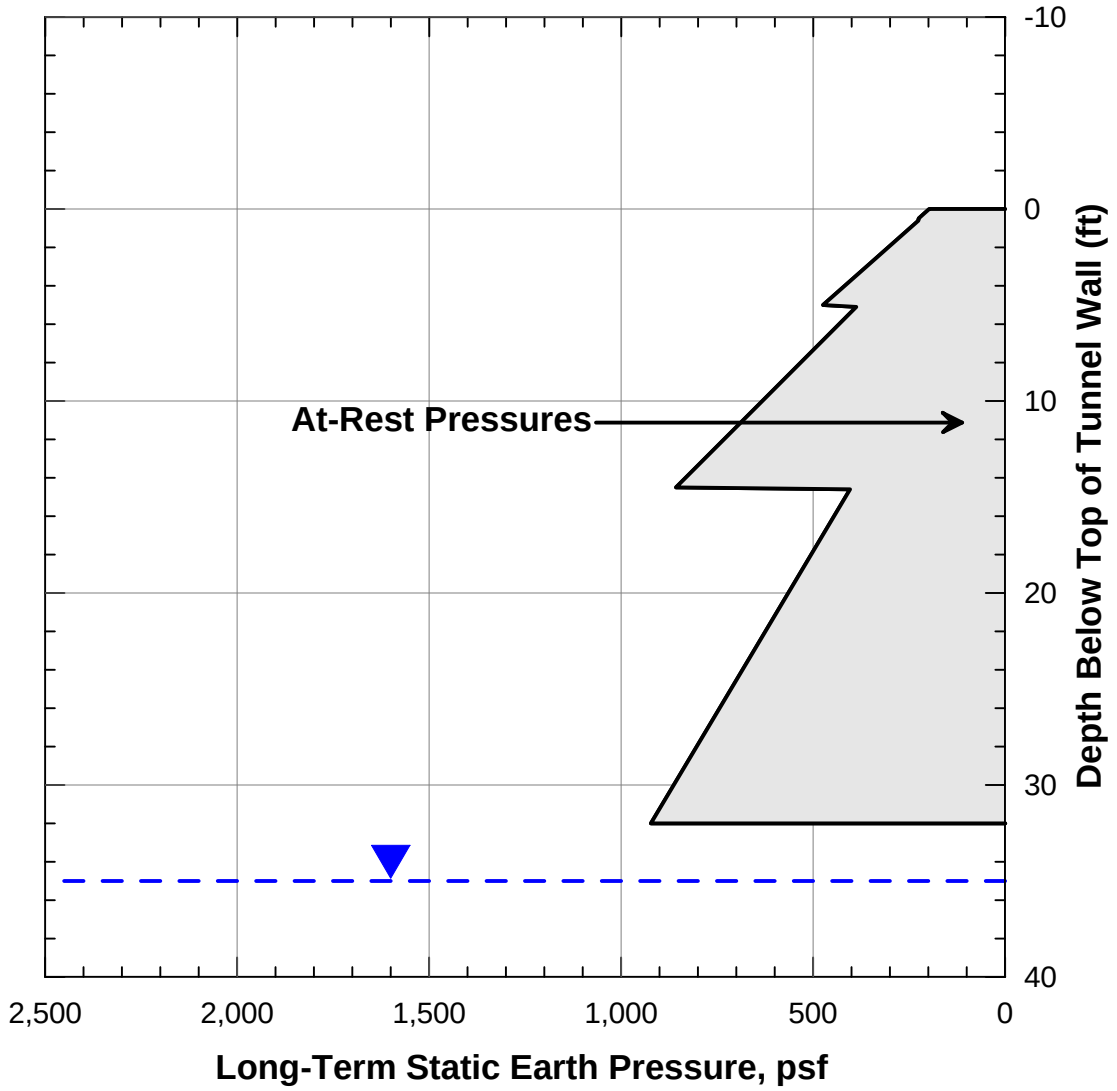
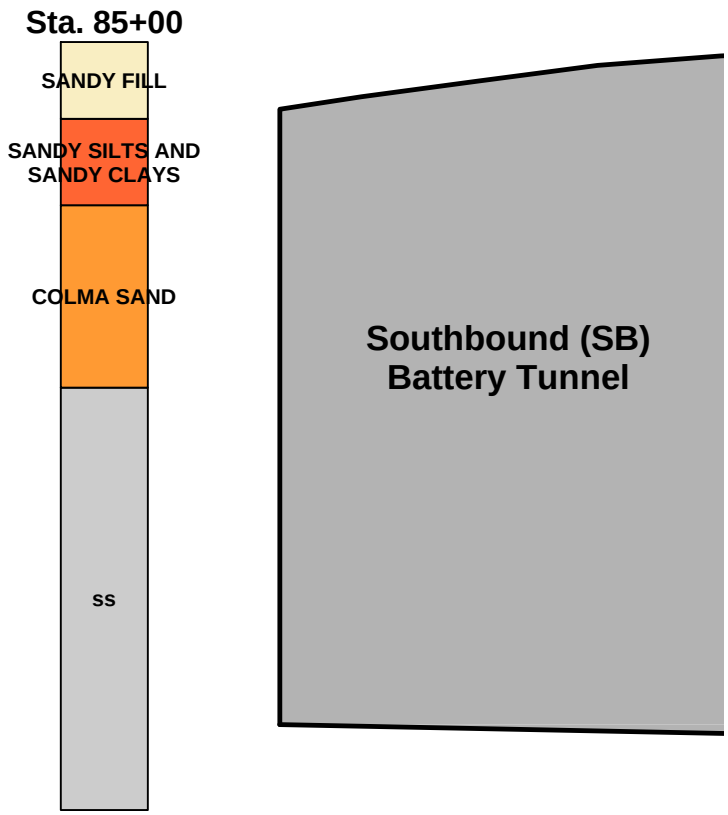
FIGURE 16

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 81SB-S.grf





LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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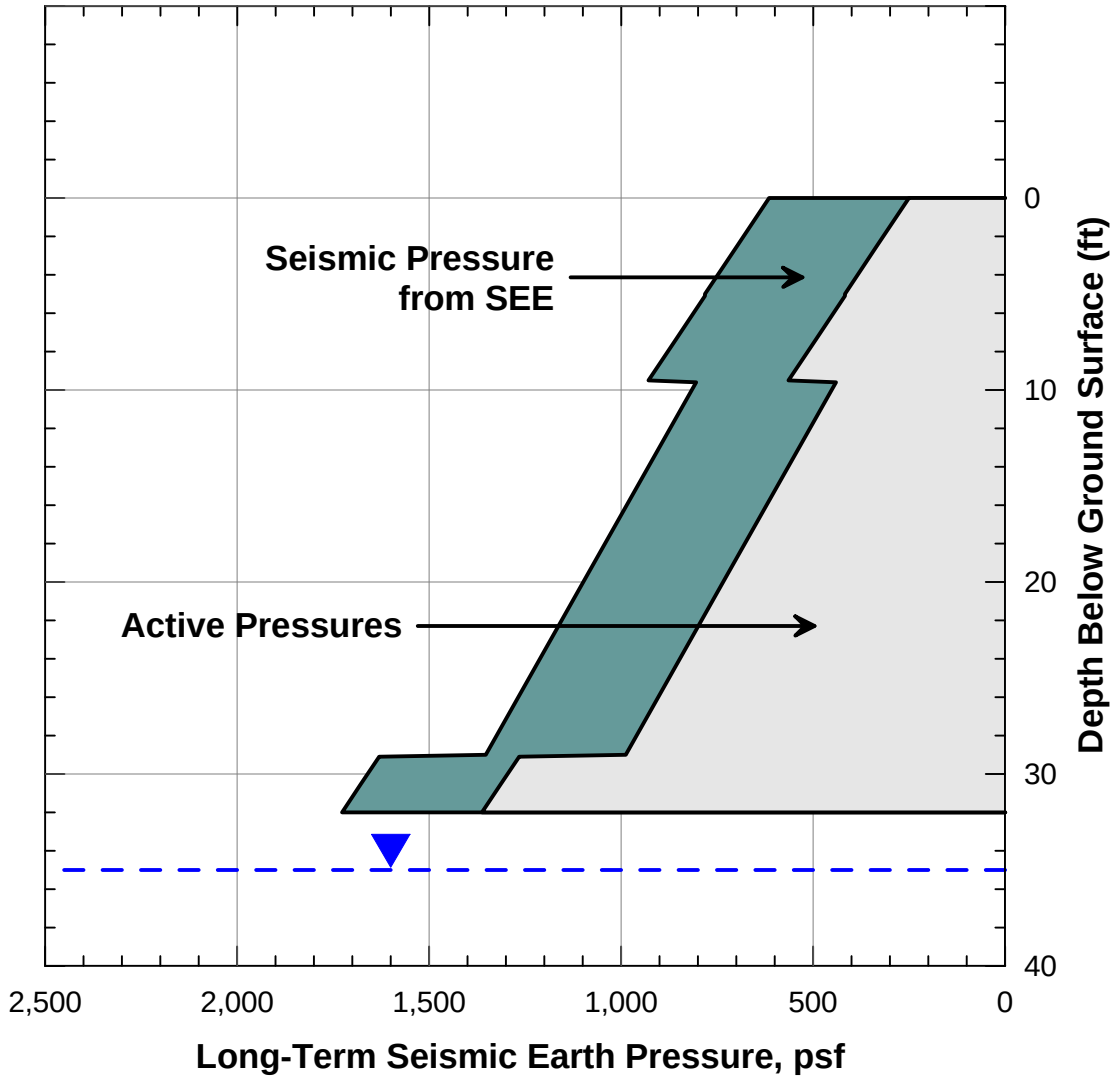
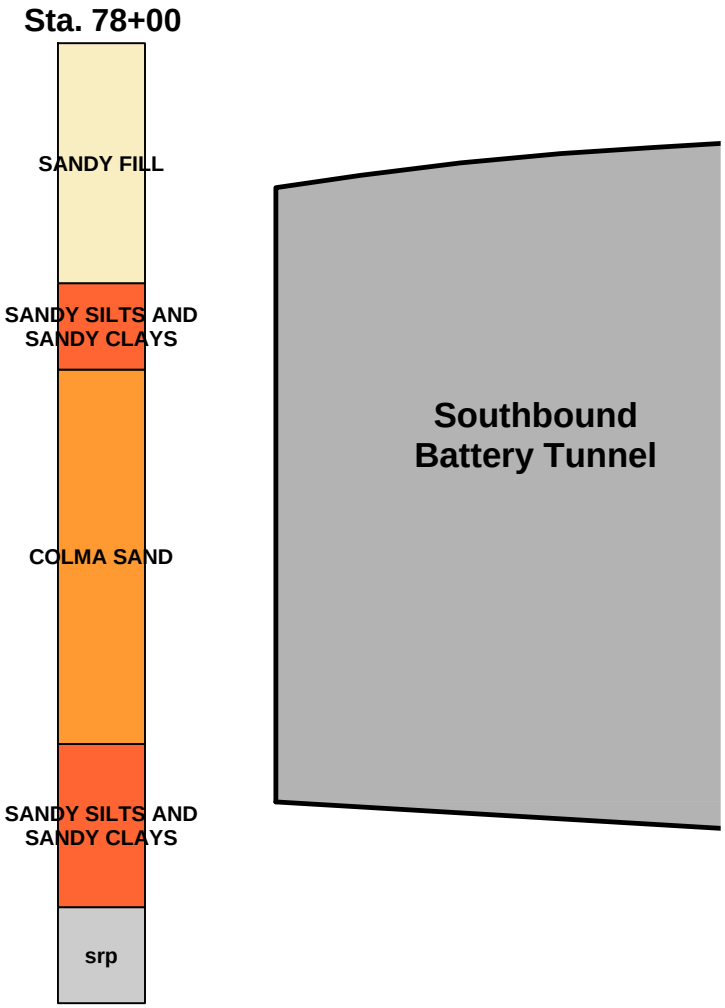
FIGURE 17

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 85SB-S.grf





LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

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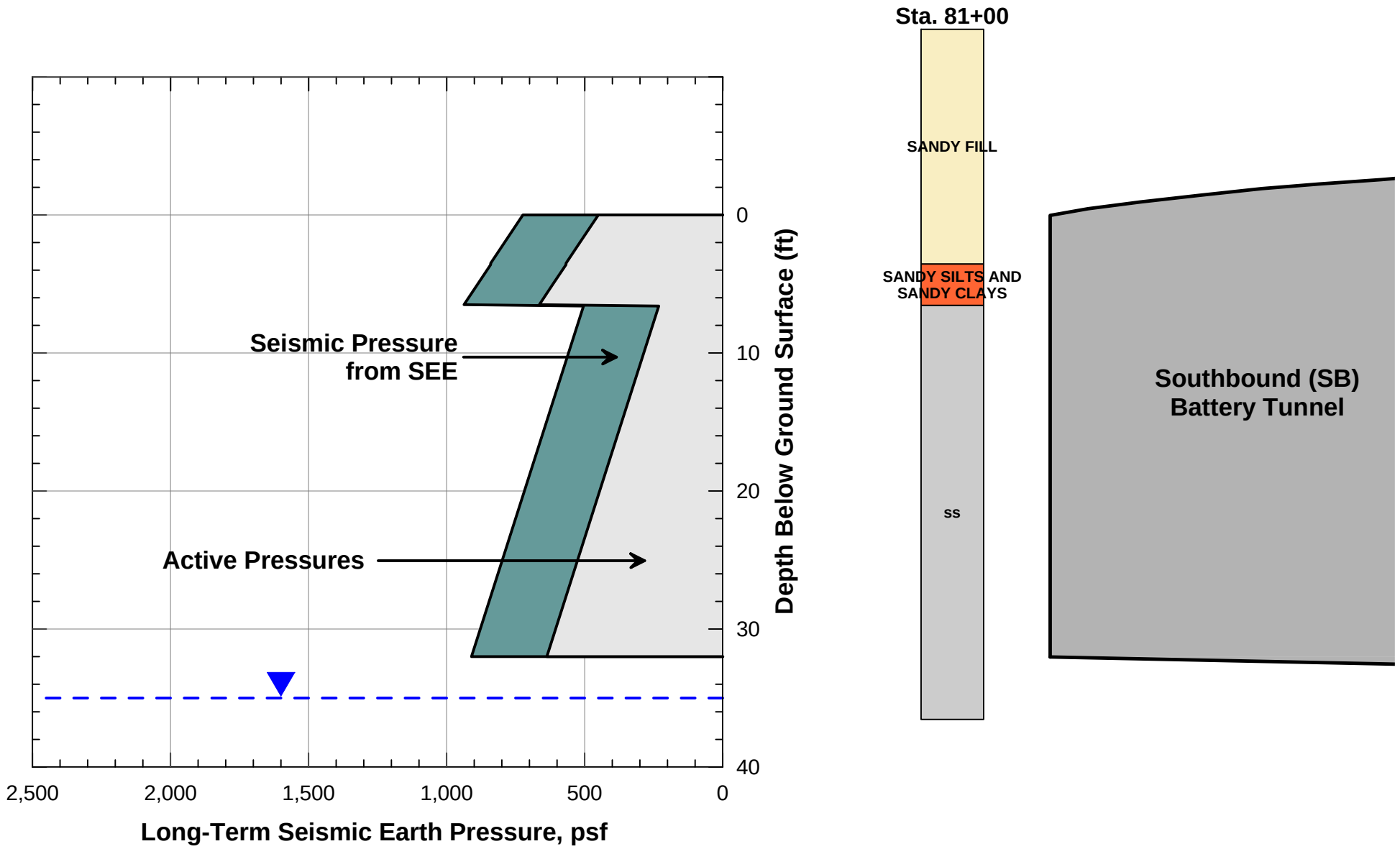
FIGURE 18

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 78SB-S.grf



LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

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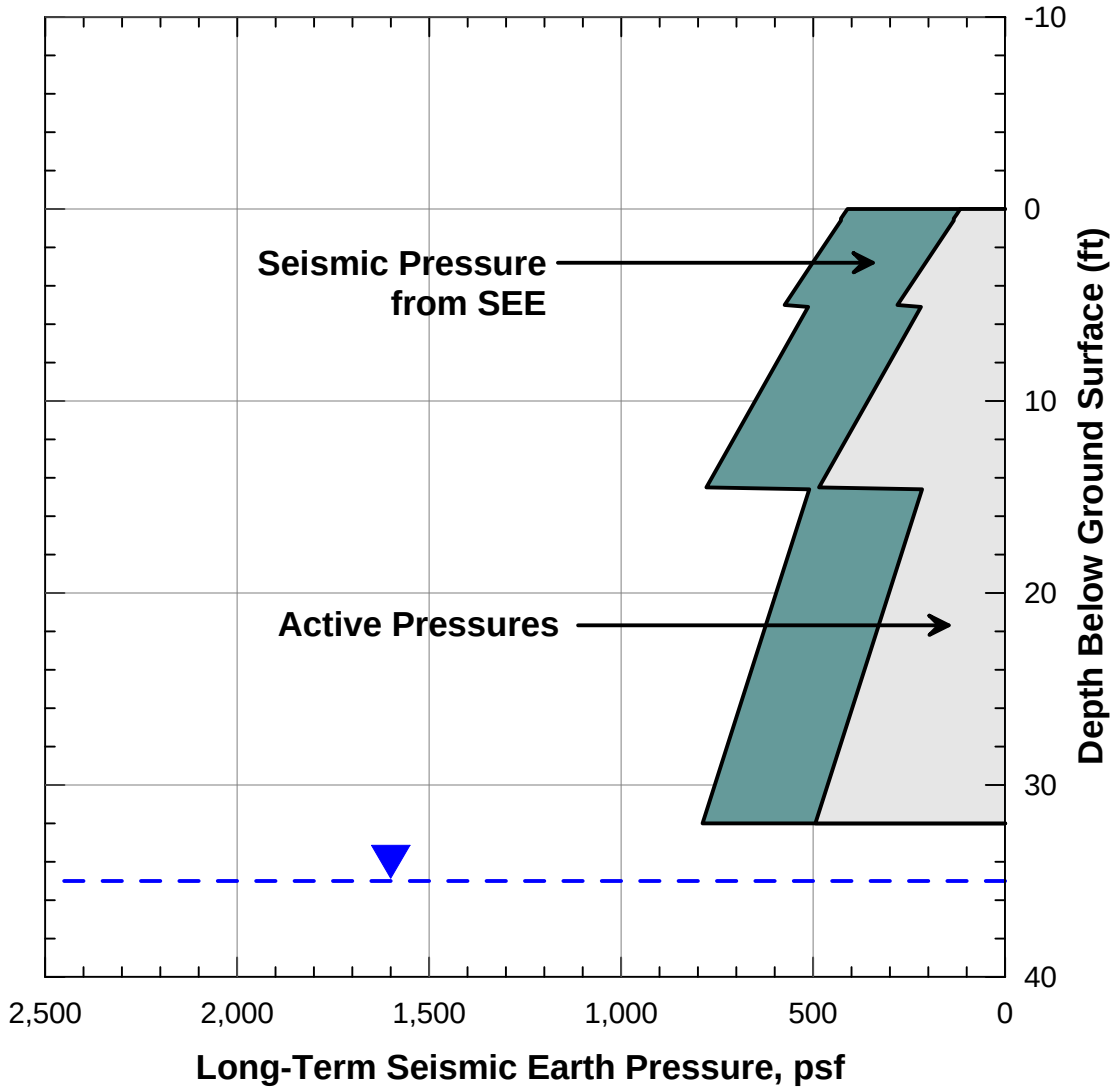
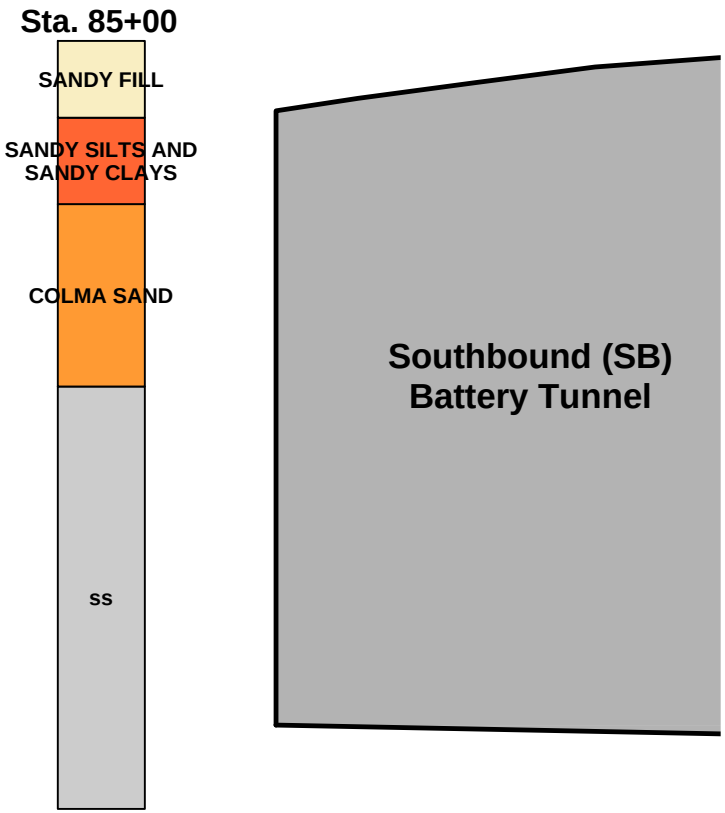
FIGURE 19

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 81SB-S.grf





LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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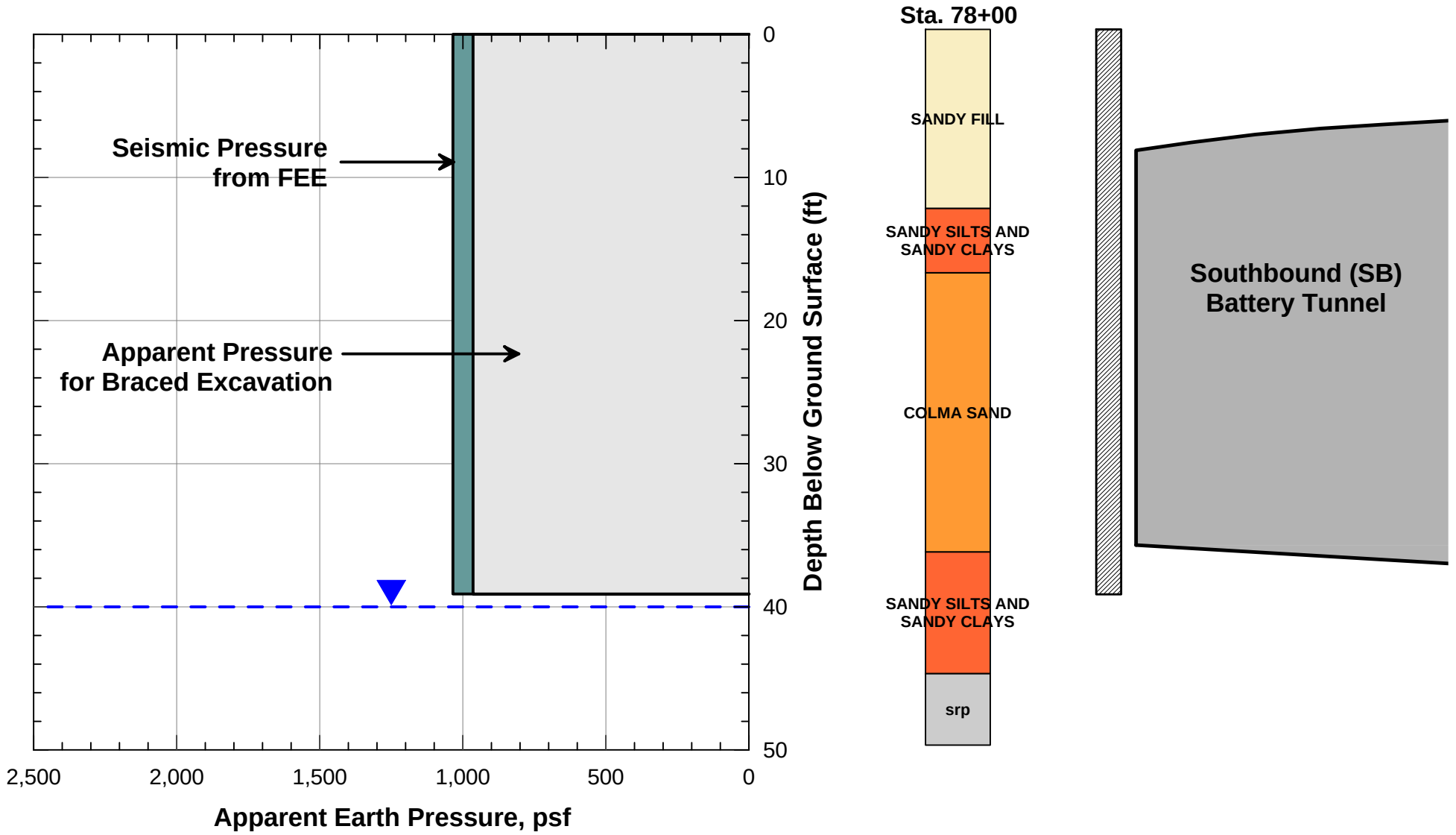
FIGURE 20

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 85SB-S.grf



APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

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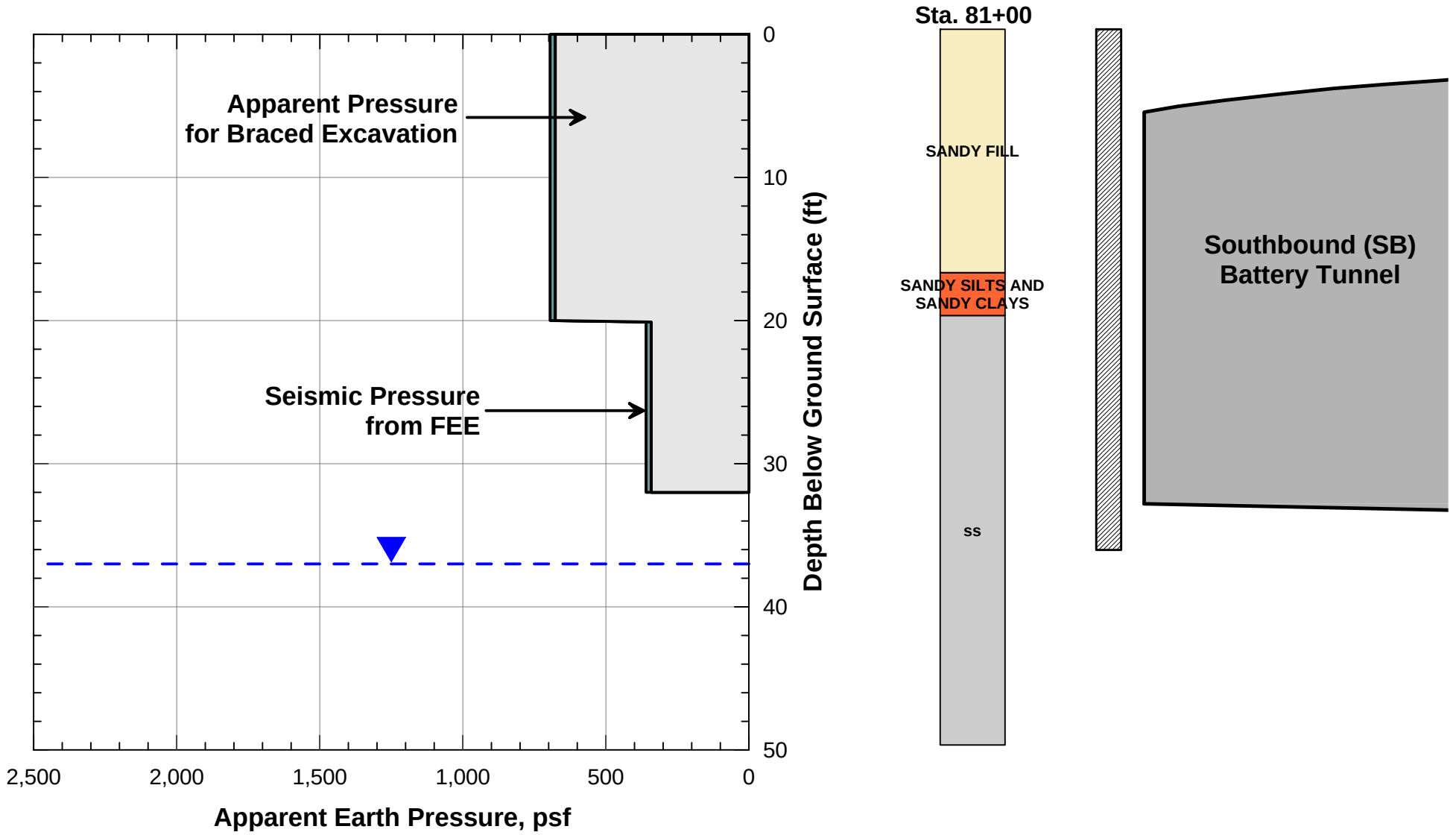
FIGURE 21

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 78SB-S.grf



APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

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August 2009 San Francisco, California

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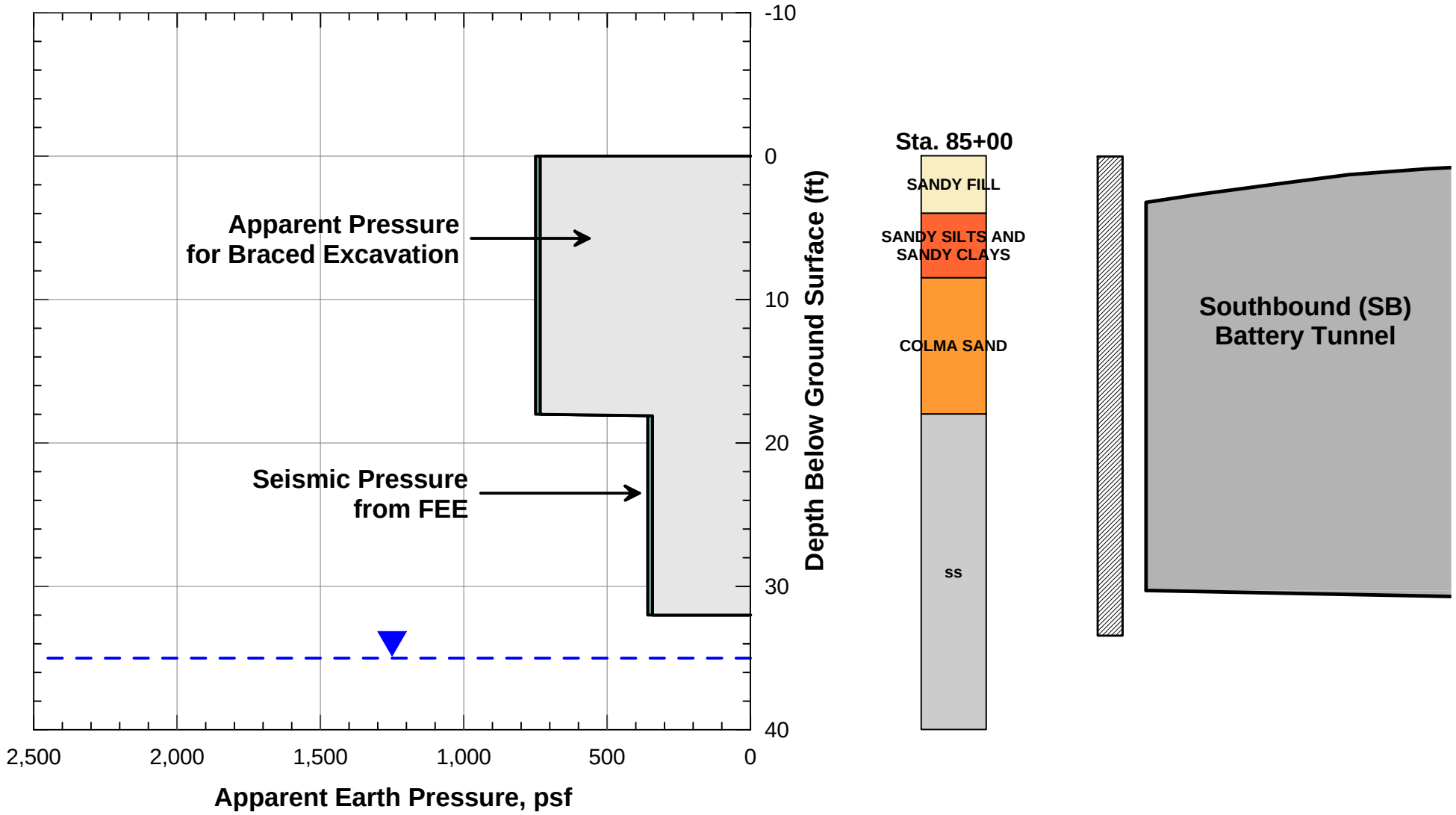
FIGURE 22

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 81SB-S.grf



APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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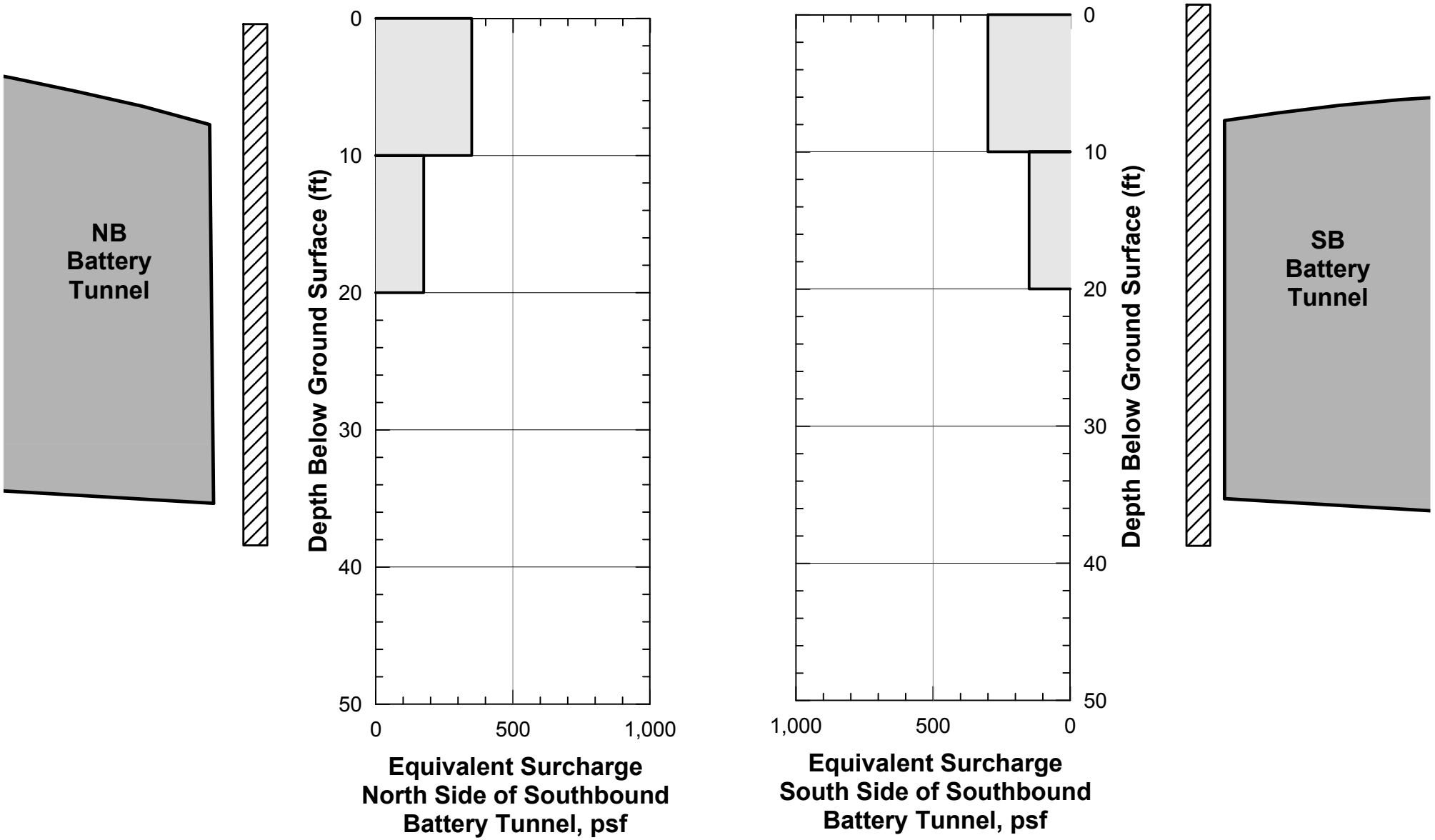
FIGURE 23

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 85SB-S.grf



EQUIVALENT SURCHARGES TO BE APPLIED TO THE TUNNEL AND RETAINING WALLS

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San Francisco County Transportation Authority
August 2009 San Francisco, California

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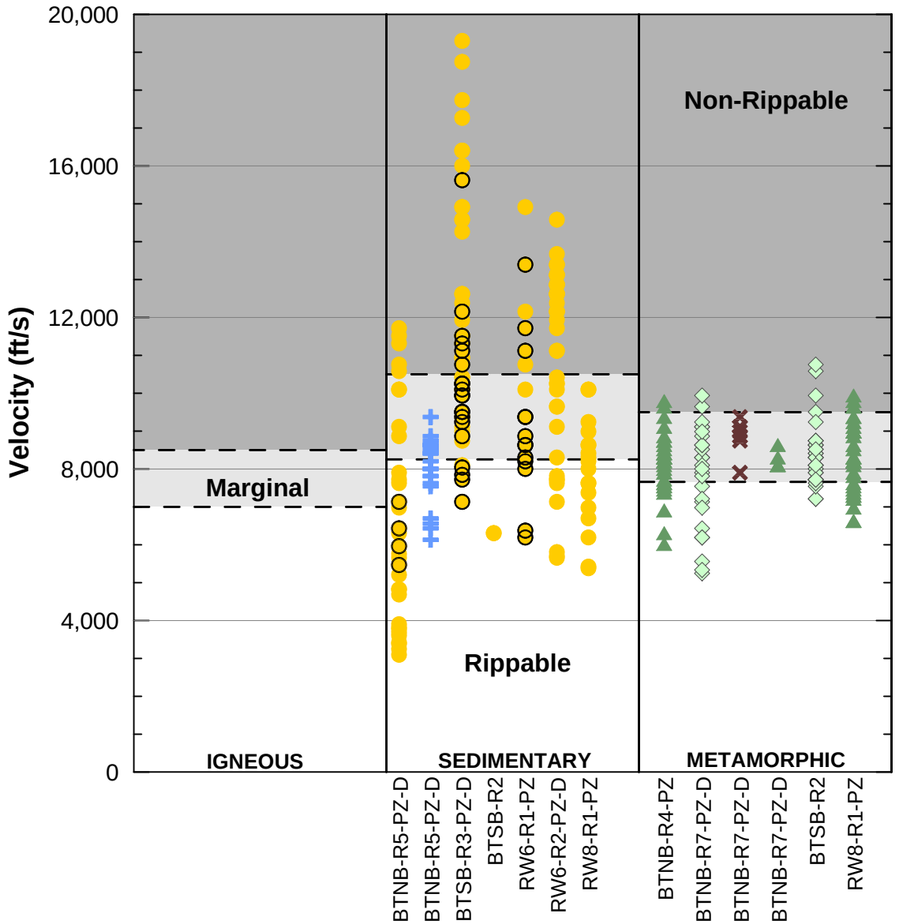
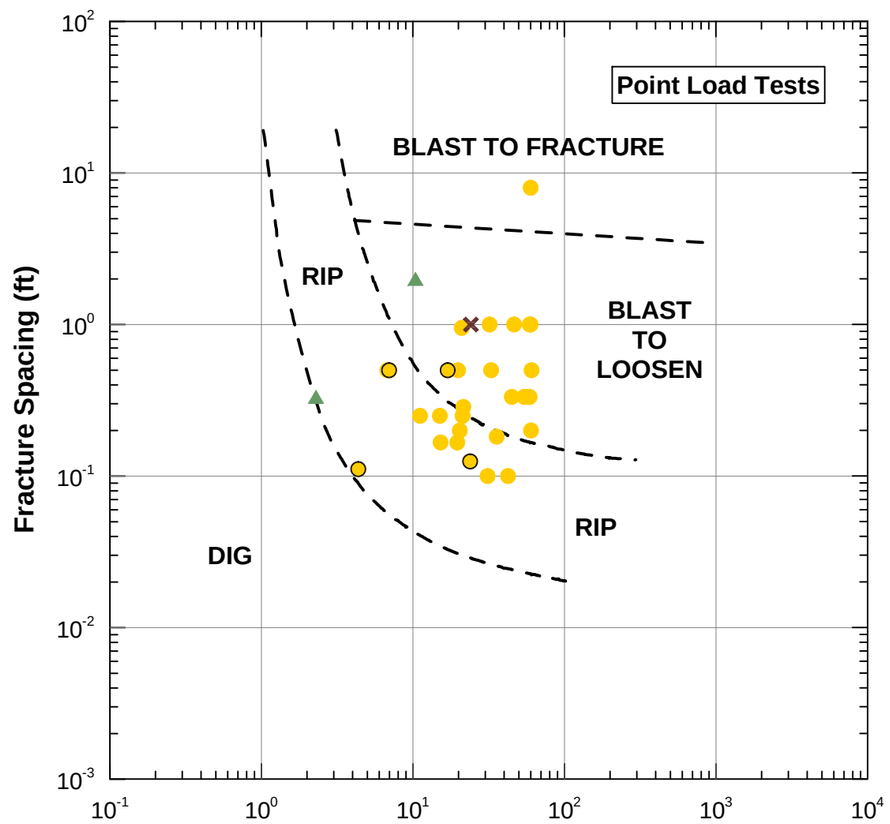
FIGURE 24

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Surcharge Pressures.grf



Symbol	Rock Identification
○	Sandstone Within 10' Of Excavation
●	Sandstone >10' Below Excavation
×	Gabbro Below Excavation
+	Melange Matrix Below Excavation
▲	Serpentinite Below Excavation
◇	Greenstone Below Excavation



Symbol	Rock Type
×	Gabbro
○	Sandstone At or Above Foundation
●	Sandstone Below Foundation
▲	Serpentinite

Notes:

1.) Excavatability of rock based on criteria as shown in Fig. 8 of Naval Facilities Engineering Command, Design Manual 7.02 (1986).
2.) Blasting criteria are as shown in Fig. 9 of Naval Facilities Engineering Command, Design Manual 7.02 (1986).
3.) Velocity data presented is from P-wave results obtained from suspension velocity logging.

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\PS Logging\Excavatability from PLI and PS.grf

EMPIRICAL ESTIMATES OF EXCAVATABILITY OF ROCK BASED ON THE RESULTS OF POINT LOAD AND SUSPENSION VELOCITY TESTS

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
August 2009 San Francisco, California

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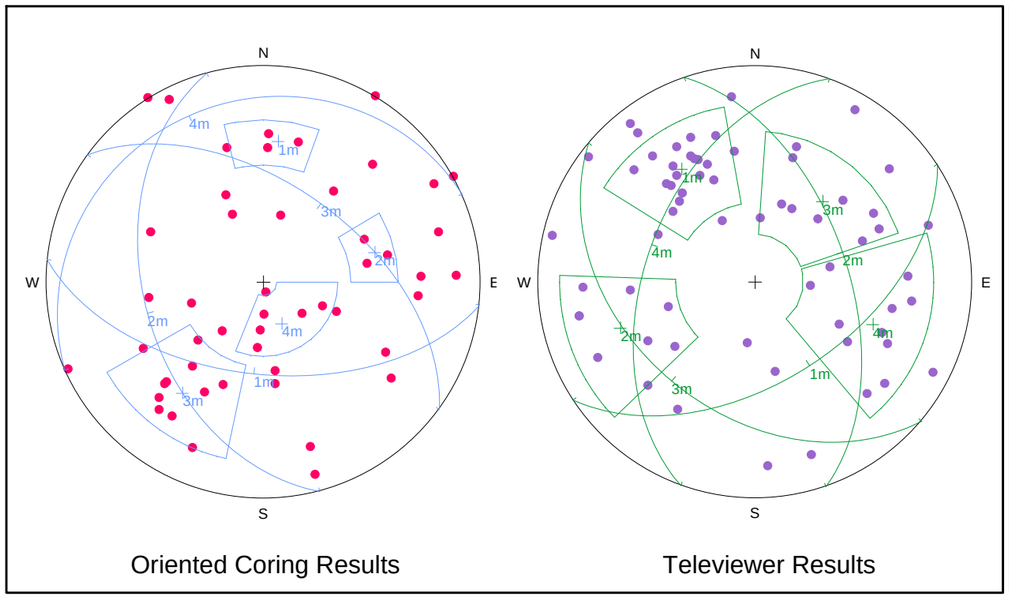
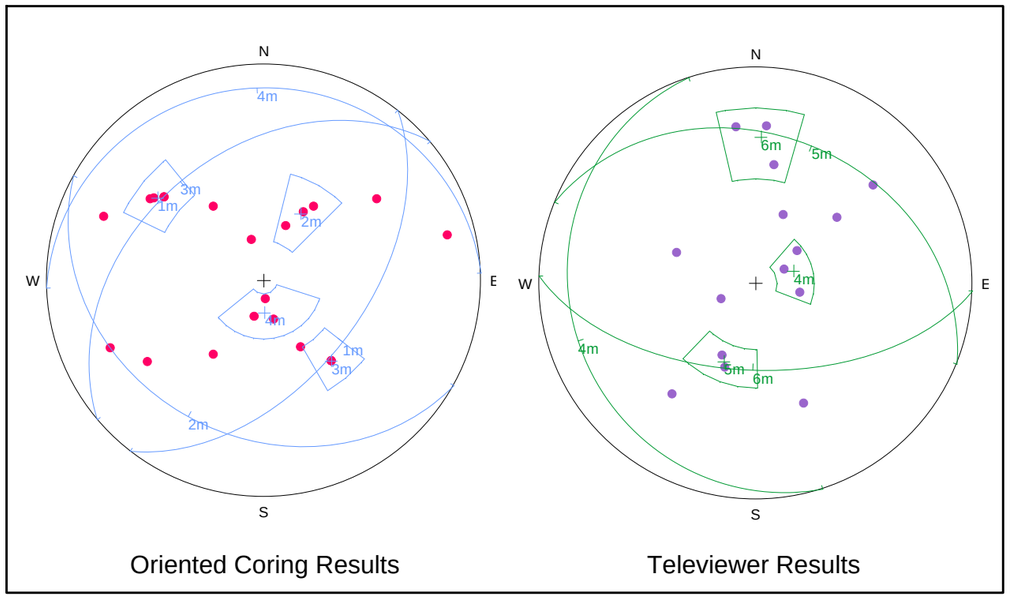
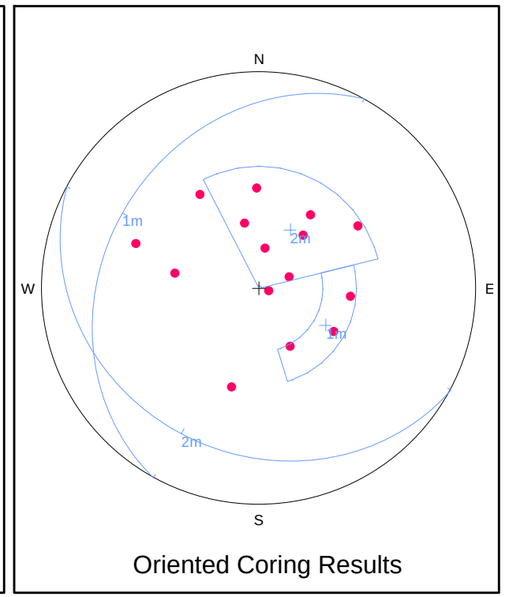
FIGURE 25



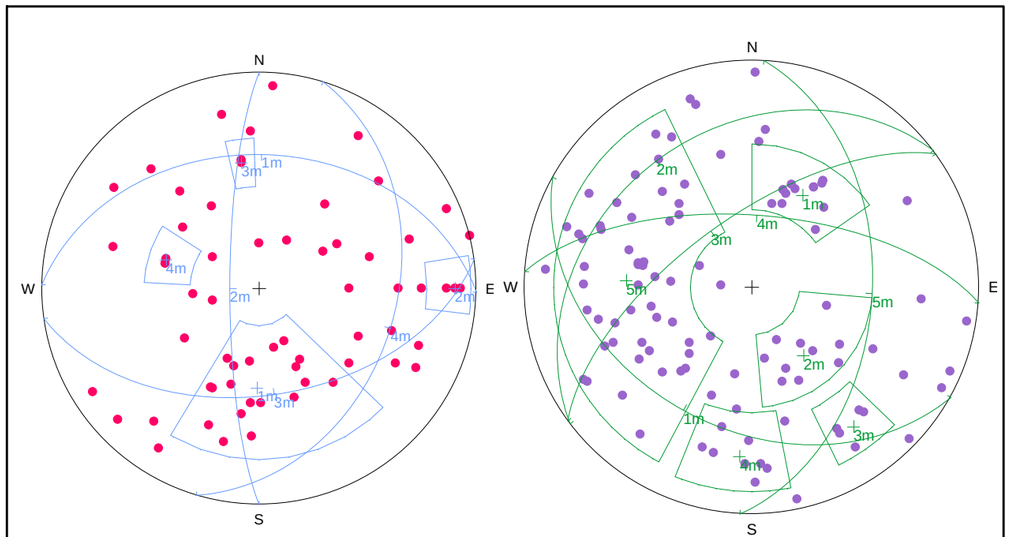
Borehole: BTNB-R5-PZ-D



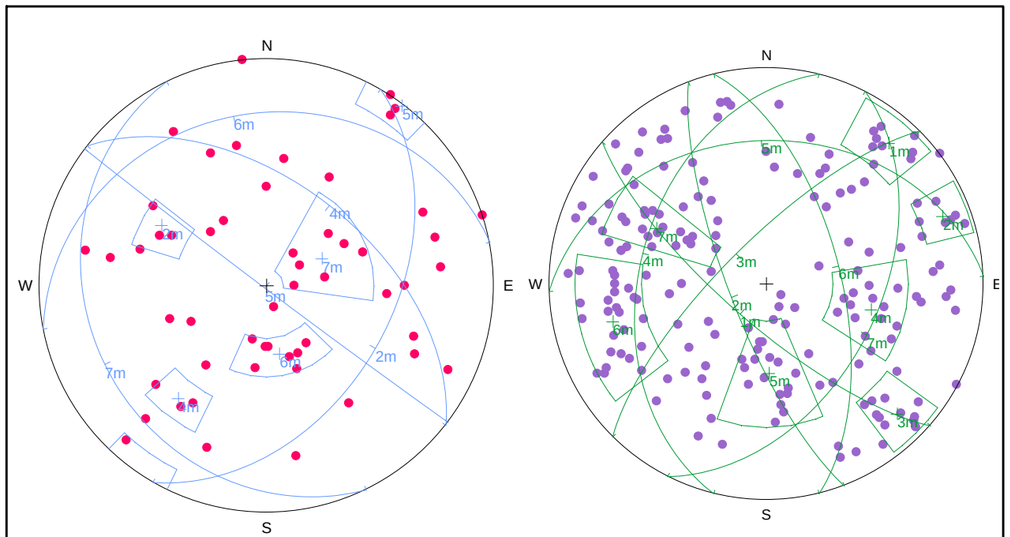
Borehole: BTNB-R7-PZ-D



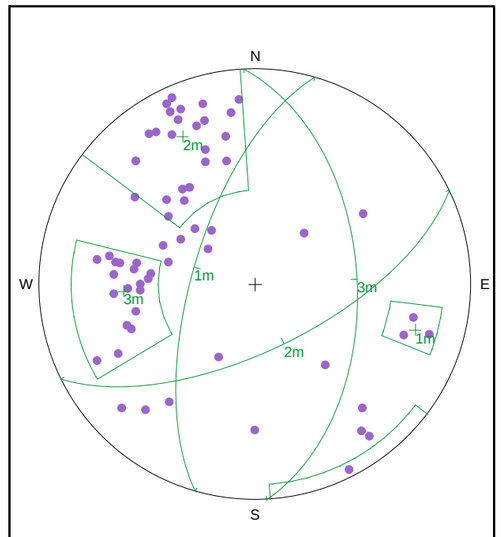
Borehole: BTNB-R6-PZ-D



Borehole: BTSB-R3-PZ-D



Borehole: RW6-R2-PZ-D



Borehole: RW6-R1-PZ

Notes:

1.) Stereonet plots are equal area, lower hemisphere projections.
2.) Groupings of similar rock orientations are shown on each plot along with the corresponding pole location.
3.) An acoustic televiewer test was not performed in Borehole BTNB-R6-PZ-D. Oriented Coring was not performed in borehole RW6-R1-PZ

COMPARISON OF RESULTS FROM ACOUSTIC TELEVIEWER TESTS AND ORIENTED ROCK CORING TESTS PLOTTED ON STEREONETS

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August 2009 San Francisco, California

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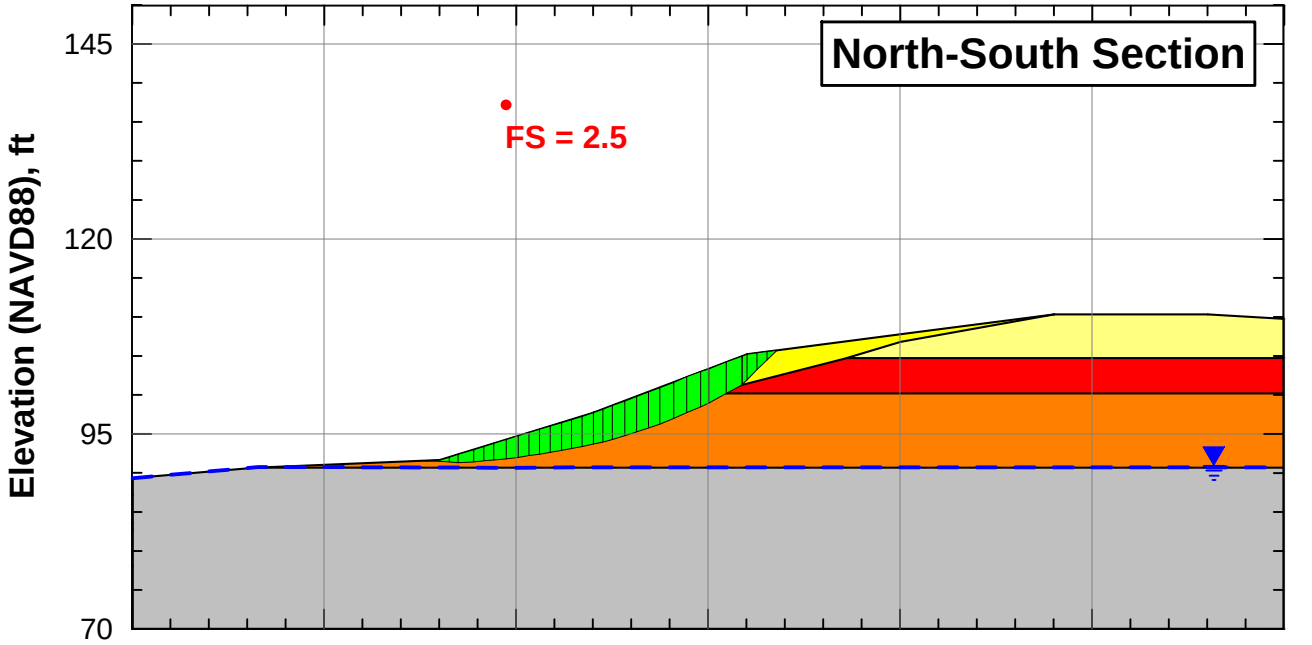
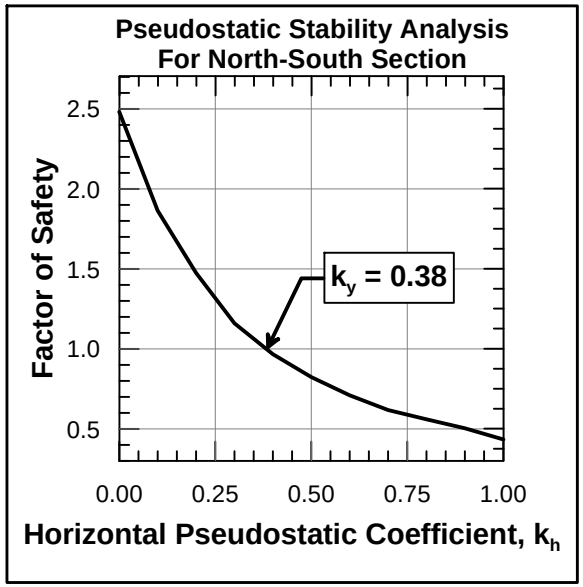
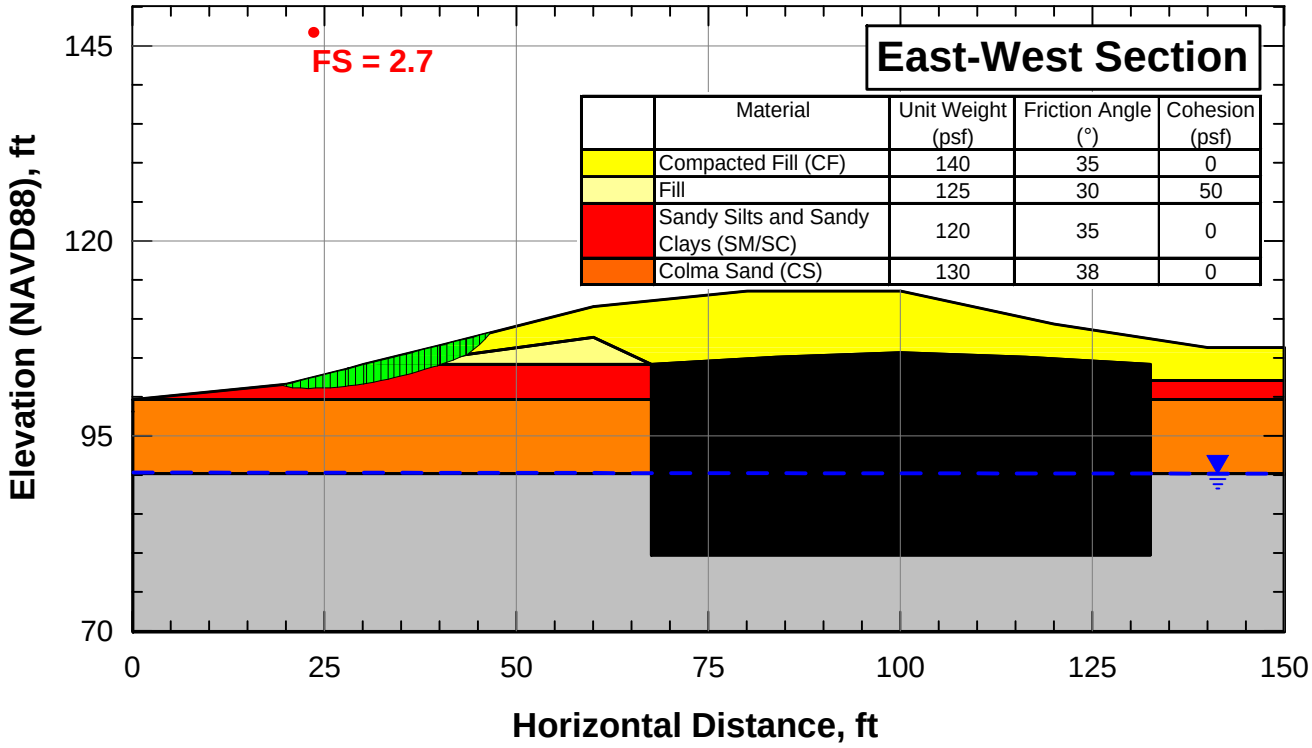
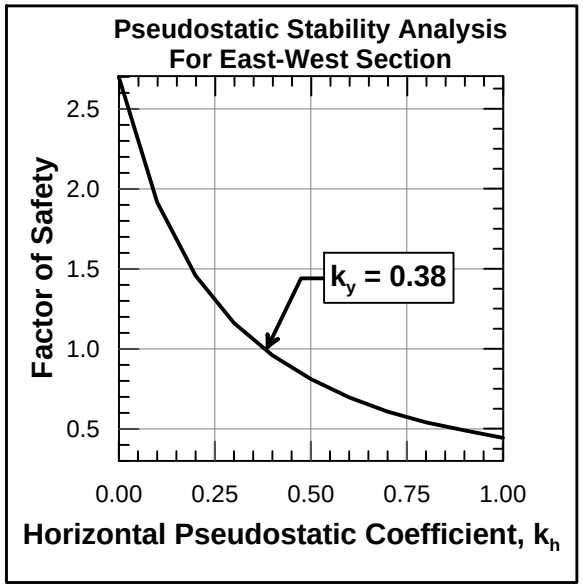
FIGURE 26

Q:\131558\4a Arup Internal Project Data\4a-15 Geotech\4a-015-002 Site Exploration Data\03 Field Tests\Oriented Coring\dips\Stereonet Comparison.grf









STABILITY ANALYSIS OF THE PROPOSED RE-GRADING AT THE WEST PORTAL OF THE SOUTHBOUND BATTERY TUNNEL

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
San Francisco, California

August 2009

ARUP PB joint venture

FIGURE 27

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stability Calcs\Battery Tunnel\West_Portal E-W.grf

Appendix A

Geotechnical Exploration Program

A.1 Logs of Test Borings
A.2 Boring Records
A.3 Logs by Others

APPENDIX A.1

Logs of Test Borings

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

BENCH MARK
BM SF 14 Elev 96.261
N 2121118.081
S 5992820.017

DATUM:
Horizontal NAD83
Vertical NAVD88

LOCATION AND DESCRIPTION:
Set 1" Caltrans brass plug in concrete, northbound Lincoln Blvd, approx. 205' north of the north over-crossing of Doyle Drive, on a concrete vista point structure, 21.1' north of the first bollard after a bus turnout, 14.4' southeast of 1.3' wide raised wall in the vista point structure, 2' west of the east edge.

REGISTERED CIVIL ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

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560 Mission Street, Suite 700
San Francisco, CA 94105

"SB" Line
Curve Data:
R = 1380.00'
Δ = 38°24'25"
T = 453.81'
L = 876.88'

"SB" LINE 80+35.11 EC

N 75°11'28.14" W

RW8-R1-PZ
BTSB-R2
BTSB-R3-PZ-D
BTSB-R1-PZ
RW6-R1-PZ
BTNB-R3
BTNB-R2
BTNB-R1
RW5-R1
BTNB-R4-PZ
BTNB-R7-PZ-D
BTNB-R6-PZ-D
BTNB-R5-PZ-D

"SB" LINE
"NB" LINE

TO SAN FRANCISCO
TO GOLDEN GATE BRIDGE
LINCOLN BLVD
SHERIDAN AVE
CEMETERY
CONC
ASPH
BATTERIES
DIRT PILES
HISTORICAL Bldg
SF TOT
DOYLE DR
V117 95.5
V114 10.1
Y 2 120 500
P.I.C. 2+111

PLAN
HOR. 1"=40'
VER. 1"=40'

SBBT-LTB1

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 1 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 07/27/09 08/07/09 08/20/09 — SHEET OF

FILE => SBBT-LTB1.dgn

USERNAME => royce.sui@arup.com PLOTTED => 8/20/2009 TIME PLOTTED => 4:34:46 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

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San Francisco, CA 94105

BENCH MARK
BM SF 14 Elev 96.261′

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

NOTES:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

PROFILE
HOR. 1"=10′
VER. 1"=10′

SBBT-LTB2

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: STEPHEN MCLANDRICH	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 2 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/29/09, 08/07/09, 08/20/09 — SHEET — OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

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PLANS APPROVAL DATE

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San Francisco, CA 94105

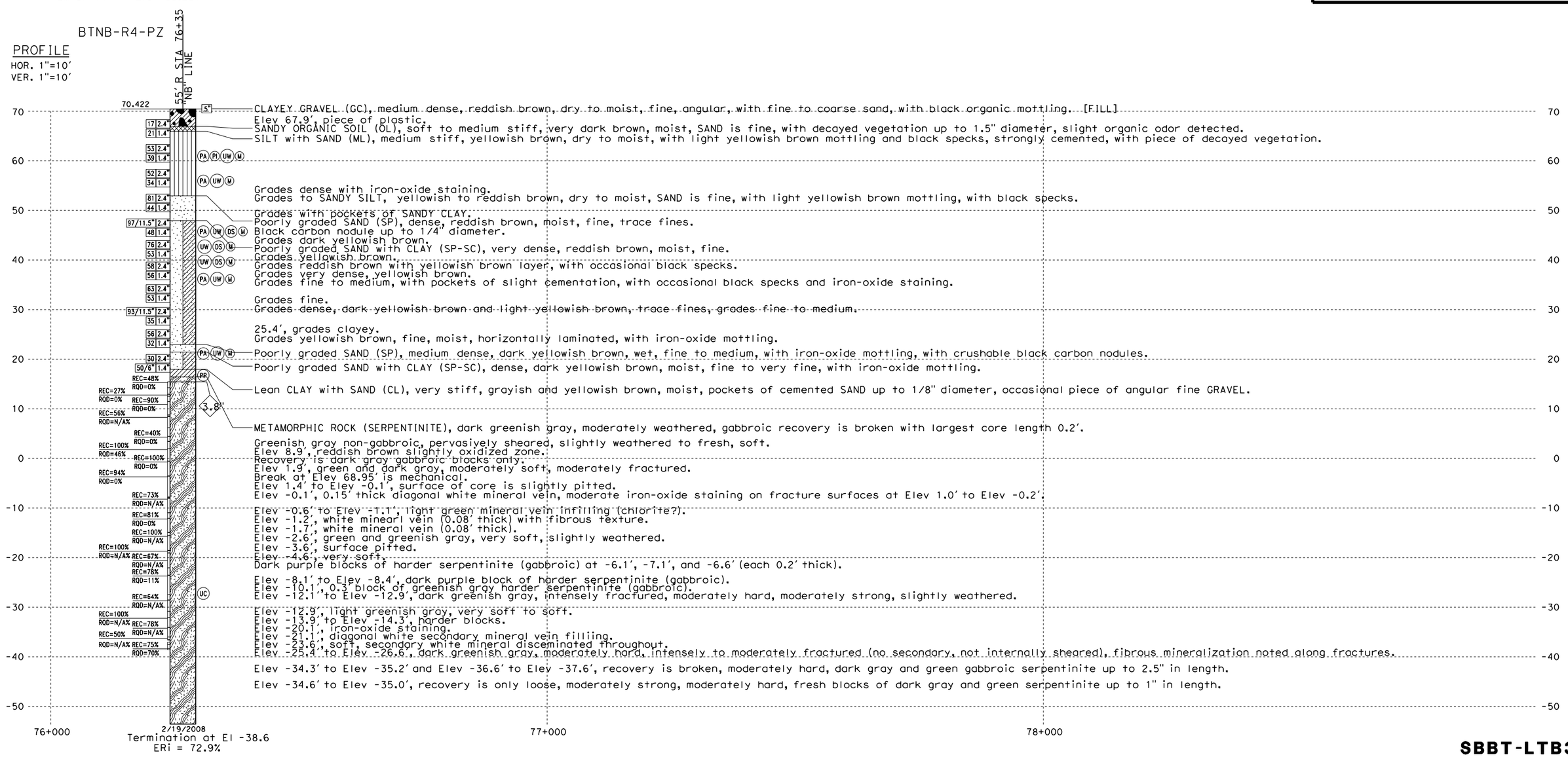
FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

BENCH MARK
BM SF 14 Elev 96.261'

BTNB-R4-PZ

PROFILE
HOR. 1"=10'
VER. 1"=10'

55' R STA 76+35 "NB" LINE



2/19/2008
Termination at El -38.6
ERi = 72.9%

CLAYEY GRAVEL (GC), medium dense, reddish brown, dry to moist, fine, angular, with fine to coarse sand, with black organic mottling. [FILL]
Elev 67.9', piece of plastic.
SANDY ORGANIC SOIL (OL), soft to medium stiff, very dark brown, moist, SAND is fine, with decayed vegetation up to 1.5" diameter, slight organic odor detected.
SILT with SAND (ML), medium stiff, yellowish brown, dry to moist, with light yellowish brown mottling and black specks, strongly cemented, with piece of decayed vegetation.

Grades dense with iron-oxide staining.
Grades to SANDY SILT, yellowish to reddish brown, dry to moist, SAND is fine, with light yellowish brown mottling, with black specks.
Grades with pockets of SANDY CLAY.
Poorly graded SAND (SP), dense, reddish brown, moist, fine, trace fines.
Black carbon nodule up to 1/4" diameter.
Grades dark yellowish brown.
Poorly graded SAND with CLAY (SP-SC), very dense, reddish brown, moist, fine.
Grades yellowish brown.
Grades reddish brown with yellowish brown layer, with occasional black specks.
Grades very dense, yellowish brown.
Grades fine to medium, with pockets of slight cementation, with occasional black specks and iron-oxide staining.

Grades fine.
Grades dense, dark yellowish brown and light yellowish brown, trace fines, grades fine to medium.

25.4', grades clayey.
Grades yellowish brown, fine, moist, horizontally laminated, with iron-oxide mottling.
Poorly graded SAND (SP), medium dense, dark yellowish brown, wet, fine to medium, with iron-oxide mottling, with crushable black carbon nodules.
Poorly graded SAND with CLAY (SP-SC), dense, dark yellowish brown, moist, fine to very fine, with iron-oxide mottling.
Lean CLAY with SAND (CL), very stiff, grayish and yellowish brown, moist, pockets of cemented SAND up to 1/8" diameter, occasional piece of angular fine GRAVEL.

METAMORPHIC ROCK (SERPENTINITE), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.
Greenish gray non-gabbroic, pervasively sheared, slightly weathered to fresh, soft.
Elev 8.9', reddish brown slightly oxidized zone.
Recovery is dark gray gabbroic blocks only.
Elev 1.9', green and dark gray, moderately soft, moderately fractured.
Break at Elev 68.95' is mechanical.
Elev 1.4' to Elev -0.1', surface of core is slightly pitted.
Elev -0.1', 0.15' thick diagonal white mineral vein, moderate iron-oxide staining on fracture surfaces at Elev 1.0' to Elev -0.2'.
Elev -0.6' to Elev -1.1', light green mineral vein infilling (chlorite?).
Elev -1.2', white mineral vein (0.08' thick) with fibrous texture.
Elev -1.7', white mineral vein (0.08' thick).
Elev -2.6', green and greenish gray, very soft, slightly weathered.
Elev -3.6', surface pitted.
Elev -4.6', very soft.
Dark purple blocks of harder serpentinite (gabbroic) at -6.1', -7.1', and -6.6' (each 0.2' thick).
Elev -8.1' to Elev -8.4', dark purple block of harder serpentinite (gabbroic).
Elev -10.1', 0.3' block of greenish gray harder serpentinite (gabbroic).
Elev -12.1' to Elev -12.9', dark greenish gray, intensely fractured, moderately hard, moderately strong, slightly weathered.
Elev -12.9', light greenish gray, very soft to soft.
Elev -13.9' to Elev -14.3', harder blocks.
Elev -20.1', iron-oxide staining.
Elev -21.1', diagonal white secondary mineral vein filliing.
Elev -23.6', soft, secondary white mineral disceminated throughout.
Elev -25.4' to Elev -26.6', dark greenish gray, moderately hard, intensely to moderately fractured (no secondary, not internally sheared), fibrous mineralization noted along fractures.
Elev -34.3' to Elev -35.2' and Elev -36.6' to Elev -37.6', recovery is broken, moderately hard, dark gray and green gabbroic serpentinite up to 2.5" in length.
Elev -34.6' to Elev -35.0', recovery is only loose, moderately strong, moderately hard, fresh blocks of dark gray and green serpentinite up to 1" in length.

SBBT-LTB3

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SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 3 of 17

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04242
EA 163741

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES: 07/29/09 | 08/07/09 | 08/20/09

SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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San Francisco, CA 94105

BENCH MARK
BM SF 14 Elev 96.261′

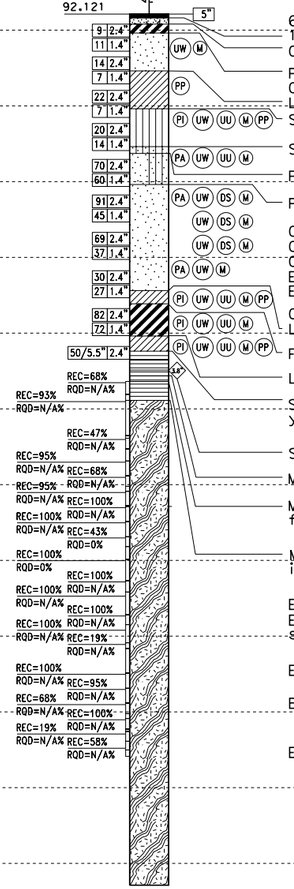
FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

PROFILE
HOR. 1"=10′
VER. 1"=10′

BTSB-R2

47′ L STA 77+65 "SB" LINE

92.121



2/29/2008
Termination at El -22.9
ERi = 76.2%

6" ASPHALT CONCRETE.
10" Unreinforced aggregate CONCRETE.
GRAVELLY fat CLAY (CH), loose, dark brown, moist, GRAVEL is angular, with SAND. [FILL]
Poorly graded SAND (SP), loose, dark yellowish brown, dry to moist, fine, trace fines. [FILL]
Grades dark brown.
Lean CLAY (CL), soft, dark brown, moist, trace fine SAND.
SILT (ML), medium stiff, yellowish brown, moist, trace fine SAND, frequent dark brown oxidized nodules (up to 1/2" diameter).
SILTY SAND (SM), medium dense, yellowish brown, moist to wet, fine, with root hairs (up to 1/16" diameter), with black oxidized nodules (up to 1/16" diameter).
Poorly graded SAND with SILT (SP-SM), medium dense, yellowish brown, moist to wet, fine to medium.
Poorly graded SAND, dense, yellowish brown, moist, fine, trace fines.
Grades to reddish brown with black oxidized nodules (up to 1/4" diameter).
Grades with increase in fines content.
Grades yellowish brown.
Elev 58.3′, grades weakly cemented.
Elev 57.1′, occasional fine GRAVEL (up to 1/2" diameter), subrounded, reddish brown (chert fragment).
Grades with occasional pockets of SANDY CLAY (up to 1/8" diameter).
Lean CLAY (CL), very stiff, yellowish brown and reddish brown, moist, trace fine SAND, with black specks.
Fat CLAY (CH), very stiff, yellowish brown and grayish brown, dry to moist, trace SAND, with black specks, mottled.
Lean CLAY (CL), hard, yellowish brown and light gray, trace fine SAND, mottled, with iron-oxide staining, with black specks
SEDIMENTARY ROCK (SANDSTONE), fine to coarse grained, light yellowish brown, decomposed, very soft, very intensely fractured. (CLAYEY SAND (SC), very dense, light yellowish brown, dry, fine to coarse, faint dark reddish brown predefined fracture planes, slight rock structure, with frequent manganese oxide staining.)
SEDIMENTARY ROCK (SILTSTONE), dark brown, intensely weathered, moderately hard, very intensely fractured.
METAMORPHIC ROCK (SERPENTINITE), greenish gray and yellowish brown, very intensely weathered, moderately soft, very intensely fractured.
METAMORPHIC ROCK (GRANULITE), medium to coarse SAND and fine GRAVEL-sized, yellowish brown and light greenish gray, intensely weathered, soft, very intensely fractured (crushed), intensely mylonized, localized sheared surfaces on more competent 0.1′ to 0.2′ thick blocks.
METAMORPHIC ROCK (SERPENTINITE), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT (ML), with SAND, soft, moist, SAND is fine.

Elev 23.7′, white secondary mineralization forming a banding effect.
Elev 23.1′, dark olive gray and very dark gray, moderately weathered, moderately hard to locally soft, inensely fractured, fractures dipping 15° to 25°, common secondary mineralization along closely spaced fractured/sheared surfaces throughout interval, commonly breaks 0.1′ to 0.2′ fragments (hard).

Elev 16.3′, greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured.

Bluish gray and very dark gray.

Elev -4.2′ to Elev -4.7′, sand-like texture.

NOTES:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40

77+000 78+000 79+000 80+000

SBBT-LTB4

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: STEPHEN MCLANDRICH	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2

SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 4 of 17

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04242
EA 163741

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES: 07/29/09 08/07/09 08/20/09

SHEET OF

FILE => SBBT-LTB4.dgn

USERNAME => royce.sui@arup.com PLOTTED => 8/20/2009 TIME PLOTTED => 4:07:45 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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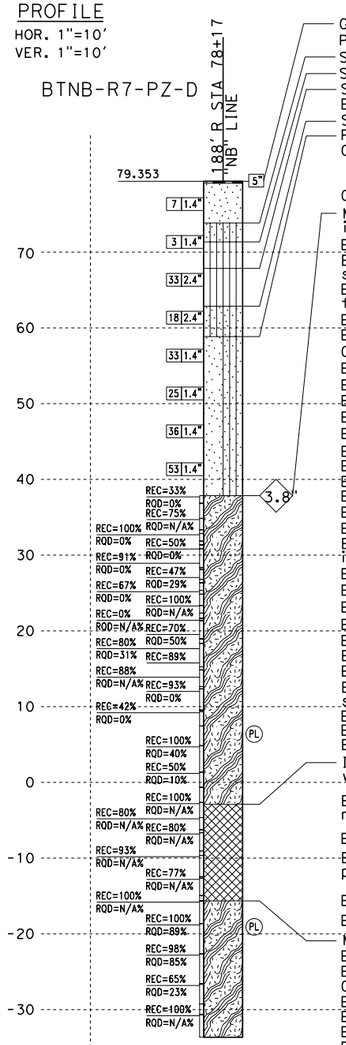
Arup PB Joint Venture
560 Mission Street, Suite 700
San Francisco, CA 94105

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

BENCH MARK
BM SF 14 Elev 96.261'

PROFILE
HOR. 1"=10'
VER. 1"=10'



GRAVEL with SAND (GP), dark gray and brown, moist, angular, sand is fine. [FILL]
Poorly graded SAND (SP), loose, dark yellowish brown, moist, fine. [FILL]
SILTY SAND (SM), loose, dark brown, wet, fine to very fine.
SILT (ML), soft, dark brown, wet, trace fine SAND, with crushable iron-oxide nodules.
SILT with SAND (ML), medium stiff, yellowish brown, moist, SAND is fine, with pockets of dark brown iron-oxide staining up to 1/4" diameter.
Elev 67.4', black vertical seam of organic filling.
SILTY SAND (SM), medium dense, yellowish brown to reddish brown, moist, with crushable iron-oxide nodules, fine.
Poorly graded SAND with SILT (SM), dense, dark yellowish to reddish brown, moist, fine.
Grades yellowish brown, with iron-oxide mottling, with black nodules (up to 1/8" diameter).

Grades very dense.
METAMORPHIC ROCK (GREENSTONE), dark greenish gray, intensely fractured, moderately hard, modergtely weathered, iron-manganese rich mineral composition, internally folliated with elongated crystals, iron-oxide staining throughout, prominent healed fractures filled with white mineral dipping 68°.
Elev 34.9', soft, moderately weathered, with moderately soft zones.
Elev 34.3' to Elev 34.2' and Elev 34.1' to Elev 33.9', soft, 0.1' to 0.2' thick intensely sheared zones, locally very intensely weathered, thin mineral filled fractures in soft zones, predominantlyn sub-horizontal very soft zones with intersecting 45° fractures, manganese-oxide coating on fracture planes.
Elev 32.4', abrupt color change to purplish brown, moderately soft, moderately strong, moderately to slightly weathered. Orthogonal filled fractures up to 45° dip.
Elev 31.9', greenish gray, core broken into fragments ranging from 0.05' to 0.2'.
Elev 30.9', intensely fractured.
Crushed zones at Elev 49.0', Elev 49.3, and Elev 49.8', Common manganese-oxide coating on fracture planes.
Elev 29.2', very intensely fractured (clayey), intensely sheared, moderately weathered.
Elev 28.1', intensely fractured, moderately hard, slightly weathered, orthogonal fracture planes.
Elev 26.4', sub-horizontal and dipping 30° fractures.
Elev 24.9', moderately fractured, very soft to soft, intensely to moderately weathered.
Elev 23.8', 1/4" thick mylonized clayey fracture filling.
Elev 23.6', internally crushed, very soft, intensely to moderately weathered.
Elev 22.1' to Elev 21.9', intensely fractured zone.
Elev 21.4', intensely fractured, soft to moderately soft, moderately weathered, iron-oxide staining on micro-fractures.
Elev 21.4', medium fractured, moderately hard, moderately strong, moderately weathered.
Elev 21.2', white preciptate on fracture face (calcite?), 1/16" thick precipitate filling on additional micro-fractures throughout.
Elev 19.7', intensely fractured, friable, very weak, severe to moderate weathering. Highly sheared zone.
Elev 18.4', slightly fractured, moderately hard, slightly weathered, variably oriented fractures, commonly filled with tan to light brown (calcite?) filling. Fractures are commonly closed (intensely spaced internally), localized iron-oxide staining.
Elev 17.4', intensely fractured, soft, locally internally sheared, moderately to slightly weathered, up to 1/4" thick tan to very light brown (calcite?) filling.
Elev 17.3', serpentinized zone (0.2').
Elev 14.9', moderately weathered, locally intensely sheared/crushed.
Elev 12.4', slightly fractured, moderately hard.
Elev 10.4', variably oriented fractures, grades green, with anastomozing veins of (clear) gray mineral filling (translucent).
Elev 9.4', intensely fractured, localized iron-oxide staining, translucent vein fillings up to 0.08' thick, variably oriented (healed shear zones), commonly fractured.
Elev 4.9', slightly fractured (internally intensely sheared), serpentinitic, soft (locally plastic), moderately to slightly weathered, continued translucent vein filling.
Elev 3.4', moderately hard, slightly weathered, abundant closed fractures, abundant fine to medium sand-sized particles along fractues, ferro-magnesium minerals predominate, localized iron-oxide staining (minor).
Elev 1.4', minor localized iron-oxide staining.
Elev 1.0', horizontal contact.
Elev 0.5', intensely fractured, very soft, moderately weathered (internally crushed), predominantly comprised of talc. Remnant rock fabric with serpentinite appearance, highly sheared.
IGNEOUS ROCK (GABBRO), dark gray and bluish gray, moderately fractured (internally sheared and crushed), very soft to moderately hard, moderately to slightly weathered. Serpentinite appearance with platey mineral structure common.
Elev -4.6', very intensely to intensely fractured, moderately soft, slightly weathered. Highly weathered (40° to 90°), intensely sheared planes/fractures. Locally phyllitic in appearance, secondary mineralization along micro-fractures, locally serpentinized appearance (chlorite?).
Elev -4.4' to Elev -4.2', approximately 40° dipping shistosity.
Elev -6.6', intensely fractured, intensely sheared with foliated appearance, alternating light green and dark gray. Green mineral (chlorite?) fibrous, perpendicular to veins. Locally crushed, friable, plastic. Primary orientation of folliation is vertical.
Elev -9.6', same as above, with irregular sub-horizontal surfaces.
Elev -12.6', intensely to moderately fractured (internally sheared/crushed).
METAMORPHIC ROCK (SERPENTINITE), bluish gray, very slightly fractured, slightly weathered (internally highly sheared), with "platey" texture, talc? on internal fracture planes.
Elev -18.2', slightly weathered to fresh.
Elev -17.6', dipping 70°.
Grades to shaley serpentinite, moderately fractured, soft to moderately hard, with soft intervals (up to 0.4' at Elev -22.7'), slightly weathered to fresh.
Elev -22.5', sub-horizontal fracture.
Elev -25.3', healed fractures with secondary mineral formation, vein fillings.
Elev -26.6', intensely fractured to crushed (internally sheared), slightly weathered to fresh, abundant chlorite? fracture and vein filling up to 1/8" wide (healed fractures).
Elev -27.5', moderately fractured, moderately hard, fresh.
Elev -27.5' to Elev -27.9', dipping 40°.
Elev -27.5' to Elev -28.4', gabbroic.
Elev -28.4', intensely fractured (internally sheared), soft, slightly weathered.
Elev -30.6', very slightly fractured (very intensely micro-fractured), fresh (much of core has appearance of highly sheared shale with secondary (chlorite?) mineral formation along weak zones).

SBBT-LTB5

RANDY ANDERSON DESIGN OVERSIGHT / SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN / CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L / POST MILES 9.0/9.2

SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 5 of 17

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04242
EA 163741

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES: 07/28/09 | 08/07/09 | 08/20/09

SHEET OF

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USERNAME => royce.sul@arup.com PLOTTED => 8/20/2009 TIME PLOTTED => 4:08:45 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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Arup PB Joint Venture
560 Mission Street, Suite 700
San Francisco, CA 94105

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

BENCH MARK
BM SF 14 Elev 96.261'

PROFILE
HOR. 1"=10'
VER. 1"=10'

BTNB-R3

67' R STA 79+10
NB LINE

86.286

5'

26|2.4"
17|1.4"
18|2.4"
15|1.4"
31|2.4"
14|1.4"
26|2.4"
24|1.4"
57|2.4"
43|1.4"
58|2.4"
37|1.4"
41|2.4"
36|1.4"
91|2.4"
45|1.4"
72|2.4"
23|1.4"
42|2.4"
50/5.5"|1.4"

GSW El. 21.6

3.8

REC=100%
RQD=N/A%
REC=77%
RQD=N/A%
REC=0%
RQD=N/A%
REC=100%
RQD=0%
REC=95%
RQD=0%
REC=28%
RQD=N/A%
REC=100%
RQD=N/A%
REC=95%
RQD=0%
REC=100%
RQD=N/A%
REC=90%
RQD=N/A%
REC=100%
RQD=N/A%
REC=88%
RQD=N/A%
REC=83%
RQD=N/A%
REC=67%
RQD=N/A%
REC=100%
RQD=10%
REC=100%
RQD=10%
REC=100%
RQD=20%
REC=100%
RQD=N/A%
REC=100%
RQD=20%
REC=60%
RQD=N/A%

7/26/2008
Termination at El -13.7
ERi = 72.9%

Elev 85.4' ASPHALT CONCRETE; 6" UNREINFORCED CONCRETE.
SILTY SAND (SM), yellowish brown, moist, SAND is fine to medium, with trace subangular serpentinite fragments, with dark brown oxidized nodules. [FILL]
Elev 84.3', serpentinite cobble up to 1/8" diameter.
SANDY SILT (ML), medium stiff, dark yellowish brown, moist, SAND is fine, with black specks. [FILL]
Elev 82.3', block of serpentinite, yellowish brown and greenish brown, fine-grained, decomposed (SILT (ML), stiff, dry to moist).
Poorly graded SAND (SP), medium dense, dark brown, moist, trace SILT, fine to medium, with occasional rootlets up to 1/16" diameter. [FILL]
SANDY SILT (ML), very stiff, yellowish brown to dark yellowish brown, moist, SAND is fine, with dark brown specks, with thin gray CLAY seams.
Cuttings are yellowish brown SANDY SILT.
CLAYEY SAND (SC), medium dense, yellowish brown, moist, fine to medium, with black specks, slightly cemented.
Grades with increased SAND content.
Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine to medium, with black specks.
Grades very dense.
Grades with iron-oxide mottling, with moderate cementation.
Grades light yellowish brown and olive gray, mottled.
Poorly graded SAND (SP), dense, yellowish brown to grayish brown, moist, fine to medium.
Grades grayish brown with iron-oxide mottling, fine.
Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine, with very dark brown mottling.
Lean CLAY with SAND and GRAVEL (CL), medium stiff to stiff, yellowish brown, moist, GRAVEL is fine to coarse, subangular serpentinite fragments.
METAMORPHIC ROCK (Serpentinite), fine-grained, yellow and greenish gray, decomposed, very soft (SILT (ML), stiff, horizontally laminated, dry).
greenish gray, light gray and reddish brown, intensely weathered, very intensely fractured, internally crushed and sheared (SILT (ML), medium stiff, moist to wet, trace fine to medium SAND), pervasively sheared, iron-oxide staining throughout rock mass.
Elev 36.05', white clay seam infilling.
Elev 34.8', 0.2' thick zone, horizontally fissured, soft, dark mineral fragments up to 0.01' in diameter.
Elev 34.3' to Elev 33.7', moderately hard, gabbroic with localized shearing.
Elev 28.3', moderately hard, with localized shearing.
Elev 27.8' to Elev 27.6', white minerals common with tan CLAY infilling.
Elev 25.8', intensely weathered, very soft, heavy iron-oxide staining.
Elev 24.7' to Elev 24.3' and Elev 23.9' to Elev 23.7', 45° dipping fractures.
Elev 24.25', Elev 23.8', and Elev 23.65', black staining on fracture surfaces (manganese-oxide?).
Elev 23.6', moderately weathered, moderately hard, iron-oxide staining limited to fracture planes.
Elev 23.0', Elev 22.85', and Elev 22.5', light yellowish brown CLAY infilling.
Elev 21.3' to Elev 21.0' and Elev 20.75' to Elev 20.5', zones of very soft serpentinite.
Heavy iron-oxide staining throughout run.
Elev 17.2', white secondary mineral deposit on fracture plane, moderately to intensely weathered, moderately hard.
Elev 16.7', sub-horizontal shearing planes with heavy iron-oxide staining.
Elev 13.9', light orangish brown staining.
Elev 13.4' to Elev 12.6', intensely weathered, very soft serpentinite.
IGNEOUS ROCK (Gabbro), aphanitic, very dark gray to black, moderately to slightly weathered, moderately hard to hard, very intensely fractured.
Elev 11.9', thin light gray secondary mineral deposit, localized shearing on through fractures, color change to very dark gray/black.
Elev 10.3', very intensely fractured (entire run).
Elev 9.9' to Elev 9.1', heavy iron-oxide staining.
METAMORPHIC ROCK (Serpentinite), intensely weathered, moderately soft, light greenish gray.
Elev 7.8' to Elev 7.6', very soft.
Elev 6.8' to Elev 6.7', very soft (CLAY-like).
Elev 6.6' to Elev 6.0', reduced diameter.
Elev 5.3', color change to dark bluish gray.
Elev 4.1', very light gray.
Elev 1.6', very soft (CLAY-like), bluish gray (gabbroic), secondary white mineral on shearing planes.
Elev -1.1' to Elev -1.3', Elev -1.7' to Elev -1.9', and Elev -2.2' to Elev -2.4', severely weathered,very soft.
Elev -1.9' to Elev -2.2', reduced diameter.
Elev -2.5', moderately weathered, intensely fractured, moderately hard, dark to very dark gray, predominantly gabbroic.
Elev -3.2' to Elev -3.5', mechanical breaks.
Elev -3.6' to Elev -4.2', very soft (CLAY-like), light bluish gray.
Elev -4.2' to Elev -5.2', variable softness (very soft to moderately hard).
Elev -5.7' to Elev -7.4', moderately hard, with horizontal markings from drill bit.
Elev -7.9' to Elev -8.3', slightly weathered, very soft.
Elev -10.2' to Elev -10.5', secondary white mineral on predominant fracture plane, ipping approximately 70°.
Elev -11.2' to Elev -11.5', intensely fractured, slightly weathered to fresh, ery soft.

90 80 70 60 50 40 30 20 10 0 -10 -20 -30

79+000 80+000 81+000 82+000

NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

SBBT-LTB6

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL AND BRANDAN KLUZNIAK	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 6 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/28/09 08/07/09 08/20/09	SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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560 Mission Street, Suite 700
San Francisco, CA 94105

BENCH MARK
BM SF 14 Elev 96.261′

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

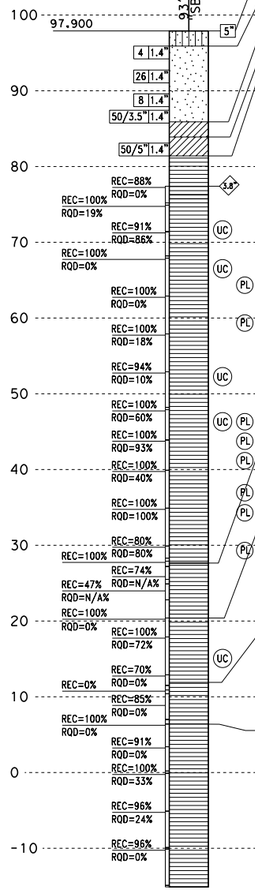
NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

PROFILE
HOR. 1"=10′
VER. 1"=10′

BTSB-R3-PZ-D

93′ L STA 80+49 "SB" LINE

97.900



4/22/2008
Termination at El -15.1
ERI = 72.9%

SILTY SAND (SM), loose, very dark brown, moist, fine, occasional fine gravel and coarse sand, slight organic odor, trace fine roots. [FILL]
Poorly graded SAND (SP), loose, dark yellowish brown, moist, fine to very fine, occasional roots (up to 1/8" thick).
Grades with dark gray to black laminations (horizontal), with occasional dark brown CLAY.
Lean CLAY with SAND (CL), medium stiff, dark brown, moist, SAND is fine.
Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, with iron-oxide nodules and mottling.
SEDIMENTARY ROCK (SANDSTONE), fine to medium grained, yellowish brown, very soft, decomposed, intensely fractured, with vertical and sub-horizontal partings, with manganese-oxide staining on vertical fracture planes, angular to subangular gravels, individual grains commonly altered around perimeter (poorly graded SAND with CLAY (SP-SC), moist, with iron-oxide mottling and nodules).
Fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes.
Elev 76.8′, approximately 1/2 face manganese-oxide stained separated by fracture from thin clay filling.
Elev 74.9′, fine to coarse grained, pitted texture, continued manganese-oxide staining of fractures at Elev 74.6′, Elev 74.4′, and Elev 73.6′; clay filling on fractures (up to 0.01′ thick), fracture dips range from sub-horizontal to 30° with occasional up to 80°.
Elev 71.4′, increase in darker minerals, fracture dips range from horizontal to 45°.
Elev 67.9′, intensely fractured.
Elev 64.9′, bluish gray, moderately weathered.
Elev 59.9′ to Elev 59.1′, very intensely fractured (crushed), with localized mylonization (variably oriented fractures with clay filling), minor pitting along some fractures, most fractures dip 20° to 40° with occasional vertical fractures. 40° common near vertical fractures, continued localized pitting, grain size is variable and mixed suggesting soft sediment deposition.
Elev 55.5′ to Elev 54.9′, irregular fracture not measured (sub-vertical).
Iron-oxide staining only, limited to fracture planes, very intensely fractured zones Elev 52.3′ to Elev 52.1′ and Elev 50.7′ to Elev 50.3′.
Elev 51.7′ to Elev 51.1′, sub-vertical.
Elev 49.9′, occasional white (quartz?) veins, aphinitic dark rock fragments (fine grained sized) within fine to medium matrix, slightly weathered.
Elev 47.9′, elongated rock fragments (aphinitic) are sub-parallel, dark minerals predominate, moderately fractured, hard.
Increased iron-oxide staining at Elev 46.9′.
Very slight iron-oxide staining, moderately to slightly fractured.
Very intensely fractured zones at 38.5′ to 38.1′ and 36.3′ to 35.8′.
Localized banding appearance of dark mineral fragments.
Unfractured, continued <0.02′ thick quartz veins, continued localized dark mineral "banding", strong, fresh to slightly weathered.
Elev 33.0′, mechanical break.
One core break is mechanical.
SEDIMENTARY ROCK (SHALE), aphanitic, no indication of bedding, dark gray, fresh, moderately hard where intact otherwise sheared, very intensely to intensely fractured, weak to moderately strong.
Elev 26.2′ to Elev 25.6′, crushed.
Elev 26.1′, Elev 0.1′ thick clay zone <50°.
Elev 24.9′ to Elev 24.7′, hard.
Elev 24.7′ to Elev 22.8′, crushed/sheared, highly variable orientation to shears, minor green serpentine fragments.
SEDIMENTARY ROCK (SANDSTONE), fine to medium grained, dark gray, slightly weathered, moderately hard, intensely fractured, slight iron-oxide staining on some fractures, fractures ~45-90°.
Elev 17.9′, fresh, continued quartz veins, with dark mineral veins, localized soft sediment deposition.
Elev 15.4′ to Elev 10.0′, sheared zone (clayey).
Elev 14.0′, slickensides parallel to strike, rake is 18° down to SE.
Elev 12.75′, dip ~18° with slickensides on fracture surface.
Elev 12.4′, dip ~37°.
SEDIMENTARY ROCK (SANDSTONE and SHALE), commonly crushed to fragments up to 0.1′ diameter, SANDSTONE is fine grained, variably oriented quartz veins within SANDSTONE intervals, light green mineral (chlorite?) within SHALE intervals, soft, moderately weathered.
Elev 11.8′, 0.2′ clay zone.
Elev 9.8′ to Elev 9.3′, crushed (not clayey).
Elev 9.1′ to Elev 8.6′, sheared zone (clayey).
Iron-oxide along fracture planes.
SEDIMENTARY ROCK (SANDSTONE), fine to medium grained, laminated to thinly bedded (contact between fine to medium grained and very fine gravel at 6.0′ ~60° to 80 dip), dark gray, moderately to slightly weathered, moderately hard to moderately soft, intensely fractured, numerous closed fractures, fractures are randomly oriented, numerous healed micro faults.
Elev 3.4′, moderately fractured with localized very intensely fractured (crushed) zones along fractures, limited to fracture planes.
Elev 0.9′, contact to medium to fine grained, moderately hard, dipping ~45°.
Elev -0.1′, slightly to moderately weathered. From Elev -1.1′ to Elev -1.9′, fracture with localized crushing and slickensides. Increase in iron-oxide staining.
Elev -3.1′ to Elev -4.3′, fine to very fine grained, moderately soft, indicating soft sediment disposition.
Elev -4.5′ to Elev -5.0′, very intensely fractured (crushed), moderately weathered, with evidence of shearing.
Elev -6.2′, quartz vein infilling.
Elev -7.1′ to Elev -7.6′, contact to fine grained.
Elev -7.6′, frequent closed/healed fractures, ruggy, (occasional iron-oxide stained openings in the core that are not, through fracturesup to 0.2′ in length and 0.03′ wide oriented near vertical to dipping ~80°).
Elev -10.1′, near parallel, sub-vertical fractures (to 110.5′), fine to medium grained from Elev -11.3, Elev -12.1′ AND Elev -13.1′ TO Elev -13.3′.
Elev -10.1′ to Elev -11.3′, very thinly bedded.
Elev -13.1′ to Elev -14.9′, frequent randomly oriented whie mineral veins (calcite?).

81+000 82+000 83+000

SBBT-LTB7

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 7 OF 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/27/09 08/07/09 08/20/09	SHEET OF

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USERNAME => royce.sui DGN PLOTTED => 8/20/2009 TIME PLOTTED => 4:11:56 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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560 Mission Street, Suite 700
San Francisco, CA 94105

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

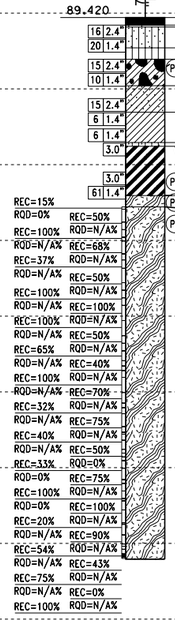
BENCH MARK
BM SF 14 Elev 96.261′

PROFILE
HOR. 1"=10′
VER. 1"=10′

BTNB-R2

70′ R STA 81+44 NB LINE

89.420



6/1/2008
Termination at El 17.9
ERi = 76.2%

4" ASPHALT CONCRETE.
7-8" UNREINFORCED CONCRETE.
3" Poorly graded SAND (SP), yellowish brown, dry to moist, fine, clean, frequent roots up to 1/4" diameter. [FILL]
SILTY SAND with GRAVEL (SM), medium dense, yellowish brown, moist, fine, GRAVEL is fine to coarse, slight horizontal laminations (from compaction?). [FILL]
SANDY SILT (ML), medium dense, yellowish brown, moist, SAND is fine to medium, piece of coarse GRAVEL. [FILL]
CLAYEY GRAVEL (GC), loose, yellowish brown and green, moist, coarse, rounded, serpentinite fragments (up to 3" diameter in shoe at 8.5′). [FILL]
CLAYEY SAND (SC),medium dense, yellowish brown, fine to coarse, with fine GRAVEL (subrounded to rounded, serpentinite fragments in CLAYEY SAND matrix). [FILL]
Lean CLAY with GRAVEL and SAND (CL), soft, brown and greenish gray, moist to wet, GRAVEL is angular serpentinite fragments, GRAVEL is fine to coarse, SAND is fine to coarse. [FILL]
Elev 72.9′, rig chatter.
SILTY SAND (SM), loose, very dark brown, wet, fine, very strong hydrocarbon/oily odor.
Fat CLAY with SAND, medium stiff to stiff, very dark brown, wet, SAND is fine, with rootlets, very strong hydrocarbon odor.
Elev 68.9′, grades grayish brown, stiff, without odor, without organics.
METAMORPHIC ROCK (SERPENTINITE), very soft, yellowish brown, greenish gray and dark gray, moist, decomposed, very intensely fractured (SANDY SILT (ML), medium stiff, sand is fine - moist).

dark greenish gray and dark gray, moderately to intensely weathered, very soft, very intensely fractured, common iron-oxide staining (localized), occasional small moderately soft zones.

Elev 60.4′, grades soft, intensely sheared throughout, fibrous texture common throughout (ML - SANDY SILT, SAND is fine, moist).

Elev 57.4′, slight iron-oxide staining, slightly weathered, harder fragments (angular) of SERPENTINITE with softer material washed away, fragments are moderately hard, up to 0.1′ in diameter (SM - SILTY SAND, fine to coarse, angular, with fine GRAVEL fragments, angular to subangular, moist).

Elev 52.0′, soft to moderately soft, faint iron-oxide staining on fracture surfaces.
Elev 51.7′, fibrous texture noted as long as 0.02′.
Elev 51.5′, moderately soft, bluish gray.
Elev 51.4′, soft.
Elev 51.4′, dark bluish gray with infilling of light greenish gray.
Elev 50.75′, fibrous texture noted as long as 0.02′.
Elev 50.25′, thin (0.01′ thick) white mineral (talc?) vein dipping 50°.
Elev 49.4′, moderately weathered with common iron-oxide staining.
Elev 48.1′, slightly weathered, very soft.
Elev 45.05′, angular fragments up to 0.1′ diameter.
Elev 41.5′ to Elev 40.8′, moderately hard, very intensely fractured, fragments of harder rock, dark gray.

Elev 39.4′, soft to moderately soft.
Elev 37.9′, very soft.
Elev 35.2′, very intensely fractured zone, fragments are moderately hard, dark bluish gray, overall matrix is very soft.

Elev 34.7′, fibrous texture noted.
Elev 33.7′, concentration of white mineral.
Elev 31.9′ to Elev 29.9′, recovery is light gray meta-sandstone and gabbro, moderately weathered, hard, 0.1′ to 0.2′ fragments, significant iron-oxide staining, hard to moderately hard.
Elev 29.9′, moderately weathered, soft, light greenish gray and orangish brown, heavy iron-oxide staining.

Elev 29.7′, concentrated iron-oxide weathering along shear planes.
Elev 27.9′, moderately soft, slightly weathered, greenish gray to olive gray, with moderately hard, white and dark gray minerals (white mineral has very fine, fibrous texture developed along planar surfaces, asbestos? White mineral also common with powdery texture disseminated thorught rock mass).

Elev 27.6′, horizontal buff sheared seam (0.01′ thick), fibrous texture noted.
Elev 26.9′, bluish gray, clayey, with green chlorite? minerals, moderately to slightly weathered, very soft.

Elev 22.4′, moderately weathered, increase in iron-oxide staining.
Elev 22.0′ to Elev 21.7′, moderately hard rock fragments (gabbro?).
Elev 19.2′, moderately to slightly weathered, increase in white mineral (talc) disseminated throughout.

Elev 17.9′, hard rock fragments.

90 80 70 60 50 40 30 20 10 0 -10 -20 -30

81+000 82+000 83+000 84+000

NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

SBBT-LTB8

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →

SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 8 of 17

REVISION DATES: 07/27/09 | 08/07/09 | 08/20/09 | SHEET | OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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Arup PB Joint Venture
560 Mission Street, Suite 700
San Francisco, CA 94105

BENCH MARK

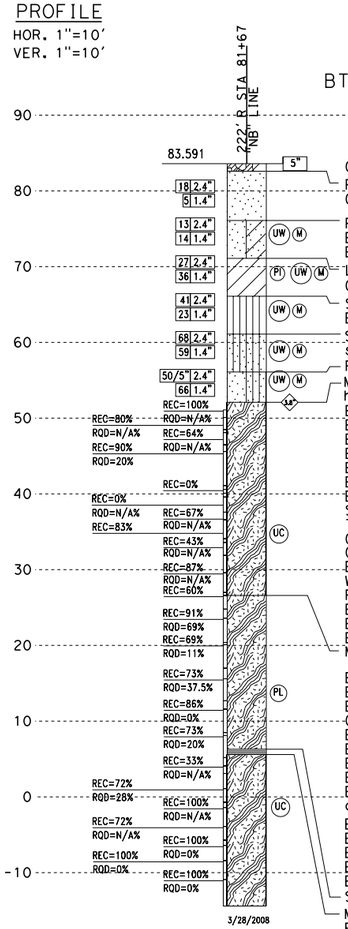
BM SF 14 Elev 96.261′

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

NOTES:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

PROFILE

HOR. 1"=10′
VER. 1"=10′



90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40

Poorly graded SAND (SP), loose, yellowish brown, moist, fine, trace fines, trace medium sand. [FILL]
Grades dark brown, grades without medium SAND, with pockets of black organic material (up to 1/8" diameter).

Poorly graded SAND with CLAY (SP-SC), medium dense, reddish brown, moist, fine, with shell fragments. [FILL]
Elev 74.5′, grades with yellowish brown mottling.
Elev 73.9′, 1/4" diameter root.

Lean CLAY (CL), stiff, yellowish brown and grayish brown, moist, mottled, trace fine to medium sand, with black oxidized nodules (up to 1/8" diameter).
Grades to CLAY with SAND, with black specks, rootlets.

SANDY SILT (ML), stiff, light yellowish brown, moist, with thin horizontal laminations.
Elev 64.6′, grades with slight iron-oxide mottling.

SILTY SAND (SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE, with SANDY CLAY partings, with black specks.

Poorly graded SAND with SILT (SP-SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE.

METAMORPHIC ROCK (Serpentinite), dark greenish gray and very dark bluish gray, moderately weathered, very soft, moderately fractured (intensely crushed), fractures are planar to sub-planar 20° from horizontal, highly sheared throughout, with micro-slickensided surfaces throughout, light brown iron-oxide staining throughout, local sub-horizontal foliation.
Elev 50.1′, grades soft, decreased iron-oxide staining.
Elev 47.4′ and 47.0′, 40° dip highly polished.
Elev 47.4′ to 47.0′, dark greenish gray, moderately hard, slightly weathered.
Elev 45.6′, sub-horizontal fracture, moderately hard.
Elev 44.0′ to 43.4′ near vertical (80°) 1/8" thick mylonized zone along fracture.
Elev 43.6′, soft to very soft, abundant very light green mineral (talc?).
Elev 42.6′, sub-horizontal fracture surfaces typically polished and sheared.
Straight drill from Elev 40.1′ to 39.6′.
Talc? is non-fibrous.
Grades soft, very dark greenish gray, with chlorite and talc? vein fillings variably oriented throughout mass, no indication of fibrous texture, fractures are irregular (sub-horizontal).
Core breaks along preferred orientation (strike N/S dip 45° west), platey appearance parallel to joints.
Elev 38.4′, additional random fractures (1/16" thick) with talc? infilling.
With less talc?
Preferential fracture planes parallel to platey structure, alternately zones of very soft to moderately soft.
Elev 29.6′, very soft to soft.
Elev 28.3′, mechanized fracture dips ~45°.
Elev 27.8′, grades with abundant iron-oxide staining, indirect fractures are sub-horizontal, continued internally sheared polished surfaces.

METAMORPHIC ROCK (Greenstone), dark greenish gray, slightly weathered, moderately hard to hard, intensely fractured with very intensely to intensely fractured zones, fractures franging from horizontal to 20° dip.
Open and healed fractures with filling and staining of black magnesium oxide. Subrounded vitreous crystals predominant throughout mass (pyroxene/olivine?), localized black vugular zones (maximum 0.2′ thick).
Elev 23.6 to 22.8′, intensely fractured (open and closed, internal shearing characterized by microstriations on plane surfaces).
Elev 23.2′, dip 40°.
Elev 22.8′, intensely fractured, moderately hard.
Grades less crystalline (micro crystalline).
Elev 21.2′, dip 70°.
Elev 20.7′, dip 70°.
Elev 20.2′ to 18.0′, very intensely fractured, very soft (with hard pieces, crumbles to 1/16" to 1" pieces, moderately weathered, with abundant iron-oxide staining).
Elev 18.0′, moderately weathered.
Elev 15.6′, intensely fractured, moderately hard, moderately weathered, fractures horizontal to 45°, filled (vertical at 70.5′), fracture with similar appearance to rest of rock, scattered fibrous minerals at random orientations (asbestos?), few apparent unique crystals.
Elev 14.0′ to 13.2′, very intensely fractured.
Elev 11.6′, fractures infilled with fibrous mineral (asbestos?)
Elev 11.3′, moderately weathered with abundant iron-oxide staining throughout, very soft, very intensely fractured.
Elev 10.6′, moderately to slightly fractured, hard, moderately weathered.
Elev 7.6′ to 6.2′ and 5.6′ to 5.2′, crushed zones (very soft, severely weathered, with abundant iron-oxide staining).

SEDIMENTARY ROCK (Greywacke), fine grained to aphanitic, yellowish brown, slightly weathered, hard, healed very thin fractures.

METAMORPHIC ROCK (Serpentinite), green and yellowish brown, moderately weathered, soft.
Recovery is dark greenish gray and dark gray pieces of serpentine and greenstone, moderately hard - not representative of rock layer.
Very dark gray, intensely fractured, moderately hard, severely weathered, talc/chlorite in fractures.
Elev 0.1′ to -0.7′, slightly fractured, veinlettes of fibrous minerals.
Elev -3.4′, very intensely fractured and sheared (crushed), soft to very soft, moderately weathered.
Elev -5.5′, very soft with zones of moderately hard, common green vitreous appearance (chlorite?).
Elev -7.5′, moderately fractured, moderately hard, slightly weathered at 90.0′, platey secondary mineral formation (chlorite?) pervasively throughout.
Elev -7.6′, fibrous, light green, translucent minerals oriented parallel to dip.
Elev -8.7′, internally sheared/crushed, very soft to soft, moderately weathered, platey secondary mineral formation pervasively throughout (chlorite?) portions of core - one locally micro-fractured with chlorite? filling.
Elev -10.9′, very dark gray, intensely fractured, moderately hard, slightly weathered.
Elev -11.4′, internally sheared/crushed.
Elev -13.4′ to -13.9′, very intensely to intensely fractured.

82+000 83+000 84+000

SBBT-LTB9

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 9 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04242 EA 163741		DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/28/09 08/07/09 08/20/09 — SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

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560 Mission Street, Suite 700
San Francisco, CA 94105

BENCH MARK

BM SF 14 Elev 96.261′

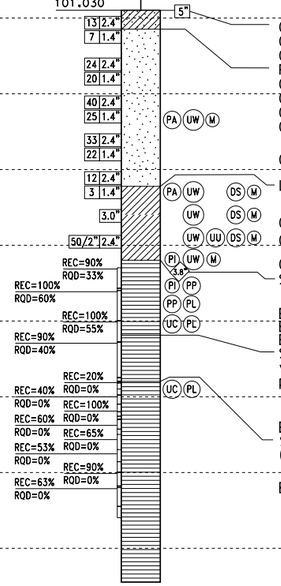
FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

PROFILE

HOR. 1"=10′
VER. 1"=10′

BTSB-R1-PZ
35′ L STA 82+30 SB LINE
101.030



1/22/2008
Termination at El 25.5
ERi = 72.8%

CLAYEY SAND (SC), loose, dark brown, dry, fine, with GRAVEL. [FILL]
Grades dry to moist.
Grades no GRAVEL, grades with pockets of yellowish brown CLAY.
Poorly graded SAND, loose, reddish brown, dry to moist, fine. [FILL]
Grades dark yellowish brown.
Grades yellowish brown to light yellowish brown, medium dense.
Grades fine to medium.
Grades fine.

Grades moist.

Lean CLAY with SAND (CL), soft, very dark gray to black, wet, with brown mottling, occasional small decayed vegetation.

Grades brown.
Grades yellowish brown with gray clay lenses and pocket of very stiff gray CLAYEY SAND.

Grades with black organic mottling, medium stiff to stiff.
SEDIMENTARY ROCK (SANDSTONE), fine to medium grained, massive gray to dark gray, moderately weathered, moderately hard, intensely fractured, anastomizing white secondary mineral vein infilling.

Elev 65.8′, slightly weathered, moderately to intensely fractured.
Elev 63.4′ to Elev 63.1′, intensely fractured.
Elev 59.2′, slightly weathered to fresh.
SEDIMENTARY ROCK, SANDSTONE and SHALE, sandstone is medium to fine grained, laminated to moderately bedded (distorted by soft sediment deformation and micro faulting white secondary mineral vein infilling occurs along faults), gray to dark gray, slightly weathered to fresh, moderately hard, moderately fractured, surface of core is occasionally pitted, fractures are commonly polished and slickensided.

Elev 53.7′ to Elev 53.4′, surface of core is commonly pitted.
SEDIMENTARY ROCK, MELANGE MATRIX, very dark gray gravel, slightly weathered to fresh, very soft, very intensely fractured (hard meta-sandstone fragments in sheared shale matrix) (lean clay with gravel (CL), soft, gravel is fine to coarse, angular, moist to wet).

Elev 41.7′, hard piece of meta-sandstone (0.3′).

100 90 80 70 60 50 40 30 20 10 0 -10 -20

82+000 83+000 84+000 85+000

SBBT-LTB10

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: STEPHEN MCLANDRICH	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 10 OF 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 01/28/09 08/07/09 08/20/09 — SHEET — OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

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FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

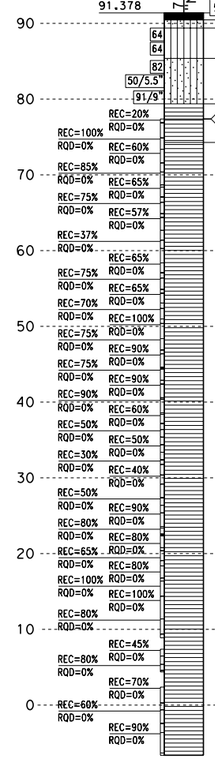
BTNB-R1

BENCH MARK
BM SF 14 Elev 96.261′

PROFILE
HOR. 1"=10′
VER. 1"=10′

77′ R STA 83+61 NB℄ LINE

91.378



6/1/2008
Termination at El -6.6
ERi = 72.9%

3.75" ASPHALT, 7.5" CONCRETE.
SILTY SAND with GRAVEL (SM), light brown, dry, fine to medium, GRAVEL is fine, angular to subangular. [FILL]
SILT with SAND (ML), hard, brown and yellowish brown, dry, trace GRAVEL, GRAVEL is angular to subangular.
SILTY SAND (SM), very dense, brown to reddish brown, moist, trace GRAVEL, GRAVEL is fine to coarse, highly weathered sandstone fragments.
SEDIMENTARY ROCK (SANDSTONE BRECCIA), reddish brown, fine grained moderately weathered,core is broken, contains CLAY and SILT, SANDSTONE pieces are hard, with soft CLAYEY, thinly weathered portions.
Grades yellow brown.
SEDIMENTARY ROCK (MELANGE MATRIX), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25′ thick) in sheared SHALE matrix.

Elev 68.4′ to Elev 68.0′, SANDSTONE piece.
Elev 66.4′ to Elev 66.1′, hard SILTSTONE piece.
Grades with SANDSTONE, SILTSTONE, and SHALE fragments.
Elev 61.4′ to Elev 60.6′, slightly serpentinized or chloritized interval.
Elev 58.4′, slightly weathered.
Grades with SHALE fragments.
Elev 53.9′ to Elev 53.1′, moderately hard SILTSTONE fragments with some SERPENTINITE.
Elev 49.9′ to Elev 49.75′, reddish brown (CHERT?) fragment.
Elev 49.4′, SHALE fragments, moderately soft.
Elev 48.4′, SILTSTONE and fine grained SANDSTONE fragments (up to 0.1 thick) in sheared SHALE matrix.

Elev 44.9′, 1.5" greenish gray, serpentinized interval.
Elev 41.6′, light gray, completely sheared throughout.
Fragments are up to 0.02′ thick.
Elev 36.0′ to Elev 35.4′, fragments are meta-SANDSTONE (up to 0.25′ thick).

Elev 30.4′, moderately weathered, with slight iron-oxide staining throughout.
Elev 28.4′, slightly weathered.
CLAY matrix is dark greenish gray, serpentinized.
Elev 22.9′, white secondary mineral deposit.
Grades slightly more gray than green and slightly more SILTSTONE layer.
Elev 22.4′ to Elev 21.6′, crushed granular interval.
White secondary mineral is more common.
Elev 17.4′, sheared SHALE matrix commonly has sandy intervals.

90 80 70 60 50 40 30 20 10 0 -10 -20 -30

84+000 85+000 86+000

SBBT-LTB11

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: STEPHEN MCLANDRICH	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 11 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04242 EA 163741		DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/29/09 08/07/09 08/20/09 — SHEET — OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

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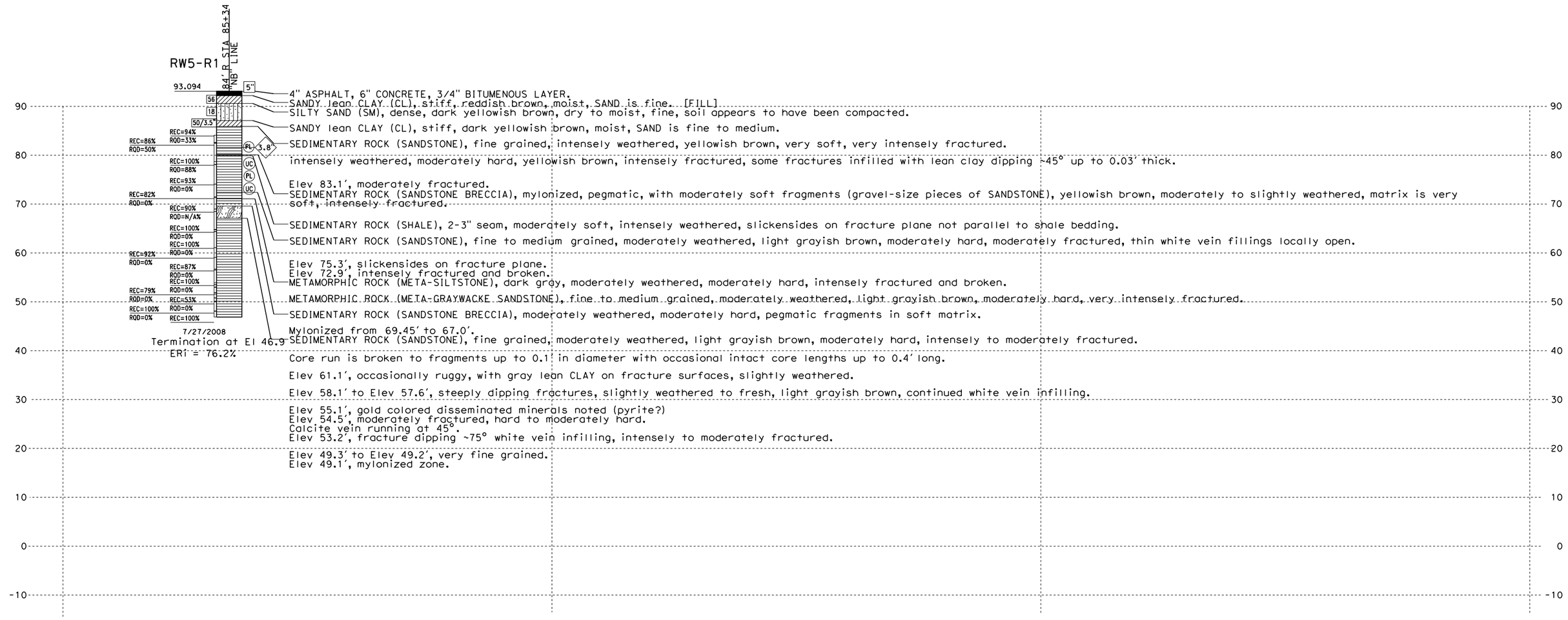
FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

BENCH MARK
BM SF 14 Elev 96.261′

PROFILE
HOR. 1"=10′
VER. 1"=10′



SBBT-LTB12

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: PETER RYAN	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 12 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 07/27/09 08/07/09 08/20/09 — SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2		

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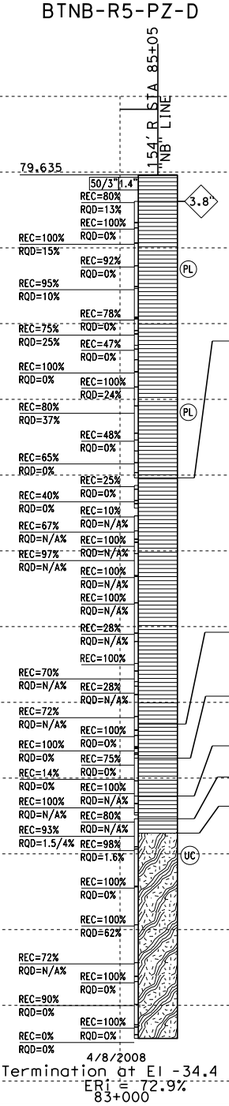
FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

BENCH MARK
BM SF 14 Elev 96.261'

PROFILE BTNB-R5-PZ-D
HOR. 1"=10'
VER. 1"=10'



1/2" ASPHALT CONCRETE.
SEDIMENTARY ROCK (SANDSTONE), fine, dark gray, intensely weathered, moderately soft, intensely fractured, with yellowish brown CLAY infilling.
medium grained to fine grained, no indication of bedding, dark grayish brown, moderately weathered, moderately hard, moderately fractured, heavy iron-oxide staining on fracture surfaces, light staining within rock mass at Elev 75.1', vein infilling up to 0.02' thick (calcite?), grades very thinly bedded, intensely fractured, fracture dipping ranges from 20° to 70°, fractures are typically intensely weathered. Grains are angular to subangular, uniform, numerous insipient fractures, very dense/lithified.
Elev 72.8', finer grained with decrease in medium grained, darker minerals, moderately to slightly weathered.
69.6', clayey sand sheared filling, entire interval appears massive (no Elev indication of bedding).
Elev 67.6', fracture orientation and spacings remain consistent with above.
Elev 63.7', seam infilling with clay.
Elev 63.1', slickensides parallel to dip.
Elev 61.7' to Elev 60.6', near vertical fracture, undulating surface intersecting fractures average orientation is 345/81E.
Elev 60.6', slightly weathered (slight iron-oxide staining).
Elev 58.6', very intensely to intensely fractured with one length from 58.1' to
Elev 57.6', intact.
Elev 56.6', hard, fresh to slightly weathered (absence of iron-oxide stains).
Elev 56.6', multiple vertical fractures entire length of core with additional sub-horizontal fractures.
Elev 56.2', white mineral, vein, hard (non-quartz).
Elev 56.0', CLAY seam infilling.
Elev 52.6' to Elev 51.6', white mineral vein fillings (unrelated to fracturing) pervasively fractured (from fragments to 0.2').
Elev 51.6', intensely fractured, fractures dipping commonly 60° to 70°, continued localized white mineral vein fillings.
Elev 48.7', 0.08' thick shear zone (light gray, silty, fine sand).
Elev 48.6', contact to fine grained SAND (medium grained above).
Elev 46.2', fine to medium grained (core broken with silty fine SAND fragments (0.01' to 0.2').
Elev 43.2', very intensely fractured (crushed) (silty, fine SAND shear zone).
Elev 41.6', 0.3' intact fragment (laminated showing soft sediment deformation), no visible sand grains.
Elev 41.3', 0.05' quartz vein.
SEDIMENTARY ROCK (MELANGE MATRIX), dark gray (consisting of fine grained SANDSTONE, very hard SILTSTONE, and fragmented hard SHALE), very intensely fractured (crushed), slightly weathered to fresh.
Very soft to hard.
Elev 31.1', fresh, fragments are fine grained, lithic SANDSTONE, occasional quartz? veins, fragments range from <0.01' to core diameter.
Elev 29.6' to Elev 28.5', crushed, very fine grained.
Elev 28.5' to Elev 27.5', clayey (primarily clay with hard fragments).
Elev 27.5' to Elev 27.2', crushed, very fine grained.
Elev 27.2' to Elev 26.7', clayey.
Scattered green mineral filling within small cavities (up to 0.08" diameter) (chlorite?).
Elev 26.6', highly sheared shale with internal slickensided shear planes within rock mass and very fine grained sandstone fragments.
Elev 23.1', less clayey (more intact shale).
Elev 22.8' to Elev 19.2', Elev 0.15' hard resistant rock fragments, core breaks are irregular sub-horizontal to 10°dip.
Elev 20.4', crushed/sheared zone without clay.
Iron-oxide staining common on fracture faces, moderately weathered.
Elev 15.1', very minor local staining on surfaces (chlorite?), iron-oxide staining throughout, primarily sheared fragments with sub-horizontal fissility.
Elev 14.1', interval ranges from pervasively sheared shale (clayey) to hard gray sandstone fragments (up to 0.25').
Elev 13.85', dipping 35°.
Elev 12.1', continued highly sheared shale.
Elev 12.1' to Elev 11.4', scattered quartz vein filling.
Elev 11.4', subangular sandstone fragments (up to 0.05') in olive brown clay matrix.
SEDIMENTARY ROCK (SANDSTONE), fine grained, hard, very intensely fractured, moderately weathered with heavy iron-oxide staining on fracture surfaces and extending slightly into the rock mass.
Elev 7.1', iron-oxide staining on some surfaces, but not all, suggesting mechanical breaks.
Elev 5.6', continued mechanical breaks, multiple fracture orientations, quartz vein (20° dip) at 74.7' (0.02' thick).
Elev 3.9', horizontal to 10° fractures, clay filled sheared fracture at Elev 3.3'.
SEDIMENTARY ROCK (MELANGE MATRIX), dark gray, fresh, very soft.
Elev -1.5', chlorite? vein (1/4" thick).
Elev -2.0', quartz vein (1/4" thick), sheared shale with hard sandstone pieces (up to 1/4"diameter).
SEDIMENTARY ROCK (SANDSTONE), dark gray, fine grained, moderately hard, very intensely fractured, fresh, not clayey.
Elev -2.7' to Elev -3.0', crushed zone.
SEDIMENTARY ROCK (MELANGE MATRIX), dark gray, slightly weathered to fresh, soft, very intensely fractured (crushed), mylonized (CLAY-like) with subangular sandstone fragments, variably oriented contacts dipping up to 30°. SANDSTONE fragments up to 0.2' thick localized shearing along thin fractures.
METAMORPHIC ROCK (META-SANDSTONE), steeply dipping, laminated relic bedding offset by healed micro-faults, dark gray, fresh, hard, moderately to slightly fractured, milky white vein filling.
Elev -9.4', clayey infilling common, very intensely fractured (crushed), random quartzitic vein filling, locally associated with fractures and planes of weakness, harder pieces within mylonized zone are moderately hard overall matrixes soft.
Elev -10.0' to Elev -11.4', fractured mylonized zones.
Elev -11.4', hard, moderately fractured.
Elev -12.4', mylonized seam (0.02' thick).
Elev -14.8', intensely to moderately fractured, mylonized zone.
Elev -15.4', crushed zone.
Elev -16.8', mylonized clay zone with quartz vein filling.
Elev -19.4', continued quartz vein filling, parallel and not parallel to fractures, moderately fractured.
Elev -23.6', sheared/mylonized, dark gray and yellowish brown, iron-oxide staining throughout fractures, very intensely fractured (crushed), slickensides of fractures at Elev -23.6' parallel to dip.
Elev -24.4', pervasively fractured, mylonized, with pervasive secondary clay formation, remanant intersecting fracture planes at 30° to 40° dip, moderately weathered.
Elev -26.9', predominantly moderately hard, intensely weathered, clay smearing and iron-oxide staining on fractures at Elev -29.4'.
Elev -26.9' to Elev -27.3' and Elev -28.9' to Elev -28.6', clayey mylonized zones (with subangular sandstone fragments in clay matrix).
Elev -28.7' to Elev -29.9', additional sub-vertical fractures.
Elev -29.4', gray clay along predominant fracture. Quartz? veins continued, primarily unrelated to fracures. Multiple fracture sets primarily between 50° - 30°.
Elev -31.1 to Elev -32.6', pervasively sheared with a substantial portion mylonized, random fracture orientations.
Elev -32.9', pervasively oxidized, intensely fractured, variably oriented fractures.

SBBT-LTB13

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 13 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES 07/29/09 08/07/09 08/20/09 — SHEET OF

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04	SF	101	8.8/9.2		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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Arup PB Joint Venture
560 Mission Street, Suite 700
San Francisco, CA 94105

BENCH MARK
BM SF 14 Elev 96.261′

FOR PLAN VIEW SEE "LOG OF TEST BORINGS 1 OF 17"

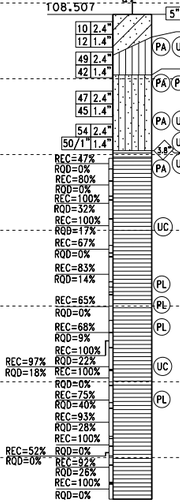
NOTE:- This LOTB sheet was prepared in accordance with the CALTRANS Soil & Rock Logging, Classification, and Presentation Manual (June 2007), with the exception of Section 2.3.

PROFILE
HOR. 1"=10′
VER. 1"=10′

RW6-R1-PZ

58′ L STA 85+24 SBT LINE

T08.507



Termination at El 44.5
ERi = 72.9%

5" CLAYEY SAND (SC), loose, dark brown, dry to moist, fine, with occasional roots, with pieces of crushable black nodules, strong organic odor. [FILL]

SILT with SAND (ML), stiff, yellowish brown, dry to moist, with iron-oxide staining, SAND is very fine, with black organic mottling and pieces of decayed vegetation.

SILTY SAND (SM), medium dense, yellowish brown, dry to moist, very fine, with frequent black specks and piece of decayed vegetation up to 1/8" diameter.

Grades dense.
Grades reddish brown, moist, fine, with slight black carbon mottling.
Grades yellowish brown, medium dense, with iron-oxide mottling, and seams of light yellowish brown CLAY.

SEDIMENTARY ROCK (SANDSTONE), yellowish brown, decomposed, soft (poorly graded SAND with CLAY (SP-SC), very dense, moist, SAND is fine with light gray CLAY infilling and black organic mottling).
Grades fine to medium grained, massive, yellowish brown and grayish brown, moderately weathered, moderately hard, obscure in-situ fractures with some evidence of variably oriented natural fractures ranging from 50° to 80°.

Elev 84.0′, intensely fractured, moderate oxidation staining on fractured planes.
Crushed zones (0.05′ thick) at Elev 83.3′, Elev 83.0′, and Elev 82.4′.
Elev 82.3′, medium fractured, variably oriented dark gray lamination due to soft sediment deformation.

Elev 79.5′ to Elev 75.2′, crushed zone with clay.
Elev 75.3′, dark gray.
Elev 71.5′, slightly weathered.
Healed and open fractures ranging from 30° to sub-vertical.
Elev 60.8′ to Elev 59.7′, multiple near vertical fractures.
Elev 58.2′ to Elev 57.3′, crushed zone.

Elev 57.75′, fresh, moderately hard to hard, with mineral precipitate infilling of fractures (no evidence of shearing).

Elev 55.5′, white mineral veins aligned at 45° occasionally correspond to fractures, additional fractures not aligned with veins.

Elev 52.5′, crushed (mechanical?)
Elev 51.5′ to Elev 50.2′, vertical fracture.
Elev 49.0′, mineral precipitate on naturally occuring fracture planes.
Elev 46.5′, crushed (primarily mechanical?)
Elev 46.0′ to Elev 45.4′, very closely fractured (mechanical).
Elev 45.4′, crushed (primarily mechanical?).

110 100 90 80 70 60 50 40 30 20 10 0 -10

85+000 86+000 87+000 88+000

SBBT-LTB14

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY: TERRENCE CARROLL	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU 04242 EA 163741		DISREGARD PRINTS BEARING EARLIER REVISION DATES →

SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 14 of 17

REVISION DATES: 07/23/09 08/07/09 08/20/09 | SHEET | OF

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REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2	8	

REGISTERED CIVIL ENGINEER _____ DATE _____

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REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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Arup PB Joint Venture
560 Mission Street, Suite 700
San Francisco, CA 94105

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring
Size	R P	Rotary drilled boring Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778-95)
[ ]	O	Other

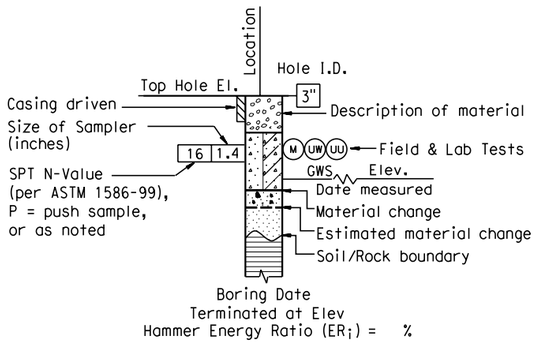
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

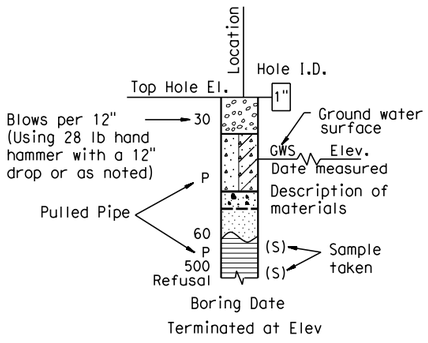
Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

PLASTICITY OF FINE-GRAINED SOILS

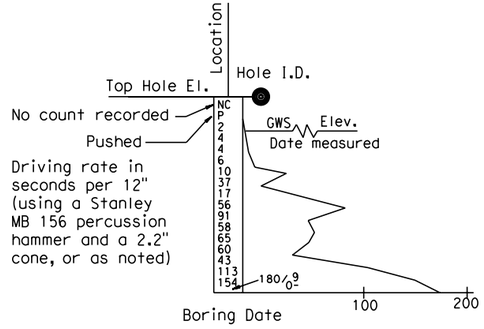
Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.



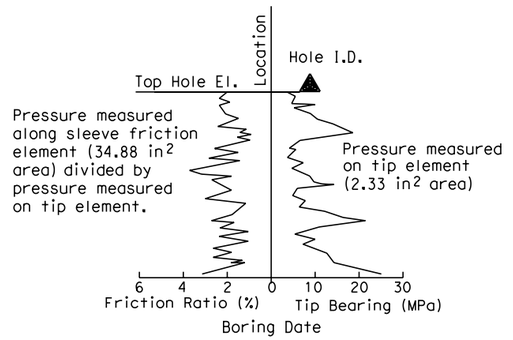
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

SBBT-LTB15

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2	SOUTHBOUND BATTERY TUNNEL LOG OF TEST BORINGS 15 of 17
OGS CIVIL LOG OF TEST BORINGS SHEET			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		CU 04242 EA 163741	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES: 07/28/09, 08/07/09, 08/20/09 — SHEET — OF

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REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (PP) Pocket Penetrometer
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (TV) Pocket Torvane
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)
- (VS) Vane Shear (AASHTO T 223)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2	9	

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Terrence Carroll — No. C68869 — Exp. 9/30/2009 — CIVIL — STATE OF CALIFORNIA

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560 Mission Street, Suite 700
San Francisco, CA 94105

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		> 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

SBBT-LTB16

RANDY ANDERSON
DESIGN OVERSIGHT
SIGN OFF DATE

FUNCTIONAL SUPERVISOR
NAME: FRANK GREGURAS

DRAWN BY: PAUL TONKIN
CHECKED BY: TERRENCE CARROLL

FIELD INVESTIGATION BY:

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

FRANK GREGURAS
PROJECT ENGINEER

BRIDGE NO. 34-161L
POST MILES 9.0/9.2

SOUTHBOUND BATTERY TUNNEL
LOG OF TEST BORINGS 16 of 17

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04242
EA 163741

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES: 07/27/09 08/07/09 08/20/09

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SF	101	8.8/9.2	10	

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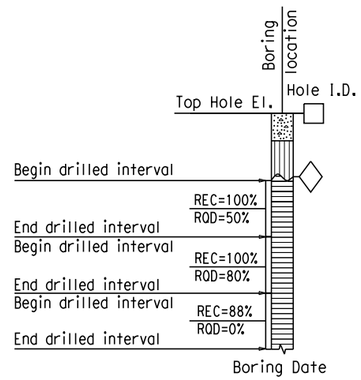
560 Mission Street, Suite 700
San Francisco, CA 94105

PERCENT CORE RECOVERY (REC) & ROCK QUALITY DESIGNATION (RQD)

$$REC = \frac{\sum \text{Length of the recovered core pieces (inches)}}{\text{Total length of core run (inches)}} \times 100\%$$

$$RQD = \frac{\sum \text{Length of intact core pieces} \geq 4\text{"}}{\text{Total length of core run (inches)}} \times 100\%$$



RELATIVE STRENGTH OF INTACT ROCK

Term	Uniaxial Compressive Strength (PSI)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

BEDDING SPACING

Description	Thickness / Spacing
Massive	Greater than 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8" to 1 ft
Thinly bedded	1-1/4" to 3-5/8"
Very thinly bedded	3/8" to 1-1/4"
Laminated	Less than 3/8"

LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

ROCK HARDNESS

Description	Criteria
Extremely Hard	Specimen cannot be scratched with a pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows.
Very Hard	Specimen cannot be scratched with a pocket knife or sharp pick. Breaks with repeated heavy hammer blows.
Hard	Specimen can be scratched with a pocket knife or sharp pick with difficulty (heavy pressure). Heavy hammer blows required to break specimen.
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure. Core breaks with moderate hammer blows.
Moderately Soft	Specimen can be grooved 1/6" deep with a pocket knife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Specimen can be grooved or gouged easily by a pocket knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very Soft	Specimen can be readily indented, grooved or gouged with fingernail, or carved with a pocket knife. Breaks with light manual pressure.

FRACTURE DENSITY

Description	Observed Fracture Density
Unfractured	No fractures.
Very slightly fractured	Lengths greater than 3 feet.
Slightly fractured	Lengths from 1 to 3 feet with few lengths less than 1 foot or greater than 3 feet.
Moderately fractured	Lengths mostly in 4" to 1 foot range with most lengths about 8"
Intensely fractured	Lengths average from 1 to 4" with scattered fragmented intervals with lengths less than 4"
Very intensely fractured	Mostly chips and fragments with a few scattered short core lengths.

Combination descriptors (such as "Very intensely to intensely fractured") are used where equal distribution of both fracture density characteristics is present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions. Only two adjacent descriptors may be combined.

WEATHERING DESCRIPTORS FOR INTACT ROCK

Description	Diagnostic features: Chemical Weathering-Discoloration and/or oxidation — Body of Rock	Diagnostic features: Chemical Weathering-Discoloration and/or oxidation — Fracture Surfaces	Diagnostic features: Mechanical Weathering-Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Diagnostic features: Texture and Solutioning — Texture	Diagnostic features: Texture and Solutioning — Solutioning	General Characteristics
Fresh	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change.	No solutioning.	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in-situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Combination descriptors (such as "slightly weathered to fresh") are permissible where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant, identifiable zones can be delineated. Only two adjacent descriptors may be combined. "Very intensely weathered" is the combination descriptor for "intensely weathered to decomposed."

SBBT-LTB17

RANDY ANDERSON DESIGN OVERSIGHT SIGN OFF DATE	FUNCTIONAL SUPERVISOR NAME: FRANK GREGURAS	DRAWN BY: PAUL TONKIN CHECKED BY: TERRENCE CARROLL	FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK GREGURAS PROJECT ENGINEER	BRIDGE NO. 34-161L POST MILES 9.0/9.2

SOUTHBOUND BATTERY TUNNEL

LOG OF TEST BORINGS 17 of 17

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04242
EA 163741

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES: 07/27/09 | 08/07/09 | 08/20/09

SHEET OF

FILE => SBBT-LTB17.dgn

USERNAME => royce.sui DGN: PLOTTED => 8/20/2009 TIME PLOTTED => 2153:31 PM

APPENDIX A.2

Boring Records

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	5-31-08	6-1-08	N2120470.078 / E5994297.737 (NAD83)	BTNB-R1
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 77ft R Sta 83+61 NB Alignment	91.378 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Bulk, 101-Sampler			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill			Not Recorded	98 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		3.75" ASPHALT CONCRETE, 7.5" UNREINFORCED CONCRETE.		S1										Bulk sample collected from 0 to 5'
	1		SILTY SAND with GRAVEL (SM), light brown, dry, fine to medium, GRAVEL is fine, angular to subangular. [FILL]												
89.38	2		SILT with SAND (ML), hard, brown and yellowish brown, dry, trace GRAVEL, GRAVEL is angular to subangular.												
	3				S2	13 24 40	64	100							
87.38	4				S3	14 28 36	64	50							
	5														
85.38	6		SILTY SAND (SM), very dense, brown to reddish brown, moist, trace GRAVEL, GRAVEL is fine to coarse, highly weathered sandstone fragments.												
	7														
83.38	8				S4	19 36 46	82	94							
	9				S5	32 50/ 5.5"	50/ 5.5"	70							
81.38	10														
	11														
79.38	12		SEDIMENTARY ROCK (Sandstone Breccia), reddish brown, fine grained, moderately weathered, core is broken, contains CLAY and SILT, SANDSTONE pieces are hard, with soft CLAYEY, thinly weathered portions.		S6	18 41 50/3"	91/9"	53							Rig chatter at 12'; switch to rock coring (101 system)
	13														
77.38	14				C7			20	0						
	15														
75.38	16														
	17				C8			100	0						
73.38	18		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C9			60	0						
	19														
71.38	20														
	21				C10			85	0						
69.38	22														
	23		23.0' - 23.4', SANDSTONE piece.		C11			65	0						
67.38	24														
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C12			75	0						
65.38	26		25.0' - 25.3', hard SILTSTONE piece.												
	27		Grades with SANDSTONE, SILTSTONE, and SHALE fragments.		C13			57	0						
63.38	28														
	29														
61.38	30		30.0' - 30.8', slightly serpentinized or chloritized interval.		C14			37	0						
	31														
59.38	32														
	33		33.0', slightly weathered.		C15			65	0						
57.38	34														
	35		Grades with SHALE fragments.		C16			75	0						Begin Box 2 at 35'
55.38	36														
	37				C17			65	0						
53.38	38		37.5' - 38.3', moderately hard SILTSTONE fragments with some SERPENTINITE.												
	39				C18			70	0						
51.38	40														
	41				C19			100	0						
49.38	42		41.5' - 41.65', reddish brown (CHERT?) fragment. 42.0', SHALE fragments, moderately soft.												Losing circulation
	43		43.0', SILTSTONE and fine grained SANDSTONE fragments (up to 0.1 thick) in sheared SHALE matrix.		C20			75	0						
47.38	44														
	45				C21			90	0						
45.38	46														
	47		46.5', 1.5" greenish gray, serpentinized interval.		C22			75	0						
43.38	48														
	49				C23			90	0						
41.38	50		49.8', light gray, completely sheared throughout.												
	51				C24			90	0						Begin Box 3 at 51'
39.38	52									10.3	135.6				PI
	53		Fragments are up to 0.02' thick.		C25			60	0						
37.38	54														
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.		C26			50	0						
35.38	56		55.4' - 56.0', fragments are meta-SANDSTONE (up to 0.25' thick).												
	57				C27			50	0						
33.38	58														
	59				C28			30	0						
31.38	60														
	61		61.0', moderately weathered, with slight iron-oxide staining throughout.		C29			40	0						
29.38	62														
	63		63.0', slightly weathered.												
27.38	64				C30			50	0						
	65														
25.38	66		CLAY matrix is dark greenish gray, serpentinized.		C31			90	0						
	67														Losing circulation
23.38	68				C32			80	0						
	69		68.5', white secondary mineral deposit. Grades slightly more gray than green and with increase in SILTSTONE content.		C33			80	0						
21.38	70		69.0' - 69.8', crushed granular interval.												
	71				C34			65	0						
19.38	72														
	73		White secondary mineral is more common.		C35			80	0						Begin Box 4 at 73'
17.38	74		74.0', sheared SHALE matrix commonly has sandy intervals.												
	75				C36			100	0						
15.38	76														
	77				C37			100	0						
13.38	78														
	79														
11.38	80				C38			80	0						
	81														
9.38	82														
	83														Drill with tricone through hard material from 82.5' to 84'
7.38	84				C39			45	0						
	85														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		SEDIMENTARY ROCK (Mélange Matrix), gray, intensely fractured, moderately weathered, moderately hard, fine-grained SANDSTONE fragments (up to 0.25' thick) in sheared SHALE matrix.												
5.38	86				C40			80	0						
	87														Drill with tricone through hard material from 87' to 89'
3.38	88														
	89				C41			70	0						
1.38	90														
	91														
-0.62	92				C42			60	0						Begin Box 5 at 92'
	93														
-2.62	94														
	95				C43			90	0						
-4.62	96														
	97														
-6.62	98		Borehole terminated at a depth of 98 feet on 6/1/2008.												
	99		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-8.62	100														
	101														
-10.62	102														
	103														
-12.62	104														
	105														
-14.62	106														
	107														
-16.62	108														
	109														
-18.62	110														
	111														
-20.62	112														
	113														
-22.62	114														
	115														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	5-31-08	6-1-08	N2120407.628 / E5994505.431 (NAD83)	BTNB-R2
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 70ft R Sta 81+44 NB Alignment	89.420 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Bulk, Shelby (2.87"), 101-Sampler			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill			Not Recorded	71.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		4" ASPHALT CONCRETE. 7-8" UNREINFORCED CONCRETE.												
	1		3" Poorly graded SAND (SP), yellowish brown, dry to moist, fine, clean, frequent roots up to 1/4" diameter. [FILL]		B1										Slight horizontal laminations (from compaction?)
87.42	2		SILTY SAND with GRAVEL (SM), medium dense, yellowish brown, moist, fine, GRAVEL is fine to coarse.												
	3				S2	4 7 9	16	83							
85.42	4		SANDY SILT (ML), medium dense, yellowish brown, moist, SAND is fine to medium, piece of coarse GRAVEL.		S3	3 4 16	20	78				PP = 1.5			
	5														
83.42	6		CLAYEY GRAVEL (GC), loose, yellowish brown and green, moist, coarse, rounded, serpentinite fragments (up to 3" diameter in shoe at 8.5').												
	7														
81.42	8				S4	4 5 10	15	67							
	9		CLAYEY SAND (SC), medium dense, yellowish brown, fine to coarse, with fine GRAVEL (subrounded to rounded, serpentinite fragments in CLAYEY SAND matrix).		S5	4 4 6	10	44							
79.42	10														
	11														
77.42	12														
	13		Lean CLAY with GRAVEL and SAND (CL), soft, brown and greenish gray, moist to wet, GRAVEL is angular serpentinite fragments, GRAVEL is fine to coarse, SAND is fine to coarse.		S6	4 8 7	15	47							Modified California sample at 12.5' was unlined
75.42	14				S7	3 2 4	6	44							
	15														
73.42	16		16.5', rig chatter.												
	17		SILTY SAND (SM), loose, very dark brown, wet, fine.		S8	3 3 3	6	72							Very strong hydrocarbon/oily odor
			Fat CLAY with SAND, medium stiff to stiff, very dark brown, wet, SAND is fine, with rootlets.												Very strong hydrocarbon/oily odor
71.42	18				U9		500 psi, last 18"	67				PP = 1.63 1.63 1.75			
	19														
69.42	20														
	21		20.5', grades grayish brown, stiff.												Without odor, without organics
67.42	22														
	23				U10		1000 psi	100							
65.42	24		METAMORPHIC ROCK (Serpentinite), very soft, yellowish brown, greenish gray and dark gray, moist, decomposed, very intensely fractured (SANDY SILT (ML), medium stiff,		S11	9 19 42	61	67							
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		sand is fine - moist).		C12			15	0						101-Coring System
63.42	26		METAMORPHIC ROCK (Serpentinite), dark greenish gray and dark gray, moderately to intensely weathered, very soft, very intensely fractured, common iron-oxide staining (localized), occasional small moderately soft zones.												
	27				C13			50	N/A						
61.42	28														
	29		29.0', grades soft, intensely sheared throughout, fibrous texture common throughout (ML - SANDY SILT, SAND is fine, moist).		C14			100	N/A						C14, shoe plugged, replaced with smaller shoe
59.42	30				C15			68	N/A						
	31														
57.42	32		32.0', slight iron-oxide staining, slightly weathered, harder fragments (angular) of SERPENTINITE with softer material washed away, fragments are moderately hard, up to 0.1' in diameter (SM - SILTY SAND, fine to coarse, angular, with fine GRAVEL fragments, angular to subangular, moist).		C16			37	N/A						
	33														
55.42	34														
	35				C17			50	N/A						
53.42	36														
	37				C18			100	N/A						
51.42	38		37.4', soft to moderately soft, faint iron-oxide staining on fracture surfaces. 37.7', fibrous texture noted as long as 0.02'.		C19			100	N/A						Slower drilling at 38'
	39		37.9', moderately soft, bluish gray. 38.0', soft. 38.0', dark bluish gray with infilling of light greenish gray.												
49.42	40		38.65', fibrous texture noted as long as 0.02'. 39.15', thin (0.01' thick) white mineral (talc?) vein dipping 50°.		C20			100	N/A						
	41		40.0', moderately weathered with common iron-oxide staining. 41.3', slightly weathered, very soft.												
47.42	42				C21			50	N/A						End Box #1 at 42'
	43														
45.42	44				C22			65	N/A						
	45		44.35', angular fragments up to 0.1' diameter.												
43.42	46				C23			40	N/A						
	47														
41.42	48		47.9' - 48.6', moderately hard, very intensely fractured, fragments of harder rock, dark gray.		C24			100	N/A						
	49														
39.42	50		50.0', soft to moderately soft.		C25			70	N/A						
	51														
37.42	52		51.5', very soft.		C26			32	N/A						
	53														
35.42	54				C27			75	N/A						
	55		54.2', very intensely fractured zone, fragments are moderately hard, dark bluish gray, overall matrix is very soft												

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	54.7', fibrous texture noted.		C28			40	N/A						
33.42	56	METAMORPHIC ROCK (Serpentinite), dark greenish gray and dark gray, moderately to intensely weathered, very soft, very intensely fractured, common iron-oxide staining (localized), occasional small moderately soft zones.												
	57	55.7', concentration of white mineral.		C29			50	0						
31.42	58	57.5' - 59.5', recovery is light gray meta-sandstone and gabbro, moderately weathered, hard, 0.1' to 0.2' fragments, significant iron-oxide staining, hard to moderately hard.		C30			33	0						
	59													
29.42	60	59.5', moderately weathered, soft, light greenish gray and orangish brown, heavy iron-oxide staining.		C31			75	N/A						
	61	59.7', concentrated iron-oxide weathering along shear planes.												
27.42	62	61.5', moderately soft, slightly weathered, greenish gray to olive gray, with moderately hard, white and dark gray minerals (white mineral has very fine, fibrous texture developed along planar surfaces, asbestos? White mineral also common with powdery texture disseminated thorught rock mass).		C32			100	0						
	63			C33			100	N/A						
25.42	64	61.8', horizontal buff sheared seam (0.01' thick), fibrous texture noted.		C34			20	N/A						
	65	62.5', bluish gray, clayey, with green chlorite? minerals, moderately to slightly weathered, very soft.		C35			89	N/A						
23.42	66													
	67	67.0', moderately weathered, increase in iron-oxide staining.		C36			54	N/A						
21.42	68	67.4' - 67.7', moderately hard rock fragments (gabbro?).												
	69													
19.42	70			C37			43	N/A						
		70.2', moderately to slightly weathered, increase in white mineral (talc) disseminated throughout.		C38			75	N/A						
	71	71.5', hard rock fragments.		C39			0	N/A						Switch to HQ at 71'
17.42	72	Borehole terminated at a depth of 71.5 feet on 6/1/2008.		C40			100							
	73	See Boring Record Legend for soil classification chart and key to test data and sampler type.												
15.42	74													
	75													
13.42	76													
	77													
11.42	78													
	79													
9.42	80													
	81													
7.42	82													
	83													
5.42	84													
	85													

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
B. Kluzniak	7-26-08	7-26-08	N2120351.985 / E5994725.98 (NAD83)	BTNB-R3
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 67ft R Sta 79+10 NB Alignment	86.286 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Bulk, 101-Sampler			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill			21.6 feet	100 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		4.5" ASPHALT CONCRETE; 6" UNREINFORCED CONCRETE.												
	1		SILTY SAND (SM), yellowish brown, moist, SAND is fine to medium, with trace subangular serpentinite fragments, with dark brown oxidized nodules. [FILL]		B1										
84.29	2		2.0', serpentinite cobble up to 1/8" diameter.												Augering slow at 2'
	3		SANDY SILT (ML), medium stiff, dark yellowish brown, moist, SAND is fine, with black specks.		S2	9 12 14	26	83				PP = 2.0			
82.29	4		4.0', block of serpentinite, yellowish brown and greenish brown, fine-grained, decomposed (SILT (ML), stiff, dry to moist).		S3	4 8 9	17	83							
80.29	6														Driller reports easier drilling/harder zone alternating from 6' to 7.5'
	7														
78.29	8		Poorly graded SAND (SP), medium dense, dark brown, moist, trace SILT, fine to medium, with occasional rootlets up to 1/16" diameter.		S4	6 8 10	18	50							
	9		SANDY SILT (ML), very stiff, yellowish brown to dark yellowish brown, moist, SAND is fine, with dark brown specks, with thin gray seams.		S5	4 6 9	15	0							
76.29	10		Cuttings are yellowish brown SANDY SILT.												
	11				S6	9 13 18	31	100							PI
74.29	12									18.9	109.4	PP = 2.125			
	13				S7	5 7 7	14	50				2.125			Drills faster at 12.5'
72.29	14														
	15														
70.29	16		CLAYEY SAND (SC), medium dense, yellowish brown, moist, fine to medium, with black specks, slightly cemented.		S8	8 11 15	26	83							
	17														
68.29	18				S9	7 11 13	24	100		18.2					With increased SAND content
	19														
66.29	20		Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine to medium, with black specks.												
	21				S10	17 23 34	57	94							
64.29	22														
	23		Grades very dense.		S11	16 21 22	43	67							
62.29	24														
	25														Slight bouncing of drill rods at 24.5'

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25		Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine to medium, with black specks.											
60.29	26		Grades with iron-oxide mottling, with moderate cementation.		S12	19 25 33	58	94						With decrease in CLAY content
	27													
58.29	28				S13	13 17 20	37	89						
	29													
56.29	30		Grades light yellowish brown and olive gray, mottled.											Without iron-oxide staining, with decrease in CLAY content
	31													
54.29	32				S14	15 19 22	41	94		23.1	102.1			
	33				S15	10 15 21	36	100						
52.29	34													
	35													
50.29	36		Poorly graded SAND (SP), dense, yellowish brown to grayish brown, moist, fine to medium.		S16	20 36 55	91	83						
	37													
48.29	38				S17	11 15 30	45	89						
	39													
46.29	40													
	41		Grades grayish brown with iron-oxide mottling, fine.		S18	23 36 36	72	83						
44.29	42													
	43		Poorly graded SAND with CLAY (SP-SC), medium dense, yellowish brown, moist, fine, with very dark brown mottling.		S19	9 11 12	23	89						
42.29	44													
	45													
40.29	46		Lean CLAY with SAND and GRAVEL (CL), medium stiff to stiff, yellowish brown, moist, GRAVEL is fine to coarse, subangular serpentinite fragments.		S20	9 15 27	42	61						Run #3 dropped from barrel, unable to recover
	47		METAMORPHIC ROCK (Serpentinite), fine-grained, yellow and greenish gray, decomposed, very soft (SILT (ML), stiff, horizontally laminated, dry).		S21	30 50/ 5.5"	50/ 5.5"	52						
38.29	48													
	49		Grades greenish gray, light gray and reddish brown, intensely weathered, very soft, very intensely fractured, internally crushed and sheared (SILT (ML), medium stiff, moist to wet, trace fine to medium SAND), pervasively sheared, iron-oxide staining throughout rock mass. 50.25', white clay seam infilling.		C22			100	N/A				
36.29	50													
	51													
34.29	52		51.5', 0.2' thick zone, horizontally fissured, soft, dark mineral fragments up to 0.01' in diameter. 52.0' - 52.6', moderately hard, gabbroic with localized shearing.		C23			77	N/A					
	53													
32.29	54													
	55													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		METAMORPHIC ROCK (Serpentinite), fine-grained, yellow and greenish gray, decomposed, very soft (SILT (ML), stiff, horizontally laminated, dry).		C24			0							
30.29	56														
	57														
28.29	58		58.0', moderately hard, with localized shearing.		C25			100	0						
	59		58.5' - 58.7', white minerals common with tan CLAY infilling.												
26.29	60														
	61		60.5', intensely weathered, very soft, heavy iron-oxide staining.		C26			95	0						
24.29	62		61.6' - 62.0' and 62.4' - 62.6', 45° dipping fractures. 62.05', 62.5', and 62.65', black staining on fracture surfaces (manganese-oxide?).												
	63		62.7', moderately weathered, moderately hard, iron-oxide staining limited to fracture planes.												
22.29	64		63.3', 63.65', and 63.8', light yellowish brown CLAY infilling.												
	65		65.0' - 65.3' and 65.55' - 65.8', zones of very soft serpentinite.		C27			28	N/A						
20.29	66		Heavy iron-oxide staining throughout run.												
	67														
18.29	68														
	69		69.1', white secondary mineral deposit on fracture plane, moderately to intensely weathered, moderately hard.		C28			100	N/A						
16.29	70		69.6', sub-horizontal shearing planes with heavy iron-oxide staining.		C29			95	N/A						
	71														
14.29	72				C30			100	N/A						
	73		72.4', light orangish brown staining. 72.9' - 73.7', intensely weathered, very soft serpentinite.												
12.29	74		IGNEOUS ROCK (Gabbro), aphanitic, very dark gray to black, moderately to slightly weathered, moderately hard to hard, very intensely fractured.		C31			90	N/A						
	75		74.4', thin light gray secondary mineral deposit, localized shearing on through fractures, color change to very dark gray/black.												
10.29	76		76.0', very intensely fractured (entire run).		C32			100	N/A						
	77		76.4' - 77.2', heavy iron-oxide staining.												
8.29	78														
	79		METAMORPHIC ROCK (Serpentinite), intensely weathered, moderately soft, light greenish gray. 78.5' - 78.7', very soft.		C33			88	N/A						
6.29	80		79.5' - 79.6', very soft (CLAY-like). 79.7' - 80.3', reduced diameter.												
	81		81.0', color change to dark bluish gray.		C34			83	N/A						
4.29	82		82.2', very light gray.												
	83														
2.29	84				C35			67	10						
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85														
0.29	86		84.7', very soft (CLAY-like), bluish gray (gabbroic), secondary white mineral on shearing planes. METAMORPHIC ROCK (Serpentinite), intensely weathered, moderately soft, light greenish gray.												
	87				C36			100	10						
-1.71	88		87.4' - 87.6', 88.0' - 88.2', and 88.5' - 88.7', severely weathered, very soft. 88.2' - 88.5', reduced diameter.												
	89		88.8', moderately weathered, intensely fractured, moderately hard, dark to very dark gray, predominantly gabbroic.												
-3.71	90		89.5' - 89.8', mechanical breaks. 89.9' - 90.5', very soft (CLAY-like), light bluish gray.		C37			100	20						
	91		90.5' - 91.5', variable softness (very soft to moderately hard).												
-5.71	92		92.0' - 93.7', moderately hard, with horizontal markings from drill bit.		C38			100	N/A						
	93														
-7.71	94		94.2' - 94.6', slightly weathered, very soft.												
	95				C39			100	20						
-9.71	96														
	97		96.5' - 96.8', secondary white mineral on predominant fracture plane, dipping approximately 70°.		C40			60	N/A						
-11.71	98		97.5' - 97.8', intensely fractured, slightly weathered to fresh, very soft. 97.8' - 100.0', moderately hard, with very soft to soft zones at 98.0', 98.4', and 98.6'.												
	99														
-13.71	100		Borehole terminated at a depth of 100 feet on 7/26/2008.												
	101		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-15.71	102														
	103														
-17.71	104														
	105														
-19.71	106														
	107														
-21.71	108														
	109														
-23.71	110														
	111														
-25.71	112														
	113														
-27.71	114														
	115														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R3
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-18-08	2-19-08	N2120366.979 / E5994998.299 (NAD83)	BTNB-R4-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 100ft R Sta 76+22 NB Alignment	70.422 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 49.5 to 69.5 ft			Not Recorded	124 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		CLAYEY GRAVEL (GC), mediuim dense, reddish brown, dry to moist, fine, angular, with fine to coarse SAND, with black organic mottling. [FILL]												
	1														
68.42	2														
	3		2.5', piece of plastic.		S1	17 9 8	17	100							
66.42	4		SANDY ORGANIC SOIL (OL), soft to medium stiff, very dark brown, moist, SAND is fine, with decayed vegetation up to 1.5" diameter, slight organic odor detected.		S2	4 8 13	21	83							
	5		SILT with SAND (ML), medium stiff, yellowish brown, dry to moist, with light yellowish brown mottling and black specks, strongly cemented, with piece of decayed vegetation.												
64.42	6														
	7														
62.42	8		Grades dense with iron-oxide staining.		S3	19 22 31	53	100		13.7	130.7				PI, PA
	9				S4	12 17 22	39	67							
60.42	10														
	11														
58.42	12														
	13		SANDY SILT (ML), yellowish to reddish brown, dry to moist, SAND is fine, with light yellowish brown mottling, with black specks.		S5	12 23 29	52	72		14.1	136.8				PA
56.42	14				S6	10 15 19	34	67							
	15		Grades with pockets of SANDY CLAY.												
54.42	16														
	17														
52.42	18		Poorly graded SAND (SP), dense, reddish brown, moist, fine, trace fines. Black carbon nodule up to 1/4" diameter.		S7	19 32 49	81	83							CR
	19				S8	14 19 25	44	83							
50.42	20		Grades dark yellowish brown.												
	21														
48.42	22														
	23		Poorly graded SAND with CLAY (SP-SC), very dense, reddish brown, moist, fine.		S9	27 47 50/ 5.5"	97/ 11.5"	86		19.5	131.9	DS = 1.32			PA
46.42	24		Grades yellowish brown.		S10		48	100		19.4 18.8	129.0 127.0	DS =			
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Poorly graded SAND with CLAY (SP-SC), very dense, reddish brown, moist, fine.			16 23 25						1.67 DS = 2.01			
44.42	26														
	27														
42.42	28		Grades reddish brown with yellowish brown layer, with occasional black specks.		S11	18 33 43	76	89							
	29														
40.42	30		Grades very dense, yellowish brown.		S12	17 23 30	53	83							
	31														
38.42	32														
	33		Grades fine to medium, with frequent pockets of slight cementation, with occasional black specks and iron-oxide staining.		S13	20 27 31	58	83		20.1	132.9				PA
36.42	34				S14	17 23 33	56	83							
	35														
34.42	36														
	37														
32.42	38		Grades fine.		S15	21 27 36	63	94							
	39				S16	11 22 31	53	67							
30.42	40														
	41														
28.42	42														
	43		Grades dense, dark yellowish brown and light yellowish brown, trace fines, grades fine to medium.		S17	30 43 50/ 5.5"	93/ 11.5"	86							
26.42	44				S18	11 19 16	35	100							Appears to be a water bearing layer at 44'
	45		45.0', grades clayey. Grades yellowish brown, fine, moist, horizontally laminated, with iron-oxide mottling.												
24.42	46														
	47														
22.42	48		Poorly graded SAND (SP), medium dense, dark yellowish brown, wet, fine to medium, with iron-oxide mottling, with crushable black carbon nodules.		S19	15 22 34	56	83		21.2	134.2				PA
	49		Poorly graded SAND with CLAY (SP-SC), dense, dark yellowish brown, moist, fine to very fine, with iron-oxide mottling.		S20	11 11 21	32	100							
20.42	50														
	51														
18.42	52														
	53		Lean CLAY with SAND (CL), very stiff, grayish and yellowish brown, moist, pockets of cemented SAND up to 1/8" diameter, occasional piece of angular fine GRAVEL.		S21	7 12 18	30	83				PP = 1.875			
16.42	54		METAMORPHIC ROCK (Serpentinite), greenish gray, very intensely weathered, soft, very intensely fractured (Lean		S22	12 50/6"	50/6"	83							
	55														

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	CLAY with SAND (CL), very stiff, moist. 54.5', grades moderately strong and moderately weathered.		C23			48	0						HQ-3 syntek bit
14.42	56	METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
	57													
12.42	58			C24			27	0						
	59	Greenish gray non-gabbroic, pervasively sheared, slightly weathered to fresh, soft.		C25			90	0						59', switch to diamond bit
10.42	60								16.5	119.7	UU = 0.36			PI
	61													
8.42	62	61.5', reddish brown slightly oxidized zone.		C26			56	N/A						
	63													
6.42	64													
	65													
4.42	66	Recovery is dark gray gabbroic blocks only.		C27			40	0						
	67													
2.42	68													
	69	68.5', green and dark gray, moderately fractured, moderately soft. Break at 68.95' is mechanical.		C28			100	46						
0.42	70	69.0' - 70.5', surface of core is slightly pitted.							7.2					
	71	70.5', 0.15' thick diagonal white mineral vein, moderate iron-oxide staining on fracture surfaces at 69.4' and 70.6'. 71.0' - 71.5', light green mineral vein infilling (chlorite?). 71.6', white minearl vein (0.08' thick) with fibrous texture. 72.1', white mineral vein (0.08' thick).		C29			100	0						
-1.58	72													
	73	73.0', green and greenish gray, very soft, slightly weathered.												Increase in drill rate at 73.4', stopped run at 74'
-3.58	74	74.0', surface pitted.		C30			94	0						
	75	75.0', very soft.												
-5.58	76								6.03					
	77	Dark purple blocks of harder serpentinite (gabbroic) at 76.5', 77.5', and 77.0' (each 0.2' thick).												
-7.58	78													
	79	78.5' - 78.8', dark purple block of harder serpentinite (gabbroic).		C31			73	N/A						
-9.58	80													
	81	80.5', 0.3' block of greenish gray harder serpentinite (grabbroic).												
-11.58	82													
	83	82.5' - 83.3', dark greenish gray, intensely fractured, moderately hard, moderately strong, slightly weathered. 83.3', light greenish gray, very soft to soft.		C32			81	0						
-13.58	84	84.3' - 84.7', harder blocks.												
	85													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
-15.58	86				C33			100	N/A						
	87														PI
-17.58	88									16.8	118.6	UU = 0.42			Lost circulation at 88' to 88.5'
	89				C34			100	N/A						
-19.58	90				C35			67	N/A						
	91		90.5', iron-oxide staining.												
-21.58	92		91.5', diagonal white secondary mineral vein filliing.												
	93														
-23.58	94		94.0', soft, secondary white mineral disceminated throughout.		C36			78	11						
	95														
-25.58	96		95.8' - 97.0', dark greenish gray, moderately hard, intensely to moderately fractured (no secondary, not internally sheared), fibrous mineralization noted along fractures.												
	97											UC = 92			
-27.58	98														
	99				C37			64	N/A						
-29.58	100														
	101														
-31.58	102														
	103				C38			100	N/A						
-33.58	104														
	105		104.7' - 105.6' and 107.0' - 108.0', recovery is broken, moderately hard, dark gray and green gabbroic serpentinite up to 2.5" in length.		C39			78	N/A						
-35.58	106		105.0' - 105.4', recovery is only loose, moderately strong, moderately hard, fresh blocks of dark gray and green serpentinite up to 1" in length.												
	107				C40			50	N/A						
-37.58	108				C41			100	70						
	109														Harder drilling 115' - 116' Harder drilling 123' - 124'
-39.58	110														Straight drill to 124'
	111														
-41.58	112														
	113														
-43.58	114														
	115														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R4-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		METAMORPHIC ROCK (Serpentinite), dark greenish gray, moderately weathered, gabbroic recovery is broken with largest core length 0.2'.												
-45.58	116														
	117														
-47.58	118														
	119														
-49.58	120														
	121														
-51.58	122														
	123														
-53.58	124		Borehole terminated at a depth of 124 feet on 2/19/2008.												
	125		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-55.58	126														
	127														
-57.58	128														
	129														
-59.58	130														
	131														
-61.58	132														
	133														
-63.58	134														
	135														
-65.58	136														
	137														
-67.58	138														
	139														
-69.58	140														
	141														
-71.58	142														
	143														
-73.58	144														
	145														

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BORING RECORD				BTNB-R4-PZ
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4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	5 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-9-08	4-10-08	N2120582.62 / E5994169.98 (NAD83)	BTNB-R5A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 154ft R Sta 85+13 NB Alignment	79.370 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	4 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
HQ Core			N/A	
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 15.0 to 35.0 ft			Not Recorded	76 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured.												0' to 1' straight drill to set casing
	1				C1			95	0						
77.37	2		1.85', moderately hard, moderately weathered.												
	3		2.8' and 5.4', heavy iron-oxide staining on fracture surfaces, sheared/mylonized clay filled fractures, slight iron-oxide staining throughout rock mass, randomly oriented fracture surfaces.												
75.37	4														
	5														PL
73.37	6														
	7		Iron-oxide staining reduced to fracture surfaces only.		C2			88	20						
71.37	8														
	9		9.0', very intensely to intensely fractured zone (0.5' thick).												
69.37	10														
	11		10.7', crushed/mylonized zone (0.3' thick).												
67.37	12		12.0', very thinly bedded (alternating light gray and gray), slightly weathered, moderately to slightly fractured, slight weathering on fracture planes, intact rock mass is unstained, hard.		C3			96	39						
	13														PL
65.37	14		14.0', intensely fractured.												
	15														
63.37	16														
	17		16.5', sheared/crushed/clay-filled zone (0.3' thick). 17.0', very intensely fractured, less iron-oxide staining, no indication of bedding, fine-grained.		C4			80	0						
61.37	18														
	19		18.5', intensely fractured, with mylonized/clay-filled zones at 19.0' and 20.0' up to 0.1' thick.		C5			88	0						At 18.5' switch from face discharge bit to side discharge/ impregnated bit
59.37	20														
	21		21.0', slightly weathered to fresh. 21.3' - 22.1', very intensely fractured.		C6			95	30						
57.37	22		22.1', intensely to moderately fractured.												
	23														PL
55.37	24		23.0', intensely to moderately fractured with very intensely fractured zone from 24.1' to 24.9'.		C7			82	26						
	25														

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BORING RECORD				BTNB-R5A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured.									UC = 706			
53.37	26		25.0', occasional thin white vein infilling (quartz?).												
	27														
51.37	28		28.0', very intensely to intensely fractured, slight clay infilling of fractures.		C8			92	0						
	29														
49.37	30														Straight drill at 30.5' to 70.6' for PS-logging
	31														
47.37	32														
	33														
45.37	34														
	35														
43.37	36														
	37														
41.37	38														
	39														
39.37	40														
	41														
37.37	42														
	43														
35.37	44														
	45														
33.37	46														
	47														
31.37	48														
	49														
29.37	50														
	51														
27.37	52														
	53														
25.37	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no apparent bedding, yellowish brown and gray, intensely to moderately weathered, moderately soft, intensely to moderately fractured.												
23.37	56														
	57														
21.37	58														
	59														
19.37	60														
	61														
17.37	62														
	63														
15.37	64														
	65														
13.37	66														
	67														
11.37	68														
	69														
9.37	70														
	71														
7.37	72														
	73														
5.37	74														
	75														
3.37	76		Borehole terminated at a depth of 76 feet on 4/10/2008. See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	77														
1.37	78														
	79														
-0.63	80														
	81														
-2.63	82														
	83														
-4.63	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
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CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-5-08	4-8-08	N2120581.324 / E5994178.193 (NAD83)	BTNB-R5-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 154ft R Sta 85+5 NB Alignment	79.635 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 78.0 to 98.0 ft			Not Recorded	114 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		1/2" ASPHALT CONCRETE.												
	1		SEDIMENTARY ROCK (Sandstone), medium grained to fine grained, no indication of bedding, dark grayish brown, moderately weathered, moderately hard, moderately fractured, heavy iron-oxide staining on fracture surfaces, light staining within rock mass at 4.5', vein infilling up to 0.02' thick (calcite?), grades very thinly bedded, intensely fractured, fracture dipping ranges from 20° to 70°, fractures are typically intensely weathered. Grains are angular to subangular, uniform, numerous insipient fractures, very dense/lithified.												
77.64	2														
	3				S1		50/3"	78							
75.64	4				C2			80	13						
	5														
73.64	6														
	7		6.8', finer grained with decrease in medium grained, darker minerals, moderately to slightly weathered.		C3			100	0						
71.64	8														
	9				C4			100	15						9.1', 2/58W 9.2', 347/4E
69.64	10		10.01', CLAYEY SAND sheared filling, entire interval appears massive (no indication of bedding).												9.6', 31/90 10.1', 82/44S 10.3', 336/28W 10.5', 352/34E 10.7', 353/39E
	11														
67.64	12		12.0', fracture orientation and spacings remain consistent with above.		C5			92	0						PL 11.1', 337/36W
	13														11.3', 38/44W 11.3', 28/48E
65.64	14														11.5', 292/24N 11.7', 344/68E
	15				C6			95	10						15.1', 78/49N
63.64	16		15.9', seam infilling with CLAY.												15.75', 359/12E 15.9', 21/42E
	17		16.5', slickensides parallel to dip.												16.5', 5/25E
61.64	18		~17.9' to 19.0", near vertical fracture, undulating surface intersecting fractures average orientation is 345/81E.												17.6', 44/55E 18.3', 3/18E
	19		19.0', slightly weathered (slight iron-oxide staining).		C7			78	0						18.35', 345/81E 18.5', 309/19N
59.64	20														
	21		21.0', very intensely to intensely fractured with one length from 21.5' to 22.0' intact.		C8			75	25						
57.64	22														
	23		23.0', hard, fresh to slightly weathered (absence of iron-oxide stains).		C9			47	0						Hole taking a little fluid at 23'
55.64	24		23.0', multiple vertical fractures entire length of core with additional sub-horizontal fractures.												
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		23.4', white mineral, vein, hard (non-quartz). 23.6', CLAY seam infilling.												
53.64	26		SEDIMENTARY ROCK (Sandstone), medium grained to fine grained, no indication of bedding, dark grayish brown, moderately weathered, moderately hard, moderately fractured, heavy iron-oxide staining on fracture surfaces, light staining within rock mass at 4.5', vein infilling up to 0.02' thick (calcite?), grades very thinly bedded, intensely fractured, fracture dipping ranges from 20° to 70°, fractures are typically intensely weathered. Grains are angular to subangular, uniform, numerous insipient fractures, very dense/lithified.		C10			100	0						
	27														
51.64	28				C11			100	24						
	29														
49.64	30		27.0' - 28.0', white mineral vein fillings (unrelated to fracturing) pervasively fractured (from fragments to 0.2').												PL
	31		28.0', intensely fractured, fractures dipping commonly 60° to 70°, continued localized white mineral vein fillings. 30.9', 0.08' thick shear zone (light gray, silty, fine SAND).		C12			80	37						30.9', 48/33S
47.64	32		31.0', contact to fine grained SAND (medium grained above).												Lost circulation 31.5' to 32.5' 32', 61/53S
	33														PL 32.6', 15/26W Taking a little water at 33'
45.64	34		33.4', fine to medium grained (core broken with silty fine SAND fragments <0.01' to 0.2').												33.3', 66/92 33.3', 34/64E 33.3', 14/56W
	35				C13			48	0						Apparent bedding caused by coring (typical 31.9' to 32.2)
43.64	36														35.35', 300/55N 35.35', 333/84W
	37		36.4', very intensely fractured (crushed) (silty, fine SAND shear zone).												36.4', 292/30N
41.64	38		38.0', 0.3' intact fragment (laminated showing soft sediment deformation), no visible sand grains.		C14			65	0						37.75', 88/78N 37.75', 67/42N
	39		38.3', 0.05' quartz vein.												
39.64	40		SEDIMENTARY ROCK (Mélange Matrix), dark gray (consisting of fine grained SANDSTONE, very hard SILTSTONE, and fragmented hard SHALE), very intensely fractured (crushed), slightly weathered to fresh.												40' to 41', straight drill At 40' rock contact gradual based on drilling change
	41				C15			25	0						Recovery is broken fragments of core, not representative of zone.
37.64	42														
	43				C16			40	0						
35.64	44														Straight drill 44' to 45'
	45				C17			1	N/A						
33.64	46														
	47		Very soft to hard.		C18			73	N/A						
31.64	48														
	49		48.5', fresh, fragments are fine grained, lithic SANDSTONE, occasional quartz? veins, fragments range from <0.01' to core diameter.		C19			127	N/A						Switch to 101 sampler at 48.5'
29.64	50		50.0' - 51.1', crushed, very fine grained.		C20			97	N/A						
	51		51.1' - 52.1', clayey (primarily CLAY with hard fragments).												
27.64	52		52.1' - 52.4', crushed, very fine grained. 52.4' - 52.9', clayey.												
	53		Scattered green mineral filling within small cavities (up to 0.08" diameter)(chlorite?).		C21			100	N/A						
25.64	54		53.0', highly sheared SHALE with internal slickensided shear planes within rock mass and very fine grained SANDSTONEfragments.							9.3	145.1				PI
	55														

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BORING RECORD				BTNB-R5-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), dark gray (consisting of fine grained SANDSTONE, very hard SILTSTONE, and fragmented hard SHALE), very intensely fractured (crushed), slightly weathered to fresh.												
23.64	56														
	57		56.5', less clayey (more intact SHALE).		C22			100	N/A						
			56.8' and 60.4', 0.15' hard resistant rock fragments, core breaks are irregular sub-horizontal to 10°dip.												
21.64	58														
	59		59.2', crushed/sheared zone without CLAY.												
19.64	60		Iron-oxide staining common on fracture faces, moderately weathered.												
	61				C23			28	N/A						
17.64	62														
	63														
15.64	64														
	65		64.5', very minor local staining on surfaces (chlorite?), iron-oxide staining throughout, primarily sheared fragments with sub-horizontal fissillity.		C24			100							
13.64	66		65.5', interval ranges from pervasively sheared SHALE (clayey) to hard gray SANDSTONE fragments (up to 0.25').		C25			70	N/A						
	67		65.75', dipping 35°.												
11.64	68		67.5', continued highly sheared SHALE.		C26			28	N/A						
			67.5' - 68.2', scattered quartz vein filling.												
	69		68.2', subangular SANDSTONE fragments (up to 0.05') in olive brown CLAY matrix.												
9.64	70														
	71														
7.64	72				C27			72	N/A						
	73	• •	SEDIMENTARY ROCK (Sandstone), fine grained, hard, very intensely fractured, moderately weathered with heavy iron-oxide staining on fracture surfaces and extending slightly into the rock mass.												
5.64	74	• •	72.5', iron-oxide staining on some surfaces, but not all, suggesting mechanical breaks.		C28			100	O						
	75	• •	74.0', continued mechanical breaks, multiple fracture orientations, quartz vein (20° dip) at 74.7' (0.02' thick).		C29			100	0						
3.64	76	• •	75.7', horizontal to 10° fractures, CLAY filled sheared fracture at 76.3'.		C30			75	0						
	77	• •			C31			14	0						Contact based on drilling change.
			SEDIMENTARY ROCK (Mélange Matrix), dark gray, fresh, very soft.												
1.64	78														
	79														
-0.36	80				C32			100	N/A						
	81		81.1', chlorite? vein (1/4" thick).												
-2.37	82	• •	81.6', quartz vein (1/4" thick), sheared SHALE with hard SANDSTONE pieces (up to 1/4"diameter).		C33			100	N/A						
	83	• •	SEDIMENTARY ROCK (Sandstone), dark gray, fine grained, moderately hard, very intensely fractured, fresh, not clayey.		C34			80	N/A						
-4.37	84	• •	82.3' - 82.6', crushed zone.												
	85	• •													84.5' to 85', straight drill

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4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		SEDIMENTARY ROCK (Mélange Matrix), dark gray, slightly weathered to fresh, soft, very intensely fractured (crushed), mylonized (CLAY-like) with subangular sandstone fragments, variably oriented contacts dipping up to 30°. SANDSTONE fragments up to 0.2' thick localized shearing along thin fractures.		C35			93	1.5/4'						Switch to HQ core barrel at 85'
-6.36	86														
	87														
-8.36	88		METAMORPHIC ROCK (Meta-Sandstone), steeply dipping, laminated relic bedding offset by healed micro-faults, dark gray, fresh, hard, moderately to slightly fractured, milky white vein filling.												PL PL
	89		89.0', clayey infilling common, very intensely fractured (crushed), random quartzitic vein filling, locally associated with fractures and planes of weakness, harder pieces within mylonized zone are moderately hard overall matrixes soft.		C36			98	1.6			UC = 634			
-10.37	90		89.6' - 91.0', fractured mylonized zones.												
	91		91.0', hard, moderately fractured.												
-12.37	92		92.0', mylonized seam (0.02' thick).												
	93														
-14.37	94				C37			100	0						
	95		94.4', intensely to moderately fractured, mylonized zone.												94.4', 39/65E
			95.0, crushed zone.												95', 60/80N 95', 2/52W
-16.37	96														95.5', 40/24E 95.6', 74/73N
	97		96.4', mylonized CLAY zone with quartz vein filling.												96.2', 23/72E 96.4', 73/28S
-18.37	98														96.6', 61/90 97.6', 88/62N
	99														98.5', 43/63W
			99.0', continued quartz vein filling, parallel and not parallel to fractures, moderately fractured.		C38			100	62						98.8', 328/90 99.4', 42/61E
-20.37	100														100.2', 307/63N 100.3', 345/54W
	101														100.9', 44/54E 101.1', 80/40N
-22.37	102														101.7', 275/61N 102.4', 40/42E
	103														
			103.2', sheared/mylonized, dark gray and yellowish brown, iron-oxide staining throughout fractures, very intensely												103.2', 294/47S
-24.37	104		fractured (crushed), slickensides of fractures at 103.2' parallel to dip.		C39			72	N/A						At 104', fluid color change from light gray to yellow brown
	105		104.0', pervasively fractured, mylonized, with pervasive secondary CLAY formation, remanant intersecting fracture												
-26.37	106		planes at 30° to 40° dip, moderately weathered.												
	107		106.5', predominantly moderately hard, intensely weathered, CLAY smearing and iron-oxide staining on fractures at 109.0'.		C40			100	0						
-28.37	108		106.5' - 106.9' and 108.5' and 108.8', clayey mylonized zones (with subangular sandstone fragments in clay matrix).												
	109		108.3' - 109.5', additional sub-vertical fractures.												
			109.0', gray CLAY along predominant fracture. Quartz? veins continued, primarily unrelated to fracures. Multiple		C41			90	0						
-30.37	110		fracture sets primarily between 50° - 30°.												
	111		110.7' - 112.2', pervasively sheared with a substantial portion mylonized, random fracture orientations.												
-32.37	112														
	113		112.5', pervasively oxidized, intensely fractured, variably oriented fractures.		C42			100	O						
-34.37	114				C43			0	0						
	115														

(continued)

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 5

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%) Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method Casing Depth	Remarks
	115		.									
-36.37	116											
	117											
-38.37	118											
	119											
-40.37	120		Borehole terminated at a depth of 114 feet on 4/8/2008.									
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.									
-42.37	122		Additional Notes:									
	123		1. Oriented rock coring performed. Where valid results were obtained, they are listed in the remarks column by depth using the following system: Depth, Strike/Dip.									
-44.37	124											
	125											
-46.37	126											
	127											
-48.37	128											
	129											
-50.37	130											
	131											
-52.37	132											
	133											
-54.37	134											
	135											
-56.37	136											
	137											
-58.37	138											
	139											
-60.37	140											
	141											
-62.37	142											
	143											
-64.37	144											
	145											

Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R5-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	5 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-27-08	3-27-08	N2120558.479 / E5994527.552 (NAD83)	BTNB-R6A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 222ft R Sta 81+61 NB Alignment	83.531 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 17.0 to 32.0 ft			Not Recorded	32 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		1/2" ASPHALT CONCRETE												Roots up to 1/4" diameter
	1		GRAVELLY CLAY (GC), poorly compacted, reddish brown, moist, GRAVEL is subangular. [FILL]												
81.53	2		Poorly graded SAND (SP), loose, fine, dark yellowish brown, moist, trace medium SAND, trace fines.												
	3				S1	4 6 8	14	50							
79.53	4				S2	2 3 3	6	50							
	5														
77.53	6														
	7														
75.53	8		Grades medium dense, with yellowish brown and reddish brown mottling, abundant rootlets (up to 1/16" diameter). 8.0', 1/2" diameter angular chert fragment.		S3	5 7 10	17	67							
	9				S4	4 8 10	18	50							
73.53	10														
	11														
71.53	12														
	13		SILT (ML), very stiff, yellowish brown and grayish brown, mottled, moist, trace fine to medium SAND, with black oxidized nodules (up to 1/8" diameter), occasional rootlet, with pockets of SANDY CLAY (up to 1/8" diameter). 14.0', grades to SILT with SAND.		S5	7 13 17	30	83				PP = 2.0			
69.53	14				S6	4 6 11	17	89							
	15														
67.53	16														Drilling slowed at 15.5'
	17														
65.53	18				S7	10 18 24	42	83							
	19		19.0', grades to SANDY SILT, without rootlets, horizontally fissured (up to 1/4").		S8	7 11 12	23	89							
63.53	20														
	21														
61.53	22														
	23		Poorly graded SAND with SILT (SP-SM), dense, yellowish brown to dark yellowish brown, moist, fine to medium, frequent dark reddish brown oxidized nodules (up to 1/4" diameter).		S9	13 19 23	42	83							
59.53	24				S10		38	89							
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 2

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25					15								
57.53	26					18								
	27		Poorly graded SAND with CLAY (SP-SC), very dense, light yellowish brown, fine to medium, with black specks, with serpentinite rock fragments (up to 1/4" diameter).			20								
55.53	28		METAMORPHIC ROCK (Serpentinite), no indication of bedding, yellowish green and very dark gray, very intensely weathered, soft, very intensely fractured, with occasional iron-oxide staining. (clayey SAND (SC) very dense, moist)		S11	13	69	83						
	29					22				48.8	108.8	UU = 0.74		PA
						47								
53.53	30				S12	41	50/5.5"	70						Straight drill to 32'
	31					50/5.5"								
51.53	32		Borehole terminated at a depth of 32 feet on 3/27/2008.											
	33		See Boring Record Legend for soil classification chart and key to test data and sampler type.											
49.53	34													
	35													
47.53	36													
	37													
45.53	38													
	39													
43.53	40													
	41													
41.53	42													
	43													
39.53	44													
	45													
37.53	46													
	47													
35.53	48													
	49													
33.53	50													
	51													
31.53	52													
	53													
29.53	54													
	55													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 2

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-26-08	3-28-08	N2120559.949 / E5994521.542 (NAD83)	BTNB-R6-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 222ft R Sta 81+67 NB Alignment	83.591 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, HQ-Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 60' to 80'			Not Recorded	98 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0		CLAYEY GRAVEL (GC), loose, reddish brown, moist, GRAVEL is subangular, trace roots (1/4" diameter). [FILL]											
	1		Poorly graded SAND (SP), loose, yellowish brown, moist, fine, trace fines, trace medium SAND.											
81.59	2													
	3				S1	7 9 9	18	61						
79.59	4		Grades dark brown, grades without medium SAND, with pockets of black organic material (up to 1/8" diameter).		S2	4 2 3	5	44						With increase in fines content
	5													
77.59	6													
	7													With shell fragments
75.59	8		Poorly graded SAND with CLAY (SP-SC), medium dense, reddish brown, moist, fine, with shell fragments.		S3	7 6 7	13	61		14.7	108.4			PA
	9		9.1', grades with yellowish brown mottling.		S4	3 7 7	14	50						
73.59	10		9.7', 1/4" diameter root.											
	11													
71.59	12													
	13		Lean CLAY (CL), stiff, yellowish brown and grayish brown, moist, mottled, trace fine to medium SAND, with black oxidized nodules (up to 1/8" diameter).		S5	7 11 16	27	83		20.5	107.3	PP = 1.5 1.4 UU = 1.2		PI
69.59	14		Grades to CLAY with SAND, with black specks, rootlets.		S6	14 16 20	36	94						
	15													
67.59	16													
	17													
65.59	18		SANDY SILT (ML), stiff, light yellowish brown, moist, with thin horizontal laminations.		S7	13 18 23	41	100		18.0	113.6	PP = 1.4 1.8 2.1 1.9		PA
	19		19.0', grades with slight iron-oxide mottling.		S8	7 11 12	23	94						
63.59	20													
	21													
61.59	22													
	23		SILTY SAND (SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE, with SANDY CLAY partings, with black specks.		S9	17 27 41	68	83		15.7	117.8			PA
59.59	24				S10		59	67						
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	SILTY SAND (SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE, with SANDY CLAY partings, with black specks.			17 27 32									
57.59	26													
	27													
55.59	28	Poorly graded SAND with SILT (SP-SM), very dense, yellowish brown, moist, fine to medium, with trace rock fragments up to 1/4" diameter, rock fragments are subangular SILTSTONE and SERPENTINITE.		S11	40 50/5"	50/5"	73		14.9	108.3				PA CU
	29			S12	29 32 34	66	83							
53.59	30													
	31													
51.59	32	METAMORPHIC ROCK (Serpentinite), dark greenish gray and very dark bluish gray, moderately weathered, very soft, moderately fractured (intensely crushed), fractures are planar to sub-planar 20° from horizontal, highly sheared throughout, with micro-slickensided surfaces throughout, light brown iron-oxide staining throughout, local sub-horizontal folliation. 33.5', grades soft, decreased iron-oxide staining.		S13										Rig chatter at 31.5'
	33			C14			100	N/A						
49.59	34			C15			80	N/A						
	35													35', 35/34W 35', 275/35N
47.59	36			C16			64	N/A						35.8', 285/62N
	37	36.2' and 36.6', 40° dip highly polished. 36.2' - 36.6', dark greenish gray, moderately hard, slightly weathered.												
45.59	38	38.0', sub-horizontal fracture, moderately hard.		C17			90	20						
	39													
43.59	40	39.6' to 40.2' near vertical (80°) 1/8" thick mylonized zone along fracture. 40.0', soft to very soft, abundant very light green mineral (talc?).												
	41	41.0', sub-horizontal fracture surfaces typically polished and sheared.												
41.59	42													
	43			C18			0							Lost circulation at 43'
		Straight drill from 43.5' to 44.0'.		C19										
39.59	44	Talc? is non-fibrous.		C20			67	N/A						
	45	Grades soft, very dark greenish gray, with chlorite and talc? vein fillings variably oriented throughout mass, no indication of fibrous texture, fractures are irregular (sub-horizontal). Core breaks along preferred orientation (strike N/S dip 45° west), platey appearance parallel to joints.												Lost fluid at 44.5', thickened mud, full circulation at 45.5'
37.59	46													
	47	47.2', additional random fractures (1/16" thick) with talc? infilling.		C21			83	N/A						
35.59	48										UC = 29			
	49													
33.59	50	With less talc?		C22			43	N/A						
	51	Preferential fracture planes parallel to platey structure, alternately zones of very soft to moderately soft.												
31.59	52													
	53													
29.59	54	54.0', very soft to soft.		C23			87	N/A						
	55													

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BORING RECORD				BTNB-R6-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		55.3', mechanized fracture dips ~45°.												
27.59	56		55.8', grades with abundant iron-oxide staining, indirect fractures are sub-horizontal, continued internally sheared polished surfaces.												
	57		METAMORPHIC ROCK (Greenstone), dark greenish gray, slightly weathered, moderately hard to hard, intensely fractured with very intensely to intensely fractured zones, fractures franging from horizontal to 20° dip. Open and healed fractures with filling and staining of black magnesium oxide. Subrounded vitreous crystals predominant throughout mass (pyroxene/olivine?), localized black vugular zones (maximum 0.2' thick).		C24			60						
25.59	58														
	59														
23.59	60				C25			91	2.4/3.5'						60.4', N/A/40
	61		60.0' - 60.8', intensely fractured (open and closed, internal shearing characterized by microstriations on plane surfaces). 60.4', dip 40°.												
21.59	62		60.8, intensely fractured, moderately hard. Grades less crystalline (micro crystalline). 62.4', dip 70°.												62.4', N/A/70
	63		62.9', dip 70°.												62.9', N/A/70
19.59	64		63.4' - 65.6', very intensely fractured, very soft (with hard pieces, crumbles to 1/16" to 1" pieces, moderately weathered, with abundant iron-oxide staining).		C26			69	0.5/4.5'						
	65														
17.59	66		65.6', moderately weathered.												
	67														
15.59	68		68.0', intensely fractured, moderately hard, moderately weathered, fractures horizontal to 45°, filled (vertical at 70.5'), fracture with similar appearance to rest of rock, scattered fibrous minerals at random orientations (asbestos?), few apparent unique crystals.		C27			73	1.5/4'						
	69														PL
13.59	70		69.6' - 70.4', very intensely fractured.												
	71														
11.59	72		72.0', fractures infilled with fibrous mineral (asbestos?) 72.3', moderately weathered with abundant iron-oxide staining throughout, very soft, very intensely fractured. 73.0', moderately to slightly fractured, hard, moderately weathered.		C28			89	0						72.1', 100/32S
	73														
9.59	74														
	75														74.8', 332/25N
7.59	76		76.0' - 77.4' and 78.0' - 78.4', crushed zones (very soft, severely weathered, with abundant iron-oxide staining).		C29			73	0.8/4'						
	77														
5.59	78		SEDIMENTARY ROCK (Greywacke), fine grained to aphanitic, yellowish brown, slightly weathered, hard, healed very thin fractures.												77.5', 58/45W
	79		METAMORPHIC ROCK (Serpentinite), green and yellowish brown, moderately weathered, soft.												
3.59	80		Recovery is dark greenish gray and dark gray pieces of serpentine and greenstone, moderately hard - not representative of rock layer.		C30			33	N/A						
	81														
1.59	82														
	83		Very dark gray, intensely fractured, moderately hard, severely weathered, talc/chlorite in fractures.		C31			72	0.7/2.5'						
-0.41	84		83.5' - 84.3', slightly fractured, veinlettes of fibrous minerals.									UC = 263			
	85														

(continued)

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BORING RECORD				BTNB-R6-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		METAMORPHIC ROCK (Serpentinite), green and yellowish brown, moderately weathered, soft.		C32			100	N/A						
-2.41	86		85.0', very intensely fractured and sheared (crushed), soft to very soft, moderately weathered.												
	87														
-4.41	88				C33			72	N/A						
	89														89.1', 328/42W
			89.1', very soft with zones of moderately hard, common green vitreous appearance (chlorite?).												
-6.41	90				C34			100	0						
	91														PI
			91.1', moderately fractured, moderately hard, slightly weathered at 90.0', platey secondary mineral formation (chlorite?) pervasively throughout.												91.2', 70/12N 91.3', 15/39S
-8.41	92		91.2', fibrous, light green, translucent minerals oriented parallel to dip.		C35			100	0						91.3', 10/15N
	93		92.3', internally sheared/crushed, very soft to soft, moderately weathered, platey secondary mineral formation pervasively throughout (chlorite?) portions of core - one locally micro-fractured with chlorite? filling.												93.5', 40/26W
-10.41	94				C36			100	0						
	95		94.5', very dark gray, intensely fractured, moderately hard, slightly weathered.												95.1', 359/38W
-12.41	96		95.0', internally sheared/crushed.												95.8', 290/50S
	97														
			97.0' - 97.5', very intensely to intensely fractured.												97.5', 348/25W 97.9', 300/33N
-14.41	98		Borehole terminated at a depth of 98 feet on 3/28/2008.												
	99		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-16.41	100		Additional Notes:												
	101		1. Oriented rock coring performed. Where valid results were obtained, they are listed in the remarks column by depth using the following system: Depth, Strike/Dip.												
-18.41	102														
	103														
-20.41	104														
	105														
-22.41	106														
	107														
-24.41	108														
	109														
-26.41	110														
	111														
-28.41	112														
	113														
-30.41	114														
	115														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R6-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-1-08	4-1-08	N2120461.975 / E5994829.468 (NAD83)	BTNB-R7A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 190ft R Sta 78+13 NB Alignment	78.961 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4")			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 28.5' to 43.5'			Not Recorded	45 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		Poorly graded SAND (SP), loose, dark yellowish to reddish brown, moist, fine. [FILL]												With fine roots in upper 3" (root mat)
	1														
76.96	2														
	3		Grades with occasional angular coarse GRAVEL and pocket of yellowish brown SANDY CLAY.		S1	6 9 16	25	94							
			Grades yellowish brown.												
74.96	4		Grades with occasional clumps of dark brown SANDY CLAY.		S2	4 3 4	7	94							
	5														
72.96	6														
	7		SILTY SAND (SM), poorly compacted, dark brown, wet, fine to very fine, SAND is fine.												
70.96	8		SILT with SAND (ML), soft, dark brown, wet, with yellowish brown mottling, with crushable iron-oxide nodules.		S3	2 2 2	4	67							
	9		Lean CLAY (CL), soft, dark brown, moist, trace fine SAND.		S4	2 4 7	11	67							
68.96	10									20.4					PI
	11														
66.96	12		SILT with SAND (ML), medium stiff, yellowish brown, moist, SAND is fine, with vertical vein of black organic filling and black mottling.												
	13				S5	8 13 19	32	83							
64.96	14		Grades to SANDY SILT without organic vein.		S6	4 5 7	12	100							
	15														
62.96	16														
	17		SILTY SAND (SM), yellowish brown, moist, fine.												
60.96	18				S7	6 7 8	15	83							
	19		SANDY lean CLAY (CL), medium stiff, yellowish brown, moist, SAND is fine, with veins of black CLAY.							20.8	107.7	UU = 0.62			PA
					S8	3 3 4	7	83							
58.96	20									23.6					PI
	21														
56.96	22		Poorly graded SAND with SILT (SP-SM), dense, dark yellowish brown to dark reddish brown, moist, fine to very fine.												
	23				S9	15 20 24	44	83		19.9	111.4				PA
54.96	24		Grades with iron-oxide staining.		S10		38	83							
	25														

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	1 of 2

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25		Poorly graded SAND with SILT (SP-SM), dense, dark yellowish brown to dark reddish brown, moist, fine to very fine.			18 18 20								
52.96	26													
	27													
50.96	28		Grades yellowish brown, medium dense, fine, with iron-oxide mottling, with pockets of iron-oxide nodules (up to 1/2" diameter).		S11	13 19 22	41	83						
	29				S12	9 10 13	23	89						
48.96	30													
	31													
46.96	32		SILTY SAND (SM), dense, yellowish brown, moist, very fine to fine, with dark gray mottling.		S13	20 28 32	60	100		20.9	109.3			CU PA
	33													
44.96	34		Grades very dense, with iron-oxide mottling.		S14	16 23 29	52	89						
	35													
42.96	36													
	37													
40.96	38		Grades without iron-oxide mottling, SAND grades fine to medium.		S15	28 32 50/5.5"	82/11.5"	84						Indication of water flow in S15 at 37.5'
	39													
	40		Poorly graded SAND with CLAY (SP-SC), dense, yellowish brown, moist, fine, with angular rock fragments up to 3/4" diameter.		S16	13 15 19	34	89						
38.96	41													
	42		METAMORPHIC ROCK (Greenstone), yellowish brown and green, decomposed, very soft, very intensely fractured (poorly graded SAND with SILT (SP-SM), moist).											Rig chatter at 41.5'
36.96	43													
34.96	44				S17	24 33 31	64	89						
	45		Borehole terminated at a depth of 45 feet on 4/1/2008.											
32.96	46		See Boring Record Legend for soil classification chart and key to test data and sampler type.											
	47													
30.96	48													
	49													
28.96	50													
	51													
26.96	52													
	53													
24.96	54													
	55													

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	2 of 2

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	3-28-08	4-3-08	N2120459.851 / E5994825.735 (NAD83)	BTNB-R7-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 188ft R Sta 78+17 NB Alignment	79.353 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ-Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" standpipe Piezo from 50' to 70'			Not Recorded	113 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		GRAVEL with SAND (GP), dark gray and brown, moist, angular, sand is fine.												
	1		Poorly graded SAND (SP), loose, dark yellowish brown, moist, fine. [FILL]												
77.35	2														
	3				S1	3 3 4	7	50							
75.35	4														
	5														
73.35	6		SILTY SAND (SM), loose, dark brown, wet, fine to very fine.												
	7														
71.35	8				S2	0 1 2	3	89							
	9		SILT (ML), soft, dark brown, wet, trace fine SAND, with crushable iron-oxide nodules.												
69.35	10														
	11														Drilling slowed at 10.5' Clay in cuttings
67.35	12		SILT with SAND (ML), medium stiff, yellowish brown, moist, SAND is fine, with pockets of dark brown iron-oxide staining up to 1/4" diameter.												
	13		12.0', black vertical seam of organic filling.		S3	9 14 19	33	89		16.8	115.1	UU = 0.87			PI
65.35	14														
	15														
63.35	16														
	17		SILTY SAND (SM), medium dense, yellowish brown to reddish brown, moist, with crushable iron-oxide nodules, fine.												
61.35	18				S4	7 7 11	18	83							
	19														
59.35	20														
	21		Poorly graded SAND with SILT (SM), dense, dark yellowish to reddish brown, moist, fine.												
57.35	22														
	23				S5	7 13 20	33	100							
55.35	24														
	25														

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	1 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Poorly graded SAND with SILT (SM), dense, dark yellowish to reddish brown, moist, fine.												
53.35	26														
	27														
51.35	28		Grades yellowish brown, with iron-oxide mottling, with black nodules (up to 1/8" diameter).		S6	10 12 13	25	100							
	29														
49.35	30														
	31														
47.35	32														
	33				S7	10 16 20	36	94							
45.35	34														
	35														
43.35	36														
	37		37.0', harder drilling.												
41.35	38		Grades very dense.		S8	14 26 27	53	94							
	39														
39.35	40														
	41		METAMORPHIC ROCK (Greenstone), dark greenish gray, intensely fractured, moderately hard, moderately weathered, iron-manganese rich mineral composition, internally folliated with elongated crystals, iron-oxide staining throughout, prominent healed fractures filled with white mineral dipping 68°.												
37.35	42				C9			33	0						
	43														
35.35	44														
	45		~44.5', soft, moderately weathered, with moderately soft zones.		C10			75	N/A						
33.35	46		45.1' - 45.2' and 45.3' - 45.5', soft, 0.1' to 0.2' thick intensely sheared zones, locally very intensely weathered, thin mineral filled fractures in soft zones, predominantly sub-horizontal												
	47		very soft zones with intersecting 45° fractures, manganese-oxide coating on fracture planes.		C11			100	0						
31.35	48		47.0', abrupt color change to purplish brown, moderately soft, moderately strong, moderately to slightly weathered. Orthogonal filled fractures up to 45° dip.		C12			50	0						
	49		47.5', greenish gray, core broken into fragments ranging from 0.05' to 0.2'.		C13			91	0						48.7', 54/25N
29.35	50		48.5', intensely fractured. Crushed zones at 49.0', 49.3', and 49.8'. Common manganese-oxide coating on fracture planes.												49.35', 22/45N 49.35', 76/57W Hole is steadily taking water
	51		50.2', very intensely fractured (clayey), intensely sheared, moderately weathered.												50.2', 353/40W 50.2', 306/89N
27.35	52		51.25', intensely fractured, moderately hard, slightly weathered, orthogonal fracture planes.		C14			74	29						
	53		53.0', sub-horizontal and dipping 30° fractures.		C15			67	0						
25.35	54														
	55				C16			100	N/A						54.6', 55/60S

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	2 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		54.5', moderately fractured, very soft to soft, intensely to moderately weathered.												55', 34/60E
23.35	56		METAMORPHIC ROCK (Greenstone), dark greenish gray, intensely fractured, moderately hard, moderately weathered, iron-manganese rich mineral composition, internally folliated with elongated crystals, iron-oxide staining throughout, prominent healed fractures filled with white mineral dipping 68°.		C17			0	N/A						55.6', 310/18N
	57				C18			70	N/A						
21.35	58		55.6', 1/4" thick mylonized clayey fracture filling.		C19			80	50						58.2', 310/47N
	59		55.8', internally crushed, very soft, intensely to moderately weathered.												59', 292/53N
19.35	60		57.3' - 57.5', intensely fractured zone. 58.0', intensely fractured, soft to moderately soft, moderately weathered, iron-oxide staining on micro-fractures.												59.7', 345/85W 60', 14/34E 60.5', 320/20S
	61		58.0', medium fractured, moderately hard, moderately strong, moderately weathered.		C20			89	31						60.5', 326/30E
17.35	62		58.2', white preciptate on fracture face (calcite?), 1/16" thick precipitate filling on additional micro-fractures throughout.												
	63		59.7', intensely fractured, friable, very weak, severe to moderate weathering. Highly sheared zone.												
15.35	64		61.0', slightly fractured, moderately hard, slightly weathered, variably oriented fractures, commonly filled with tan to light brown (calcite?) filling. Fractures are commonly closed (intensely spaced internally), localized iron-oxide staining.												
	65		62.0', intensely fractured, soft, locally internally sheared, moderately to slightly weathered, up to 1/4" thick tan to very light brown (calcite?) filling.		C21			88	N/A						65.2', 320/20S
13.35	66		62.1', serpentinized zone (0.2').												65.8', 320/20S
	67		64.5', moderately weathered, locally intensely sheared/crushed.												
			67.0', slightly fractured, moderately hard.		C22			93	0						
11.35	68														
	69		69.0', variably oriented fractures, grades green, with anastomozing veins of (clear) gray mineral filling (translucent).												
9.35	70		70.0', intensely fractured, localized iron-oxide staining, translucent vein fillings up to 0.08' thick, variably oriented (healed shear zones), commonly fractured.		C23			42	0						
	71														
7.35	72														
	73														PL
5.35	74														
	75		74.5', slightly fractured (internally intensely sheared), serpentinitic, soft (locally plastic), moderately to slightly weathered, continued translucent vein filling.		C24			100	40						
3.35	76		76.0', moderately hard, slightly weathered, abundant closed fractures, abundant fine to medium sand-sized particles along fractues, ferro-magnesium minerals predominate, localized iron-oxide staining (minor).												
	77														
1.35	78		78.0', minor localized iron-oxide staining. 78.4', horizontal contact.		C25			50	10						
	79		78.9', intensely fractured, very soft, moderately weathered (internally crushed), predominantly comprised of talc.												78.91', 344/54E
-0.65	80		Remnant rock fabric with serpentinite appearance, highly sheared.												
	81														
-2.65	82				C26			100	N/A						
	83		IGNEOUS ROCK (Gabbro), dark gray and bluish gray, moderately fractured (internally sheared and crushed), very soft to moderately hard, moderately to slightly weathered. Serpentinite appearance with platey mineral structure common.												
-4.65	84		84.0', very intensely to intensely fractured, moderately soft,		C27			80	N/A						
	85														

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Department of Transportation
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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	3 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		slightly weathered. Highly weathered (40° to 90°), intensely sheared planes/fractures. Locally phyllitic in appearance, secondary mineralization along micro-fractures, locally serpentinized appearance (chlorite?).												
-6.65	86		84.2' - 84.4', approximately 40° dipping shistosity.		C28			80	N/A	14.8	122.2	UU = 0.29			PI
	87		IGNEOUS ROCK (Gabbro), dark gray and bluish gray, moderately fractured (internally sheared and crushed), very soft to moderately hard, moderately to slightly weathered. Serpentinite appearance with platey mineral structure common.												
-8.65	88														
	89		86.0', intensely fractured, intensely sheared with folliated appearance, alternating light green and dark gray. Green mineral (chlorite?) fibrous, perpendicular to veins. Locally crushed, friable, plastic. Primary orientation of folliation is vertical.		C29			93	N/A						
-10.65	90														
	91		89.0', with irregular sub-horizontal surfaces.												
-12.65	92		92.0', intensely to moderately fractured (internally sheared/crushed).		C30			77	N/A						
	93														
-14.65	94														
	95		METAMORPHIC ROCK (Serpentinite), bluish gray, very slightly fractured, slightly weathered (internally highly sheared), with "platey" texture (talc?) on internal fracture planes.		C31			100	N/A						
-16.65	96														
	97														
-18.65	98				C32			100	89						
	99		98.4', slightly weathered to fresh.												PL
			99.0', dipping 70°.												
-20.65	100														
	101														
-22.65	102		Grades to shaley serpentinite, moderately fractured, soft to moderately hard, with soft intervals (up to 0.4' at 102.1'), slightly weathered to fresh.		C33			98	85						
	103		102.1', sub-horizontal fracture.												102.5', 307/24N
															103.1', 30/34W
-24.65	104														103.7', 34/4W
	105		104.7', healed fractures with secondary mineral formation, vein fillings.												104.7', 331/30W
															105.6', 66/48S
-26.65	106		106.0', intensely fractured to crushed (internally sheared), slightly weathered to fresh, abundant chlorite? fracture and vein filling up to 1/8" wide (healed fractures).		C34			65	23						
	107		106.9', moderately fractured, moderately hard, fresh.												
-28.65	108		106.9' and 107.25', dipping 40°.												
			106.9' to 107.8', gabbroic.												
	109		107.8', intensely fractured (internally sheared), soft, slightly weathered.												
-30.65	110		110.0', very slightly fractured (very intensely micro-fractured), fresh (much of core has appearance of highly sheared shale with secondary (chlorite?) mineral formation along weak zones).		C35			100	N/A						
	111														
-32.65	112														
	113														
-34.65	114														
	115														

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				BTNB-R7-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161R	T. Carroll		8-24-09	4 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method Casing Depth	Remarks
	115		.										
-36.65	116												
	117												
-38.65	118												
	119												
-40.65	120		Borehole terminated at a depth of 113 feet on 4/3/2008.										
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.										
-42.65	122		Additional Notes:										
	123		1. Oriented rock coring performed. Where valid results were obtained, they are listed in the remarks column by depth using the following system: Depth, Strike/Dip.										
-44.65	124												
	125		2. On 4/2/2008 downhole geophysical (suspension) logging was performed by GEOVision, Inc. Acoustic televiewer peformed on 4/2/2008. Packer tests performed on 4/2/2008.										
-46.65	126												
	127												
-48.65	128												
	129												
-50.65	130												
	131												
-52.65	132												
	133												
-54.65	134												
	135												
-56.65	136												
	137												
-58.65	138												
	139												
-60.65	140												
	141												
-62.65	142												
	143												
-64.65	144												
	145												

Department of Transportation
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REPORT TITLE: BORING RECORD				HOLE ID: BTNB-R7-PZ-D
DIST.: 4	COUNTY: S.F.	ROUTE: 101	POSTMILE: 8.3/9.4	EA: 163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER: 34-0161R	PREPARED BY: T. Carroll		DATE: 8-24-09	SHEET: 5 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	1-17-08	1-22-08	N2120323.729 / E5994396.263 (NAD83)	BTSB-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 35ft L Sta 82+30 SB Alignment	101.030 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Failing 1500	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Shelby (2.87"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.8%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 23.5 to 33.5 ft			Not Recorded	75.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		CLAYEY SAND (SC), loose, dark brown, dry, fine, with GRAVEL. [FILL]												
	1														
			Grades dry to moist.												
99.03	2		Grades no GRAVEL, grades with pockets of yellowish brown CLAY.		S1	4 6 7	13	100							
	3		Poorly graded SAND (SP), loose, reddish brown, dry to moist, fine.												
97.03	4		Grades dark yellowish brown.		S2	2 2 5	7	78							
	5														
95.03	6														
	7		Grades yellowish brown to light yellowish brown, medium dense.												
93.03	8		Grades fine to medium.		S3	5 10 14	24	100							
	9		Grades fine.		S4	4 9 11	20	100							CR
91.03	10														
	11														
89.03	12														
	13				S5	9 13 27	40	100		15.0	105.8				PA
87.03	14				S6	6 11 14	25	44							
	15														
85.03	16														
	17														
83.03	18		Grades moist.		S7	8 14 19	33	67							
	19				S8	5 9 13	22	56							
81.03	20														
	21														
79.03	22														
	23				S9	10 6 6	12	33		26.4 25.3	100.5 100.7	DS = 1.1 DS = 12.5			PA
77.03	24		Grades brown.		S10		3	67		30.8	95.9	DS =			
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Poorly graded SAND (SP), loose, reddish brown, dry to moist, fine.			0 1 2						1.51			
75.03	26														
	27		Lean CLAY with SAND (CL), soft, brown, wet. [SANDY CLAY]												
73.03	28				U11		225 psi	97		22.0	106.5	PP = 1.25 UU = 0.74			
	29									22.8	100.6				C PI PI
71.03	30		Grades yellowish brown with gray clay lenses and pocket of very stiff gray CLAYEY SAND.												
	31														
69.03	32														
	33		Grades with black organic mottling, medium stiff to stiff.		S12	8 50/2"	50/2"	100				PP = 0.5			
			SEDIMENTARY ROCK (Sandstone), fine to medium grained, massive, gray to dark gray, moderately weathered, moderately hard, intensely fractured, anastomizing white secondary mineral vein infilling.												
67.03	34				C13			90	33						
	35		35.2', slightly weathered, moderately to intensely fractured.												PL
65.03	36											UC = 780			
	37				C14			100	60						
63.03	38		37.6' - 37.9', intensely fractured.												
	39														PL
61.03	40														
	41				C15			100	55						
59.03	42		41.8', slightly weathered to fresh.												
	43		SEDIMENTARY ROCK (Sandstone and Shale), sandstone is medium to fine grained, laminated to moderately bedded (distorted by soft sediment deformation and micro faulting white secondary mineral vein infilling occurs along faults), gray to dark gray, slightly weathered to fresh, moderately hard, moderately fractured, surface of core is occasionally pitted, ractures are commonly polished and slickensided.											
57.03	44				C16			90	40						
	45											UC = 908			
55.03	46														PL
	47		47.3' - 47.6', surface of core is commonly pitted.												
53.03	48														
	49		SEDIMENTARY ROCK (Mélange Matrix), very dark gray gravel, slightly weathered to fresh, very soft, very intensely fractured (hard meta-sandstone fragments in sheared shale matrix)(lean clay with gravel (CL), soft, gravel is fine to coarse, angular, moist to wet).		C17			20	0						End of Box 1 at 49.0' Lost circulation at 49.0' on Run C17, recovered core consists primarily of harder fragments with occasional intervals of intact core consisting of sheared/brecciated meta-sandstone and shale. We install 4' casing to 52'.
51.03	50				C18			40	0						
	51														
49.03	52				C19			100	0						
	53				C20			60	0						
47.03	54				C21			65	0						
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Mélange Matrix), very dark gray gravel, slightly weathered to fresh, very soft, very intensely fractured (hard meta-sandstone fragments in sheared shale matrix)(lean clay with gravel (CL), soft, gravel is fine to coarse, angular, moist to wet).												
45.03	56														Hole is consistently caving to about 54'; we drill with tricone to 58' and install 4" casing to 58'
	57														
43.03	58				C22			53	0						
	59		59.3', hard piece of meta-sandstone (0.3' diameter).												
41.03	60														Hole caved to 60' after drilling to 67', switch to 101-system.
	61				C23			90	0						
39.03	62														
	63				C24			63	0						
37.03	64														
	65														
35.03	66														
	67														Straight drill to 75.5' and monitor cuttings - all melange matrix; the aggregate is mostly siltstone
33.03	68														
	69														
31.03	70														
	71														
29.03	72														
	73														
27.03	74														
	75														
25.03	76		Borehole terminated at a depth of 75.5 feet on 1/22/2008.												
	77		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
23.03	78														
	79														
21.03	80														
	81														
19.03	82														
	83														
17.03	84														
	85														

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 3

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-25-08	2-29-08	N2120218.262 / E5994858.344 (NAD83)	BTSB-R2
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 47ft L Sta 77+65 SB Alignment	92.121 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), 101-Sampler			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 7 feet AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill				115 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		6" ASPHALT CONCRETE.												
	1		10" UNREINFORCED CONCRETE.												
90.12	2		GRAVELLY fat CLAY (CH), poorly compacted, dark brown, moist, GRAVEL is angular, with SAND. [FILL]												
	3		Poorly graded SAND (SP), loose, dark yellowish brown, dry to moist, fine, trace fines.		S1	4 4 5	9	100		5.3	112.8				
88.12	4				S2	4 5 6	11	100							
	5														
86.12	6														
	7		Grades dark brown.												
84.12	8		Lean CLAY (CL), medium stiff, dark brown, moist, trace fine SAND.		S3	7 7 7	14	50				PP = 0.875			
	9				S4	3 3 4	7	89							
82.12	10														
	11														
80.12	12														
	13		Lean CLAY (CL), medium stiff to stiff, yellowish brown, moist, trace fine SAND, dark brown oxidized nodules (up to 1/2" diameter).		S5	5 9 13	22	83		22.5	104.6	PP = 1.0 UU = 0.93			PI
78.12	14				S6	5 7 8	7	89							
	15														
76.12	16														
	17														
74.12	18		SILTY SAND (SM), medium dense, yellowish brown, moist to wet, fine, with root hairs (up to 1/16" diameter), with black oxidized nodules (up to 1/16" diameter).		S7	6 9 11	20	83		19.1	114.0	UU = 0.93			PA
	19		Poorly graded SAND with SILT (SP-SM), medium dense, yellowish brown, moist to wet, fine to medium.		S8	6 7 7	14	83							
72.12	20														
	21														
70.12	22														
	23		Poorly graded SAND (SP), dense, yellowish brown, moist, fine, trace fines.		S9	20 30 40	70	83							CR
68.12	24				S10		60	89							
	25														

(continued)

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Poorly graded SAND (SP), dense, yellowish brown, moist, fine, trace fines.			20 30 30									
66.12	26													
	27													
64.12	28			S11	24 41 50	91	72		20.7	107.6	DS = 1.87			Grades to reddish brown with black oxidized nodules (up to 1/4" diameter). PA
	29								21.8	106.8				
				S12	12 19 26	45	100		20.6	107.8	DS = 1.56 DS = 2.20			Grades with increase in fines content.
62.12	30													
	31													
60.12	32													
	33	Grades medium dense, yellowish brown.		S13	26 34 35	69	83							
58.12	34	33.8', grades weakly cemented.		S14	12 14 23	37	89		21.2	106.0				PA, CU
	35	35.0', occasional fine GRAVEL (up to 1/2" diameter), subrounded, reddish brown (chert fragment).												
56.12	36	Grades with pockets of SANDY CLAY (up to 1/8" diameter).												
	37	Lean CLAY (CL), very stiff, yellowish brown and reddish brown, moist, trace fine SAND, with black specks.												
54.12	38			S15	9 13 17	30	83		20.7	108.1	UU = 1.15			
	39	Fat CLAY (CH), stiff, yellowish brown and grayish brown, dry to moist, trace fines, trace SAND, with black specks, mottled.							22.3	104.3	PP = 1.63 UU = 1.84			PI PI
52.12	40			S16	10 12 15	27	89							
	41													
50.12	42													
	43	Lean CLAY (CL), hard, yellowish brown and light gray, trace fine SAND, mottled, with iron-oxide staining, with black specks		S17	15 32 50	82	50		19.4	110.9	PP = >2.0 UU = 3.14			PI
48.12	44			S18	15 33 39	72	67							
	45	SEDIMENTARY ROCK (Sandstone), fine to coarse grained, light yellowish brown, decomposed, very soft, very intensely fractured. (CLAYEY SAND (SC), very dense, light yellowish brown, dry, fine to coarse, faint dark reddish brown predefined fracture planes, slight rock structure, with frequent manganese-oxide staining.)												
46.12	46													
	47	SEDIMENTARY ROCK (Siltstone), dark brown, intensely weathered, moderately hard, very intensely fractured.												
44.12	48			S19	28 50/5.5"	50/5.5"	70							
	49	METAMORPHIC ROCK (Serpentinite), greenish gray and yellowish brown, very intensely weathered, moderately soft, very intensely fractured.		C20			68	N/A						
42.12	50	METAMORPHIC ROCK (Granulite), medium to coarse SAND and fine GRAVEL-sized, yellowish brown and light greenish gray, intensely weathered, soft, very intensely fractured (crushed), intensely mylonized, localized sheared surfaces on more competent 0.1' to 0.2' thick blocks.												
	51			C21			93	N/A						
40.12	52	METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
	53													
38.12	54													
	55													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
36.12	56				C22			47	N/A						
	57														
34.12	58														
	59				C23			95	N/A						
32.12	60														
	61				C24			68	N/A						
30.12	62														
	63				C25			95	N/A						
28.12	64														
	65				C26			100	N/A						
26.12	66														
	67				C27			100	N/A						
24.12	68														
	69		68.4', white secondary mineralization forming a banding effect.		C28			43	0						
22.12	70		69.0', dark olive gray and very dark gray, moderately weathered, moderately hard to locally soft, intensely fractured, fractures dipping 15° to 25°, common secondary mineralization along closely spaced fractured/sheared surfaces throughout interval, commonly breaks 0.1' to 0.2' fragments (hard).												
	71														
20.12	72				C29			100	0						
	73														
18.12	74														
	75				C30			100	N/A						
16.12	76		75.8', greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured.		C31			100	N/A						
	77														
14.12	78														
	79				C32			100	N/A						
12.12	80		Bluish gray and very dark gray.												
	81				C33			100	N/A						
10.12	82														
	83				C34			19	N/A						
8.12	84														
	85														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		METAMORPHIC ROCK (Serpentinite), greenish gray and dark gray, intensely weathered, variably very soft to moderately hard, very intensely fractured, sharp changes in rock texture (non-grading), more intensely weathered intervals exhibit texture of SILT with SAND (ML), soft, moist, SAND is fine.												
6.12	86														
	87				C35			100	N/A						
4.12	88														
	89				C36			95	N/A						
2.12	90														
	91				C37			68	N/A						
0.12	92														
	93				C38			100	N/A						
-1.88	94														
	95				C39			19	N/A						
-3.88	96														
	97		96.3' - 96.8', sand-like texture.		C40			58	N/A						
-5.88	98														
	99														
-7.88	100														Straight drill from 98' to 115' done with CME 550
	101														
-9.88	102														
	103														
-11.88	104														
	105														
-13.88	106														
	107														
-15.88	108														
	109														
-17.88	110														
	111														
-19.88	112														
	113														
-21.88	114														
	115														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R2
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%) Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method Casing Depth	Remarks
	115		.									
-23.88	116											
	117											
-25.88	118											
	119											
-27.88	120		Borehole terminated at a depth of 115 feet on 2/29/2008.									
	121		See Boring Record Legend for soil classification chart and key to test data and sampler type.									
-29.88	122		Additional Notes:									
	123		1. On 2/29/2008 downhole geophysical (suspension) logging was performed by GEOVision, Inc.									
-31.88	124											
	125											
-33.88	126											
	127											
-35.88	128											
	129											
-37.88	130											
	131											
-39.88	132											
	133											
-41.88	134											
	135											
-43.88	136											
	137											
-45.88	138											
	139											
-47.88	140											
	141											
-49.88	142											
	143											
-51.88	144											
	145											

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE: BORING RECORD				HOLE ID: BTSB-R2
DIST.: 4	COUNTY: S.F.	ROUTE: 101	POSTMILE: 8.3/9.4	EA: 163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER: 34-0161L	PREPARED BY: T. Carroll		DATE: 8-24-09	SHEET: 5 of 5

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-23-08	4-23-08	N2120227.544 / E5994550.875 (NAD83)	BTSB-R3A-PZ-S
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 92ft L Sta 80+54 SB Alignment	98.049 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Bulk			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 9.0 to 18.0 ft			Not Recorded	19.3 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		SILTY SAND (SM), poorly compacted, dark brown, moist to wet, fine, slight organic odor, trace fine roots. [FILL]		B1										
	1		CLAY with GRAVEL (CL), poorly compacted, dark brown, moist, GRAVEL is subangular, with chert fragments, with veins of yellowish brown CLAY and roots.												CR
96.05	2				S2										
	3		Poorly compacted, dark yellowish brown, moist.		S3	2 3 4	7	83		6.7	115.6				PA
94.05	4				S4	2 3 6	9	100							
	5														
92.05	6				S5										
	7														
90.05	8		Grades medium dense, yellowish brown.		S6	9 13 16	29	100							
	9														
88.05	10				S7	3 4 7	11	83		9.2 10.4 9.3	109.1 112.9 109.7	DS = 0.47 DS = 0.52 DS = 0.75			PA
	11														
86.05	12		Lean CLAY with SAND (CL), medium stiff, dark brown, moist, SAND is fine to medium with dark yellowish brown mottling. [BURIED SOIL HORIZON]		S8	5 6 8	14	83		18.6	131.8	UU = 0.39			PI
	13														
84.05	14		Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, with iron-oxide nodules and mottling. [SANDY CLAY]		S9	2 4 5	9	100							
	15														
82.05	16														
	17		SEDIMENTARY ROCK (Sandstone), very soft, fine to medium grained, decomposed, intensely fractured, with light yellowish brown CLAY infilling (Poorly graded SAND with CLAY (SP-SC), moist, with iron-oxide mottling and nodules). [BEDROCK]		S10	28 50/4"	50/4"	80							Rods bouncing at 16.5'
80.05	18				S11	65 50/6"	50/6"	17		10.5	142.2	UU = 1.28			PA
	19														
78.05	20		Borehole terminated at a depth of 19.3 feet on 4/23/2008.												
	21		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
76.05	22														
	23														
74.05	24														
	25														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3A-PZ-S
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 1

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	4-18-08	4-22-08	N2120225.975 / E5994556.115 (NAD83)	BTSB-R3-PZ-D
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 93ft L Sta 80+49 SB Alignment	97.900 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (track)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.9%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 50.0 to 70.0 ft			Not Recorded	113 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		SILTY SAND (SM), loose, very dark brown, moist, fine, occasional fine GRAVEL and coarse SAND, slight organic odor, trace fine roots. [FILL]												Very wet at ground surface due to lawn watering
95.90	2		Poorly graded SAND (SP), loose, dark yellowish brown, moist, fine to very fine, occasional roots (up to 1/8" thick).		S1	2 2 2	4	83							
93.90	4														
91.90	6														
89.90	8		Grades with dark gray to black laminations (horizontal), with occasional dark brown CLAY.		S2	7 12 14	26	50							
87.90	10														
85.90	12		Lean CLAY with SAND (CL), medium stiff, dark brown, moist, SAND is fine.		S3	3 4 4	8	100							
83.90	14		Lean CLAY with SAND (CL), medium stiff, yellowish brown, moist, with iron-oxide nodules and mottling.												
81.90	16														
79.90	18		SEDIMENTARY ROCK (Sandstone), fine to medium grained, yellowish brown, very soft, decomposed, intensely fractured, with vertical and sub-horizontal partings, with manganese-oxide staining on vertical fracture planes, angular to subangular GRAVEL, individual grains commonly altered around perimeter (poorly graded SAND with CLAY (SP-SC), moist, with iron-oxide mottling and nodules).		S4	30 50/ 3.5"	50/3.5"	63							Drilling slowed at 16.5'
77.90	20				S5	50/5"	50/5"	80							
75.90	22		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes. 21.1', approximately 1/2 face manganese-oxide stained separated by fracture from thin clay filling.		C6			88	0						21.1', 330/31E 21.2', 38/67S 21.65', 48/63N 21.8', 90/79S 22.0', 305/70W 22.25', 200/61E 22.6', 76/90
73.90	24		23.0', fine to coarse grained, pitted texture, continued manganese-oxide staining of fractures at 23.3', 23,5', and 24.3'; CLAY filling on fractures (up to 0.01' thick), fracture dips range from sub-horizontal to 30° with occasional up to 80°		C7			100	19						
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to									UC = 351			
71.90	26		moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes.												PL
	27		26.5', increase in darker minerals, fracture dips range from horizontal to 45°.		C8			91	86						
69.90	28														
	29														
67.90	30		30.0', intensely fractured.		C9			100	0			UC = 241			
	31														30.5', 38/41W 30.65', 296/42N 30.9', 310/45N
65.90	32														31.2', 60/28N 31.5', 285W/375 31.9', 20/57E and 309/37S
	33		33.0', bluish gray, moderately weathered.												32.1', 285W/37S PL
63.90	34														32.9', 60/34W 33.2', 26/42E 34.0', 32/76E
	35				C10			100	0						34.8', 288/37S
61.90	36														
	37														PL
59.90	38		38.0' - 38.8', very intensely fractured (crushed), with localized mylonization (variably oriented fractures with clay filling),												
	39		minor pitting along some fractures, most fractures dip 20° to 40° with occasional vertical fractures.												
57.90	40		Common near vertical fractures, continued localized pitting, grain size is variable and mixed suggesting soft sediment		C11			100	18						40.2', 357/62W From 40.3' to 41.4' fracture is curvilinear
	41		deposition.												40.3' to 40.8', 58/79S 40.8' to 41.4', 67/83N
55.90	42														41.6', 47/78S 41.7', 334/40N
	43		42.4' - 43.0', irregular fracture not measured (sub-vertical).												42.95', 56/34S 43.2', 85/25S
53.90	44														43.4', 30/21N
	45											UC = 679			
			Iron-oxide staining only, limited to fracture planes, very intensely fractured zones 45.6' to 45.8' and 47.2' to 47.6'.		C12			94	10						45.2', 24E/29E 45.4', 8/49E
51.90	46		46.2' - 46.8', sub-vertical.												45.7', 90/82S 46.0', 290/67N
	47														46.1', 359/44E 46.2' - 46.8', sub-vertical fracture
49.90	48														46.8', 33/73W
			48.0', occasional white (quartz?) veins, aphinitic dark rock fragments (fine grained sized) within fine to medium matrix,												47.1', 90/75N (shearing along plane) 47.4', 352/49W
	49		slightly weathered.												
47.90	50														PL
			50.0', elongated rock fragments (aphinitic) are sub-parallel, dark minerals predominate, moderately fractured, hard.		C13			100	60			UC = 1210			
	51		Increased iron-oxide staining at 51.0'.												
45.90	52														
	53														
															PL
43.90	54		Very slight iron-oxide staining, moderately to slightly fractured.		C14			100	93						
	55														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	SEDIMENTARY ROCK (Sandstone), fine to medium grained, no indication of bedding, yellowish brown, intensely to moderately weathered, moderately hard, intensely fractured, manganese-oxide staining on fracture planes.												54.85', 16/38E 54.95', 72/63N 55.1', 0/17E PL 56.0', 75/18S
41.90	56													
	57													
39.90	58			C15			100	40						PL
	59	Very intensely fractured zones at 59.4' to 59.8' and 61.6' to 62.1'.												
37.90	60	Localized banding appearance of dark mineral fragments.												PL
	61													
35.90	62													
	63													PL
		Unfractured, continued <0.02' thick quartz veins, continued localized dark mineral "banding", strong, fresh to slightly weathered.		C16			100	100						
33.90	64													
	65	64.9', mechanical break.												PL
31.90	66													
	67													
														PL
29.90	68	One core break is mechanical.		C17			80	80						
	69													
27.90	70			C18			100							
		SEDIMENTARY ROCK (Shale), aphanitic, no indication of bedding, dark gray, fresh, moderately hard where intact otherwise sheared, very intensely to intensely fractured, weak to moderately strong.		C19			74	N/A						
	71	71.7' - 72.3', crushed.												
25.90	72	71.8', 0.1' thick CLAY zone <50°.												
	73	73.0' - 73.2', hard.		C20			47	N/A						
		73.2' - 75.1', crushed/sheared, highly variable orientation to shears, minor green serpentine fragments.												
23.90	74													
	75													
21.90	76													
	77													
		SEDIMENTARY ROCK (Sandstone), fine to medium grained, dark gray, slightly weathered, moderately hard, intensely fractured, slight iron-oxide staining on some fractures, fractures ~45-90°.		C21			100	0						
19.90	78													
	79													
17.90	80	80.0', fresh, continued quartz veins, with dark mineral veins, localized soft sediment deposition.		C22			100	72						
	81													
											UC = 253			81.4', 330/36W
15.90	82													
	83	82.5' - 87.9', sheared zone (clayey).												82.7', 7/28E
														83.5', 346/23E
13.90	84	83.9', slickensides parallel to strike, rake is 18° down to SE.												83.9', 322/46E 84.3', 335/22E
	85													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 4

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		85.15', dip ~18° with slickensides on fracture surface. 85.5', dip ~37°.		C23			70	0						84.5', 288/54N 84.8', 4/44E
11.90	86		SEDIMENTARY ROCK (Sandstone and Shale), commonly crushed to fragments up to 0.1' diameter, SANDSTONE is fine grained, variably oriented quartz veins within SANDSTONE intervals, light green mineral (chlorite?) within SHALE intervals, soft, moderately weathered. 86.1', 0.2' CLAY zone. 88.1' - 88.6', crushed (not clayey). 88.8' - 89.3', sheared zone (clayey).		C24			0							
9.90	88				C25			85	0						
7.90	90														
	91		Iron-oxide along fracture planes.												
5.90	92		SEDIMENTARY ROCK (Sandstone), fine to medium grained, laminated to thinly bedded (contact between fine to medium grained and very fine gravel at 91.9' ~60° to 80° dip), dark gray, moderately to slightly weathered, moderately hard to moderately soft, intensely fractured, numerous closed fractures, fractures are randomly oriented, numerous healed micro faults.		C26			100	0						PL
3.90	94														
	95		94.5', moderately fractured with localized very intensely fractured (crushed) zones along fractures, limited to fracture planes.		C27			91	0						
1.90	96														
	97		97.0', contact to medium to fine grained, moderately hard, dipping ~45°.												
-0.10	98		98.0', slightly to moderately weathered. From 99.0' to 99.8', fracture with localized crushing and slickensides. Increase in iron-oxide staining.		C28			100	33						98.4', 3/58E and 321/40W PL 99.4', 297/70N and 348/71W 99.6', 74/44W 99.9', 286/59S 100.1', 352/50W 100.8', 25/42E 101.2', 335/33E
-2.10	100														
	101		101.0' - 102.2', fine to very fine grained, moderately soft, indicating soft sediment disposition.												
-4.10	102														102.0', (contact) 4/83W
	103		102.4' - 102.9', very intensely fractured (crushed), moderately weathered, with evidence of shearing.		C29			96	24						102.4', N42W/63SW
-6.10	104		104.1', quartz vein infilling.												
	105		105.0' - 105.5', contact to fine grained.												
-8.10	106		105.5', frequent closed/healed fractures, ruggy, (occasional iron-oxide stained openings in the core that are not, through fractures up to 0.2' in length and 0.03' wide oriented near vertical to dipping ~80°).												105.5', 304/21S 106.25', (parallel to bedding) 90/54S 106.75', 13/62E and 342/44E 106.9', 90/34S
	107														
-10.10	108		108.0', near parallel, sub-vertical fractures (to 110.5'), fine to medium grained from 109.2' to 110.0' and 111.0' to 111.2'. 108.0' - 109.2', very thinly bedded.		C30			96	0						
-12.10	110														
	111		111.0' to 112.8', frequent randomly oriented whie mineral veins (calcite?).												
-14.10	112														
	113		Borehole terminated at a depth of 113 feet on 4/22/2008.												
-16.10	114		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	115														

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				BTSB-R3-PZ-D
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 4

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
P. Ryan	7-26-08	7-27-08	N2120520.291 / E5994131.737 (NAD83)	RW5-R1
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 84ft R Sta 85+34 NB Alignment	93.094 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Fraste Multi-drill (truck)	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill			11.1 feet	46.2 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		4" ASPHALT CONCRETE, 6" UNREINFORCED CONCRETE, 3/4" BITUMENOUS LAYER.												
	1		SANDY lean CLAY (CL), stiff, reddish brown, moist, SAND is fine. [FILL]												
91.09	2														
	3		SILTY SAND (SM), dense, dark yellowish brown, dry to moist, fine, soil appears to have been compacted.		S1	20 26 30	56	100		13.8	117.7				Soil appears to have been compacted
89.09	4														
	5				S2	7 8 10	18	89							
87.09	6		SANDY lean CLAY (CL), stiff, dark yellowish brown, moist, SAND is fine to medium.												
	7														
85.09	8		SEDIMENTARY ROCK (Sandstone), fine grained, intensely weathered, yellowish brown, very soft, very intensely fractured.		S3	41 50/ 3.5"	50/ 3.5"	89							
	9														
	10		Moderately hard, intensely fractured, some fractures infilled with lean CLAY dipping ~45° up to 0.03' thick.		C4			94	33						
83.09			10.0', moderately fractured.												PL
	11				C5			86	50						
81.09	12		SEDIMENTARY ROCK (Sandstone Breccia), mylonized, pegmatic, with moderately soft fragments (gravel-size pieces of SANDSTONE), yellowish brown, moderately to slightly weathered, matrix is very soft, intensely fractured.												
	13														
79.09	14		SEDIMENTARY ROCK (Shale), 2-3" seam, moderately soft, intensely weathered, slickensides on fracture plane not parallel to shale bedding.												
	15		SEDIMENTARY ROCK (Sandstone), fine to medium grained, moderately weathered, light grayish brown, moderately hard, moderately fractured, thin white vein fillings locally open.		C6			100	88						PL
77.09	16														
	17														
75.09	18		17.8', slickensides on fracture plane.												
	19				C7			93	0						
73.09	20														
			20.2', intensely fractured and broken.												
	21		METAMORPHIC ROCK (Meta-Siltstone), dark gray, moderately weathered, moderately hard, intensely fractured and broken.												
71.09	22				C8			82	0						End Box #1 at 21.8'
	23		METAMORPHIC ROCK (Meta-Graywacke Sandstone), fine to medium grained, moderately weathered, light grayish brown, moderately hard, very intensely fractured.												
69.09	24		SEDIMENTARY ROCK (Sandstone Breccia), moderately weathered, moderately hard, pegmatic fragments in soft matrix.												
	25				C9			90							

(continued)

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW5-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 2

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Mylonized from 23.65' to 26.1'.						22						
67.09	26		SEDIMENTARY ROCK (Sandstone), fine grained, moderately weathered, light grayish brown, moderately hard, intensely to moderately fractured.												
	27														PL
65.09	28														
	29		Core run is broken into fragments up to 0.1' in diameter with occasional intact core lengths up to 0.4' long.		C10			100	0						Loss of fluid circulation; added drilling polymer
63.09	30														
	31														
61.09	32		32.0', occasionally vuggy, with gray lean CLAY on fracture surfaces, slightly weathered.		C11			100	0						
	33														
59.09	34				C12			92	0						
	35		35.0' - 35.5', steeply dipping fractures, slightly weathered to fresh, light grayish brown, continued white vein infilling.												
57.09	36														
	37				C13			87	0						
55.09	38		38.0', gold colored disseminated minerals noted (pyrite?)												
	39		38.6', moderately fractured, hard to moderately hard. Calcite vein dipping at 45°.												Mechanical break at 39'
53.09	40		39.9', fracture dipping ~75° white vein infilling, intensely to moderately fractured.		C14			100	0						
	41				C15			79	0						
51.09	42				C16			53	0						Continued circulation loss
	43				C17			100	0						
49.09	44		43.8' - 43.9', very fine grained. 44.0', mylonized zone.												
	45				C18			100							
47.09	46														
	47		Borehole terminated at a depth of 46.2 feet on 7/27/2008. See Boring Record Legend for soil classification chart and key to test data and sampler type.												
45.09	48														
	49														
43.09	50														
	51														
41.09	52														
	53														
39.09	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW5-R1
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 2

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
T. Carroll	2-27-08	2-28-08	N2120380.7 / E5994104.938 (NAD83)	RW6-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 58ft L Sta 85+24 SB Alignment	108.507 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			CME 550	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), HQ Core			Automatic, 140 lbs., 30-inch drop	76.2%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 12.0 to 22.0 ft			Not Recorded	64 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0		CLAYEY SAND (SC), loose, dark brown, dry to moist, fine, with occasional roots, with pieces of crushable black nodules. [FILL]											Strong organic odor
106.51	2													
	3		SILT with SAND (ML), stiff, yellowish brown, dry to moist, with iron-oxide staining, SAND is very fine, with black organic mottling and pieces of decayed vegetation.		S1	3 3 7	10	83		15.4	124.3			PA
104.51	4				S2	3 5 7	12	67						
	5													
102.51	6													
	7				S3	11 19 30	49	72						
100.51	8		SILTY SAND (SM), medium dense, yellowish brown, dry to moist, very fine, with frequent black specks and piece of decayed vegetation up to 1/8" diameter.							15.7				PI, PA
	9				S4	14 22 20	42	56						
98.51	10		Grades dense.											
	11													
96.51	12		Grades reddish brown, moist, fine, with slight black carbon mottling.		S5	14 21 26	47	78		16.6	128.7	DS = 0.62		PA
	13									16.8	127.2	DS = 0.66		
94.51	14				S6	13 20 25	45	67		16.3	129.1	DS = 0.88		
	15													
92.51	16													
	17		Grades yellowish brown, medium dense, with iron-oxide mottling, and seams of light yellowish brown CLAY.		S7	8 12 42	54	67		21.2	131.1	DS = 0.94		Did not clean hole prior to coring (began coring at 17'; new hole at 19')
90.51	18		SEDIMENTARY ROCK (Sandstone), yellowish brown, decomposed, soft (poorly graded SAND with CLAY (SP-SC), very dense, moist, SAND is fine with light gray CLAY infilling and black organic mottling).							22.1	131.0	DS = 1.05		PA
	19				S8	34 50/1"	50/1"	71		18.7	134.1	DS = 1.33		
88.51	20		Grades fine to medium grained, massive, yellowish brown and grayish brown, moderately weathered, moderately hard, heavy mechanical breaks (at 0.1' to 0.2'), obscure in-situ fractures with some evidence of variably oriented natural fractures ranging from 50° to 80°.		C9			47	0					Core has reduced diameter (0.15') at 20' due to heavy chatter.
	21													
86.51	22				C10			80	0					
	23													
84.51	24													Core at full diameter (~2.5").
	25				C11			100	32					

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		24.5', intensely fractured, moderate oxidation staining on fractured planes.												
82.51	26		SEDIMENTARY ROCK (Sandstone), yellowish brown, decomposed, soft (poorly graded SAND with CLAY (SP-SC), very dense, moist, SAND is fine with light gray CLAY infilling and black organic mottling).												
	27		Crushed zones (0.05' thick) at 25.2', 25.5', and 26.1'.		C12			100	17			UC = 222			Decreased rotation rate to keep core from rattling
80.51	28		26.2', medium fractured, variably oriented dark gray lamination due to soft sediment deformation.												
	29		29.0' - 33.3', crushed zone with clay.												
78.51	30														
	31				C13			67	0						
76.51	32				C14			83	14						
	33														
74.51	34		33.2', dark gray.												
	35														PL
72.51	36				C15			65	0						
	37		37.0', slightly weathered.		C16			68	9						PL
70.51	38														
	39														Mechanical breaks at 38.75' and 38.85'
68.51	40														PL
	41														
66.51	42		Healed and open fractures ranging from 30° to sub-vertical.		C17			100	22						
	43														
64.51	44				C18			97	18						
	45											UC = 1043			
62.51	46														
	47				C19			100	0						
60.51	48		47.7' - 48.8', multiple near vertical fractures.												
	49				C20			75	40						
58.51	50														PL
	51		50.3' - 51.2', crushed zone. 50.75', fresh, moderately hard to hard, with mineral precipitate infilling of fractures (no evidence of shearing).												
56.51	52				C21			93	28						
	53														PL
54.51	54		53.0', white mineral veins aligned at 45° occasionally correspond to fractures, additional fractures not aligned with veins.												
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				RW6-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 3

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), yellowish brown, decomposed, soft (poorly graded SAND with CLAY (SP-SC), very dense, moist, SAND is fine with light gray CLAY infilling and black organic mottling).												
52.51	56		56.0', crushed (mechanical?)		C22			100	0						
	57		57.0' - 58.3', vertical fracture.		C23			52	0						
50.51	58														
	59														
48.51	60		59.5', mineral precipitate on naturally occuring fracture planes.		C24			92	26						
	61														PL
46.51	62		62.0', crushed (primarily mechanical?)		C25			100	0						
	63		62.5' - 63.1', very closely fractured (mechanical).												
			63.1', crushed (primarily mechanical?).												
44.51	64		Borehole terminated at a depth of 64 feet on 2/28/2008.												
	65		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
42.51	66														
	67														
40.51	68														
	69														
38.51	70														
	71														
36.51	72														
	73														
34.51	74														
	75														
32.51	76														
	77														
30.51	78														
	79														
28.51	80														
	81														
26.51	82														
	83														
24.51	84														
	85														

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

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BORING RECORD				RW6-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 3

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
K. Karina	6-5-08	6-5-08	N / E (NAD83)	RW8-R1A-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 68 ft L Sta 76+18 SB Alignment	90.000 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Hollow Stem Auger			Mobile B53	8 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Bulk			Automatic, 140 lbs., 30-inch drop	70.0%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
2" dia. Standpipe Piezo Screened 25.0 to 45.0 ft			Not Recorded	46.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		Poorly-graded SAND (SP), brown, dry to moist, SAND is fine, trace of roots. [FILL]		B1										
	1														
88.00	2		Grades with fragments of concrete and brick up to 1.5" diameter.												
	3														
86.00	4														
	5		SAND is very loose to loose.		S2	6	10	56							
84.00	6				S3	6 4	4	81							
	7					2 2 2									
82.00	8		Poorly-graded SAND (SP), loose, dark brown, moist, SAND is fine, trace SILT.												
	9														
80.00	10				S4	3 4 6	10	100							
	11														
78.00	12		SANDY SILT (ML), soft, brown, moist, SAND is fine. [BURIED SOIL HORIZON]		S5	1 1/12"	1/12"	100							
	13		SILTY CLAY (CL-ML), soft, dark brown, wet, SAND is fine.												
76.00	14														
	15		Lean CLAY (CL), very stiff, orangish brown, moist, with grayish brown mottling and black specks, trace of fine SAND. [SANDY CLAY]		S6	5 6 10	16	100				PP = 1.5			
74.00	16														
	17				S7	4 6 10	16	100							
72.00	18		Decayed root (1/8" diameter, 10" long).												
	19														
70.00	20		Lean CLAY with SAND (CL), very stiff, yellowish brown, moist, SAND is fine to medium.		S8	6 12 14	26	100				PP = 1.75 1.875			
	21														
68.00	22		Grades with increase in moisture content.		S9	5 5 6	11	100							
	23														
66.00	24														
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1A-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 2

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND (SC), medium dense, yellowish brown, moist to wet, fine to medium. [COLMA SAND]		S10	4 5 7	12	100							
64.00	26														
	27														
62.00	28														
	29		Poorly-graded SAND with CLAY (SP-SC), dense, dark yellowish brown to reddish brown, moist, SAND is fine to medium, with black stains.												
60.00	30				S11	11 13 18	31	100							
	31														
58.00	32														
	33														
56.00	34														
	35		Grades very dense, with iron-oxide staining.		S12	17 23 31	54	100							
54.00	36														
	37														
52.00	38														
	39														
50.00	40		Grades medium dense, moist. 40.4', piece of crushable iron-oxide nodule, seam of dark gray staining.		S13	8 12 13	25	100							
	41														
48.00	42														
	43														
46.00	44		Lean CLAY (CL), stiff, yellowish brown, moist, with black specks, trace of fine SAND. [SANDY CLAY]												
	45				S14	3 5 7	12	100							
44.00	46		Fat CLAY (CH), medium stiff, yellowish brown, moist, with light grayish brown mottling, with rock-like structure, with black staining and vein of iron-oxide staining. [RESIDUAL SOIL]												
	47		Borehole terminated at a depth of 46.5 feet on 6/5/2008.												
42.00	48		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
	49														
40.00	50														
	51														
38.00	52														
	53														
36.00	54														
	55														

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

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REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1A-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 2

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
S. McLandrich	1-10-08	1-17-08	N2120199.669 / E5995008.466 (NAD83)	RW8-R1-PZ
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Gregg Drilling and Testing, Inc.			Offset 68ft L Sta 76+18 SB Alignment	90.616 ft (NAVD88)
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Mud Rotary			Failing 1500	5 in. (soil); 4 in. (rock)
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
MC (2.4"), SPT (1.4"), Grab, Shelby (2.87"), HQ Core			Automatic, 140 lbs., 30-inch drop	72.8%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Neat Cement Grout Backfill			Not Recorded	130 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0														
	1		SILTY SAND (SM), dark brown, moist, fine SAND, with fine angular GRAVEL. [FILL]		S1										No driven samples in top 5', because of potential underground utilities With roots and plant debris, earthy odor detected.
88.62	2		2.0' - 2.5', remnant BRICK structure.												
	3		Poorly graded SAND with SILT (SP-SM), loose, fine, yellowish brown, moist, with wood pieces. [FILL]		S2										Earthy odor detected.
86.62	4														
	5														
84.62	6		Grades brown.												
	7														
82.62	8		Poorly graded SAND (SP), loose, yellowish brown, moist, very fine SAND, trace of fines.		S3	1 2 2	4	100		9.6	99.5				OC
	9		Grades dark brown.		S4	0 2 3	5	100							Slight increase in fines content
80.62	10														
	11		Lean CLAY (CL), medium stiff, dark brown, moist, trace of fine SAND..												Earthy odor detected
78.62	12														
	13				S5	0 0 0	0	100		22.4	104.0				PA
76.62	14		Lean CLAY (CL), medium stiff, yellowish brown, with black specks and dark gray mottling, trace of very fine SAND.		S6	1 3 3	6	100				PP = 0.375			
	15														
74.62	16														
	17														
72.62	18		Grades very stiff.		S7	8 12 16	28	100		19.0	110.4	PP = 1.85			PI
	19				S8	5 7 10	17	100							
70.62	20		Increase in SAND content, SAND is fine.												
	21														
68.62	22														
	23		Grades with trace of fine SAND.		U9		100 psi	100		19.6	105.7	UU = 0.73			PI, PA, C
66.62	24						200 psi			18.2	110.8				PI, PA, CU
	25														

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BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	1 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25		Poorly graded SAND with CLAY (SP-SC), medium dense, fine to medium, reddish brown, moist, with occasional coarse SAND.											Black organic pieces in drill cuttings
64.62	26													
	27													
62.62	28				S10	9 16 20	36	100						
	29		Grades with black specks.		S11	9 16 16	32	100		15.3				PA
60.62	30													
	31													
58.62	32													
	33		Grades yellowish brown with black mottling and iron-oxide staining.		S12	10 20 26	46	100		19.6 20.0	108.9 108.6	DS = 1.93		PA
56.62	34				S13	7 15 23	38	100		19.5	111.5	DS = 2.24 DS = 2.56		
	35													Thin interbedded olive brown layer noted in shoe
54.62	36													
	37													
52.62	38		Grades without iron-oxide staining and without black mottling.		S14	25 29 40	69	100						
	39				S15	13 23 19	42	100						
50.62	40													
	41													
48.62	42		Lean CLAY (CL), stiff to very stiff, reddish brown, moist, with trace SAND, with frequent black specks and crushable nodules.											
	43				S16	8 9 11	20	100		23.1 21.1	103.1 102.4	UU = 0.64 PP = 1.0		PI PI, C
46.62	44				S17	7 7 9	16	100						
	45		Lean CLAY (CL), reddish brown, with crushed nodules, with white veins, slight rock structure, decomposed rock.											
44.62	46													
	47													
	48		SEDIMENTARY ROCK (Sandstone), fine to medium, reddish brown, decomposed, very soft (poorly graded SAND (SP), very dense, SAND is fine to medium, moist).		S18 S19	50/4" 50/5"	50/4" 50/5"	100 100						
42.62														
	49													
40.62	50													
	51		Grades to yellowish brown, moderately weathered, moderately soft to soft, moderately fractured, numerous incipiant fractures, fractures are filled with white precipate (soft).		C20			96	NA					Begin HQ system coring at 51.0'
38.62	52		51.3' - 52.2', brecciated zone.											
	53													
36.62	54													
	55													

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REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	2 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		SEDIMENTARY ROCK (Sandstone), fine to medium, reddish brown, decomposed, very soft (poorly graded SAND (SP),												PL
34.62	56		very dense, SAND is fine to medium, moist).		C21			100	NA						
	57														
32.62	58														
	59		59.2' - 60.0', interbedded siltstone lenses (0.1 to 0.3' thick) with soft sediment deformation.												
30.62	60				C22			56	7						
	61														
28.62	62		61.4' - 62.8', very intensely fractured (fragments of sandstone and siltstone mylonized)												
	63														
26.62	64														
	65		Fractures are variably oriented, heavy iron-oxide staining on fracture surfaces.		C23			83	0						
24.62	66														
	67														
22.62	68				C24			80	14						PL
	69														
20.62	70		69.8' - 70.6', interbedded siltstone lenses (soft sediment deformation?).												
	71														
18.62	72		SEDIMENTARY ROCK (Sandstone Breccia), fine grained, dark brown and yellowish brown, moderately weathered, soft with harder inclusions, moderately fractured.		C25			88	0						
	73														
16.62	74		METAMORPHIC ROCK (Serpentinite), dark greenish gray, intensely weathered, very soft, very intensely fractured,												
	75		pervasively sheared.		C26			100	0						At 74.5' we began to lose fluid and the hole began caving
14.62	76		SEDIMENTARY ROCK (Sandstone Breccia), fine to medium grained, dark yellowish brown, moderately weathered, soft (with 0.05' to 0.1' thick fragments of siltstone and sandstone).		C27			80	0						SPT from 74' to 75.5'; blowcount 4, 13, 26
	77		METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.												
12.62	78														
	79				C28			50	12						After drilling to 79', hole caved to 75'
10.62	80		79.5' - 79.8' and 80.3' - 80.6', white apparent decomposition to talc?												
	81														
8.62	82														
	83														
6.62	84				C29			42	0						
	85														

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BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		84.9' - 85.8', white apparent decomposition to talc? METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.												
4.62	86														
	87														
2.62	88														
	89				C30			0							
0.62	90														
	91				C31			65	0						
-1.38	92														
	93		93.0', white secondary mineral "blocks" and vein fillings common throughout interval (up to 0.05' thick).		C32			60	0						
-3.38	94														
	95				C33			100	50						
-5.38	96														
	97														
-7.38	98				C34			83	0						
	99														
-9.38	100														
	101				C35			100	0						
-11.38	102														
	103														
-13.38	104														
	105				C36			93	7						
-15.38	106														
	107														
-17.38	108		108.0' - 110.7', intensely fractured (mechanical).		C37			68	0						
	109														
-19.38	110														
	111														
-21.38	112				C38			93	55						
	113														
-23.38	114		Healed white anastomized fractures.												
	115														

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BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	4 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	Description	Sample Location	Sample Number	Blows per 6 In	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115		METAMORPHIC ROCK (Serpentinite), light greenish gray and dark greenish gray, slightly weathered to fresh, very soft to moderately hard, moderately to slightly fractured, common white secondary mineral veins, commonly intensely sheared.												
-25.38	116				C39			98	22						
	117		116.9' - 119.9', polished surfaces on fractures.												
-27.38	118		117.8' - 120.0', brecciated zone.												
	119														
			119.3', fibrous texture noted.												
-29.38	120				C40			100	60						
	121		120.6' - 123.1', very dark gray, gabbroic, dense, moderately hard, moderately fractured.												
			121.5', fibrous secondary mineral deposit on fracture.												
-31.38	122		122.15' - 123.0', white mineral vein infilling.									UC = 127			PL
	123		123.1', light greenish gray, soft, intensely fractured (non-gabbroic).												
-33.38	124														
			124.35', 0.01' thick fibrous secondary mineral deposit on fracture-oriented perpendicular to fracture.												
	125				C41			74	0						
-35.38	126		126.3', gabbroic.												
	127														
-37.38	128														
	129														
-39.38	130		Borehole terminated at a depth of 130 feet on 1/17/2008.												
	131		See Boring Record Legend for soil classification chart and key to test data and sampler type.												
-41.38	132														
	133														
-43.38	134														
	135														
-45.38	136														
	137														
-47.38	138														
	139														
-49.38	140														
	141														
-51.38	142														
	143														
-53.38	144														
	145														

Department of Transportation
Division of Engineering Services
Geotechnical Services

REPORT TITLE				HOLE ID
BORING RECORD				RW8-R1-PZ
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	5 of 5

CALTRANS FORMAT DOYLEDRIVE_ARUPLOGS.GPJ ARUP LIBRARY_CALTRANS FORMAT.GLB 8/24/09

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic / Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE				
BORING RECORD LEGEND				
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
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CONSISTENCY OF COHESIVE SOILS

Descriptor	Unconfined Compressive Strength (tsf)	Pocket Penetrometer (tsf)	Torvane (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	0.25 - 0.50	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	0.50 - 1.0	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	1.0 - 2.0	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	2.0 - 4.0	1.0 - 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60} - Value (blows / foot)
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Descriptor	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE

Descriptor		Size
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CEMENTATION

Descriptor	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

NOTE: This legend sheet provides descriptors and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (July 2007), Section 2, for tables of additional soil description components and discussion of soil description and identification.

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE: BORING RECORD LEGEND

DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701

PROJECT OR BRIDGE NAME: Doyle Drive Replacement Project

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
34-0161L	T. Carroll	8-24-09	2 of 3

ROCK GRAPHIC SYMBOLS

IGNEOUS ROCK

SEDIMENTARY ROCK

METAMORPHIC ROCK

BEDDING SPACING

Descriptor	Thickness or Spacing
Massive	> 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8 inches to 1 ft
Thinly bedded	1-1/4 to 3-5/8 inches
Very thinly bedded	3/8 inch to 1-1/4 inches
Laminated	< 3/8 inch

WEATHERING DESCRIPTORS FOR INTACT ROCK

	Diagnostic Features					
	Chemical Weathering-Discoloration-Oxidation		Mechanical Weathering and Grain Boundary Conditions	Texture and Solutioning		
Descriptor	Body of Rock	Fracture Surfaces		Texture	Solutioning	General Characteristics
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy"	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation (refer to grain boundary conditions)	All fracture surfaces are discolored or oxidized; surfaces are friable	Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated	Altered by chemical disintegration such as via hydration or argillation	Leaching of soluble minerals may be complete	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened.
Decomposed	Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay		Complete separation of grain boundaries (disaggregated)	Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes".

Note: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

RELATIVE STRENGTH OF INTACT ROCK

Descriptor	Uniaxial Compressive Strength (psi)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

ROCK HARDNESS

Descriptor	Criteria
Extremely Hard	Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows
Very hard	Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows
Hard	Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows
Moderately Soft	Specimen can be grooved 1/6 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure
Soft	Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure
Very Soft	Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light hand pressure

CORE RECOVERY CALCULATION (%)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

RQD CALCULATION (%)

$$\frac{\Sigma \text{ Length of intact core pieces} > 4 \text{ in.}}{\text{Total length of core run (in.)}} \times 100$$

FRACTURE DENSITY

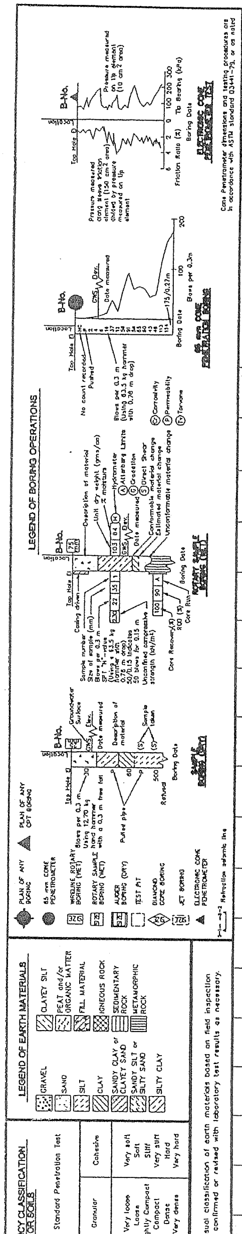
Descriptor	Criteria
Unfractured	No fractures
Very Slightly Fractured	Lengths greater 3 ft
Slightly Fractured	Lengths from 1 to 3 ft, few lengths outside that range
Moderately Fractured	Lengths mostly in range of 4 in. to 1 ft, with most lengths about 8 in.
Intensely Fractured	Lengths average from 1 in. to 4 in. with scattered fragmented intervals with lengths less than 4 in.
Very Intensely Fractured	Mostly chips and fragments with few scattered short core lengths

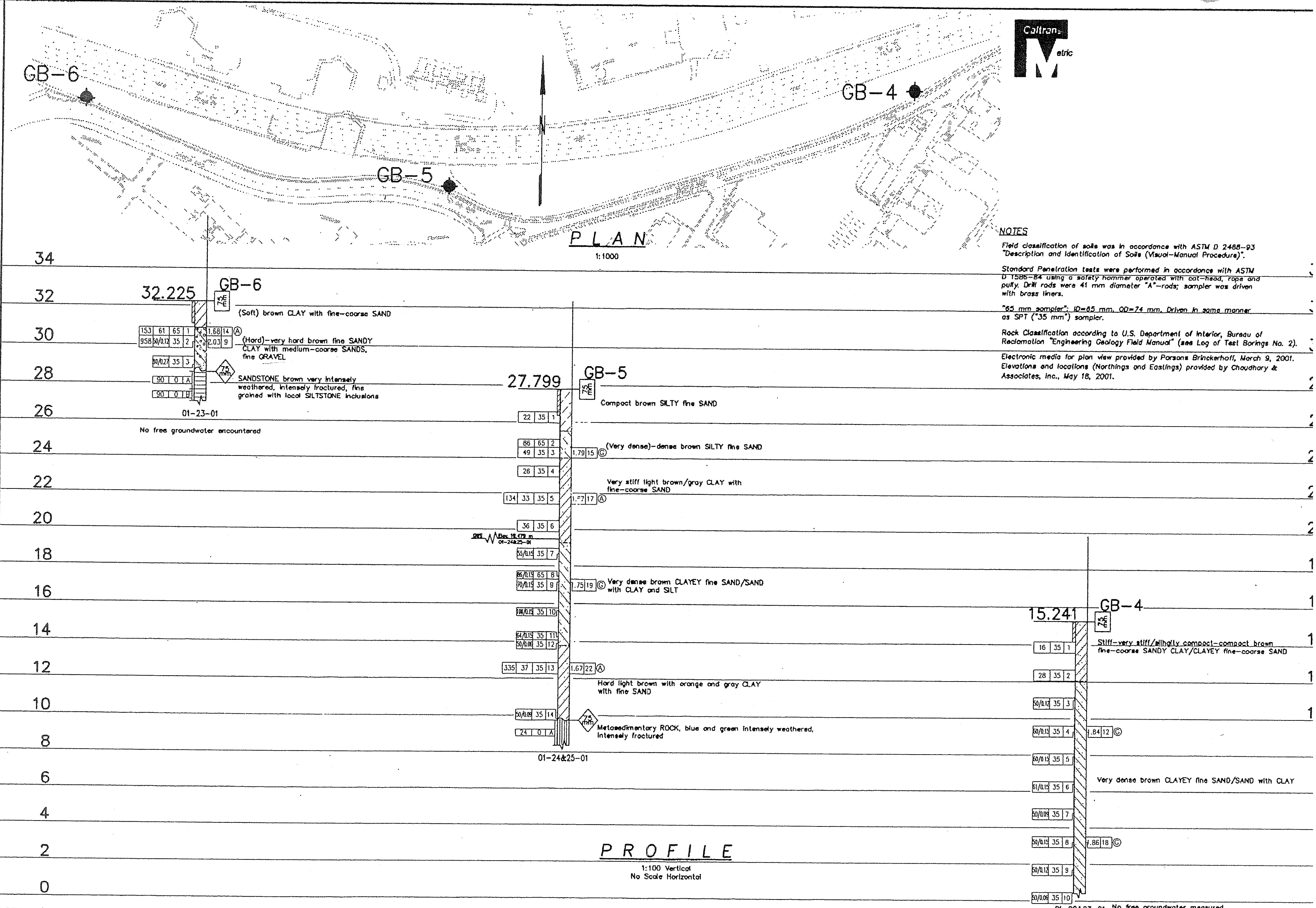
Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE				
BORING RECORD LEGEND				
DIST.	COUNTY	ROUTE	POSTMILE	EA
4	S.F.	101	8.3/9.4	163701
PROJECT OR BRIDGE NAME				
Doyle Drive Replacement Project				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
34-0161L	T. Carroll		8-24-09	3 of 3

APPENDIX A.3

Logs by Others





NOTES

Field classification of soils was in accordance with ASTM D 2488-93 "Description and Identification of Soils (Visual-Manual Procedure)".

Standard Penetration tests were performed in accordance with ASTM D 1586-84 using a safety hammer operated with cat-head, rope and pully. Drill rods were 41 mm diameter "A"-rods; sampler was driven with brass liners.

"65 mm sampler": ID=65 mm, OD=74 mm. Driven in same manner as SPT ("35 mm") sampler.

Rock Classification according to U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual" (see Log of Test Borings No. 2).

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Choudhary & Associates, Inc., May 18, 2001.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001	

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

KP

DOYLE DRIVE RECONSTRUCTION PROJEC

LOG OF TEST BORINGS No. 3

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

CU EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET

Tabor Consultants Job No. 202/300/133 file id: 202300133a.dwg date: 05/24/01

Caltrans EXPLORATION BORING FIELD LOG

Date 2/26/08 Boring No. ____

Location Doyle Drive, Hig Viaduct, Crissy Field A. Lab No. ____ EA No. 163701 Page 1 of 3

Dist. 04 Co. SF Rt. 101 P.M. ____ Br. No. ____ Purpose of Work ____

____ Ft. Rt. Lt. ____ Line. Sta. ____ Northings. ____ Eastings. ____ Elev. ____

Ground Water Data: Date / Time	Water Level	Bot. of Boring		
			Logged By: R Nashed	Drill Crew: Brad, Javed, Randy
			Drill rig: CME-750	Hammer Type and Weight: Automatic
			Drilling Method: Rotary Wash - Coring	Casing: N/A
			Hole Completion: 2/28/08	

Depth	Sample Interval Tool	Blows RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
1								
2								
3							Sand (SP), v. loose, brown, slightly moist, medium grained	
4								
5								
	1	3						
6		1						
		3						
7							Silty sand (SW), medium dense, reddish brown, medium to fine grained	
8								
9								
10								
		3						
11	2	9						
		13						
12								
13							Sand (SP), dense, yellowish brown, medium grained	
14								
15								
		12						
16	3	18						
		16						
17								
18								
19		2B						Brass tube Samples
20		2A					Sandstone, coarse to medium grained, massive, yellowish brown to dark brown, hard, intensely weathered, intensely fractured and jointed	
		Refusal						
21		%17		%72				Core 20.0' to 25.0'
22								30 min
23								
24							Sandstone, coarse grained, massive, reddish brown, v. hard, moderately weathered, moderately fractured and jointed	
25								
26		%40		%95				29 min
27								
28								
29								
30								
31		%22		%87			The same as above	24 min
32								

34-015744-A1

Caltrans | EXPLORATION BORING FIELD LOG | Date 2/28/08 | Boring No.

Location Doyle Drive - High Viaduct - Crissy Field Ave | Loc No. | EA No. 163701 | Page 2 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Rt. | Ft. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date / Time | Water Level | Bot. of Boring

Logged By : R Washed | Drill Crew : Brad, Jarod, Randy

Drill rig : CME - 750 | Hammer Type and Weight : Automatic

Drilling Method : Rotary Wash - Coring | Casing : N/A

Hole Completion : 2/28/08

Depth	Sample Interval	Tool Blows / RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
33	3'							
34								
35							The same as above	
36		147	1/97					21 min
37								
38	3'							
39								
40							Sandstone, massive, coarse grained gray, hard, slightly weathered, slightly fracture, moderately jointed	cont. on 2/27/08
41		177	1/97					
42								27 min
43	3'							
44								
45								
46		173	1/109				Sandstone, massive, coarse grained, dark brown to gray, hard moderately weathered, slightly fractured, and moderately jointed	
47								
48	6'							22 min
49								
50								
51		165	1/97				Sandstone as above, but gray	
52								
53	7'							22 min
54								
55								
56		138	1/98				Sandstone, massive, coarse grained, gray, hard, moderately weathered, intensely fractured and intensely jointed	
57								
58	9'							19 min
59								
60								
61		133	1/90				The same as above	
62								
63	9'							26 min
64								
65								
66		137	1/95				Sandstone, massive, coarse grained, dark gray, moderately slightly weathered moderately fractured, intensely jointed	
67								
68	9'							33 min
69								
70								
71		143	1/109				Sandstone, massive, coarse grained, gray to yellowish gray, hard, intensely weathered, intensely fractured and slightly jointed	
72								30 min

2903

Caltrans | EXPLORATION BORING FIELD LOG | Date 2/27/08 | Boring No.

Location Doyle Drive, high Viaduct, Crissy field | Log No. | EA No. 163701 | Page 3 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Bork

Rt. Ft. Lt. | Line. Sta. | Northings. | Eastings. | Elev.

Ground Water Data: Date/Time | Water Level | Bot. of Boring

Logged By : R Washed | Drill Crew : Brad, Javod, Randy

Drill rig : CME 750 | Hammer Type and Weight : Automatic

Drilling Method : Rotary Wash / Coring | Casing : N/A

Hole Completion : 2/28/08

Depth	Sample Interval	Total Blows/RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
73								
74								
75							Sandstone, massive, coarse grained, gray, hard, intensely to moderately weathered, intensely fractured and jointed	
76		143	195					
77								27 min
78	12							
79								
80							Sandstone, massive, coarse grained, gray, hard, slightly weathered, moderately fractured, slightly jointed	
81		175	109					
82								23 min
83	13							
84								
85							Sandstone, massive, coarse grained, gray to yellow, with gravel, moderately weathered, intensely fractured and intensely jointed	
86		159	109					
87								21 min
88								
89	14							
90							Sandstone as above	
91		145	190					Continue on 2/29/08
92							Shale, thinly bedded, fine grained, black, soft, intensely weathered	From 93' 2"
93	15							to 93' 8"
94		143	4/100					21 min
95	16						Sandstone as above / Shear Zone	From 93' 8" ± 95'
96			197				Sandstone as above	7 min
97							Shaley Sandstone (melange) massive, coarse grained, dark gray	
98	17						V. hard, slightly weathered, intact rock, few joints, calcic veinlets	30 min
99								
100							Shale, thinly bedded, micaceous, grained, black, intensely weathered intensely fractured	
							Graywake, massive, coarse grained, black, moderately hard to moderately soft, intensely weathered, intensely fractured	
							The Bottom of the Hole @ 110 Ft	

34-015 ESB-A1

Caltrans | EXPLORATION BORING FIELD LOG | Date 2/20/08 | Boring No.

Location Doyle Drive - High Viduct, Crissy Field | Proj No. | EA No. 163 701 | Page 1 of 3

Dist. 04 Co. SF Rt. 101 P.M. | Br. No. | Purpose of Work

Ft., Rt., Lt., Line, Sta., Northings, Eastings, Elev.

Ground Water Data: Date/Time | Water Level | Hor. of Boring

Logged By : R Nashed | Drill Crew : Brad, Corie, Andy

Drill rig : CME-750 | Hammer Type and Weight : Automatic

Drilling Method : Rotary wash - Coring | Casing : N/A

Hole Completion : 2/21/08

Depth	Sample Interval	Total Blows	RQD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
1									
2									
3									
4									
5								Sand (SP), Colour Convertion / Evidence brownish yellow, slightly moist, medium grained	
	1	20							
6		20							
		28							
7									
8									
9									
10								The same as above	
	2	12							
11		19							
		23							
12									
13									
14									
15								The same as above	
	3	12							
16		20							
		25							
17									
18									
19									
20								Sand stone, coarse grained brownish yellow, soft, intensely weathered, massive, calcareous veinlets	Bedrock @ depth 20 ft
	4	Refusal							
21									
22									
23									
24									
25								Sand stone, coarse grained yellowish brown, hard, moderately weathered, massive	From 25 to 29 ft
26	5	Refusal							
	1/25	1/63							
27								The same, but moderately soft and moderately fractured	18 min
28									
29									
30	1/00	1/00						The same, but moderately hard, slightly weathered, intact rock with a joint	From 29 ft to 30 ft

5 min

34-015755 A1

Caltrans | EXPLORATION BORING FIELD LOG | Date 2/20/08 | Boring No.

Location Doyle Drive, High Viduct, Crissy Field Ave | Log No. | EA No. 163701 | Page 2 of 3

Dist. 04 Co. SF Rt. 101 P.M. Br. No. Purpose of Work

Rt. Ft., Lt. Line, Sta. Northings. Eastings. Elev.

Ground Water Data: Date / Time | Water Level | Bot. of Boring

Logged By : R Nashed | Drill Crew : Brad, Cerle, Andy

Drill rig : CME - 750 | Hammer Type and Weight : Automatic

Drilling Method : Rotary Wash, Coring | Casing : N/A

Hole Completion : 2/21/08

Depth	Sample Interval	Tool, Blows, ROD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
31	3	23		93			Sandstone, massive, coarse grained yellowish brown to olive, moderately hard, slightly weathered, intensely jointed and fractured.	28 min
32								
33								
34								
35								
36	4	53		90			The same as above.	
37								
38							Shaley Sandstone, thinly bedded, fine to medium grained yellowish brown	27 min
39							v. soft, decomposed	
40							Sandstone as above	
41	5	38		96				
42							Shaley Sandstone as above	
43								21 min
44							Sandstone, massive, coarse grained, yellowish brown, moderately hard, moderately weathered, intensely fractured and sheared.	
45								
46	6	67		97				
47								
48							Sandstone as above, but less fractured and jointed.	19 min
49								
50								
51	7			93			Sandstone, massive, coarse grained, gray, moderately to v. hard, slightly weathered, few fractures and joints	From 50.0 To 54 ft
52								18 min
53								
54							The same as above	
55	8	8"					Sandstone gravel (rock fragments)	To be continue in 2/2
56		0		70			Sub-rounded to size 2".	(From 54.0 to 55.0 ft = 7 min)
57							Sandstone, massive, coarse grained	
58	9						gray, slightly weathered, v. intensely fractured and jointed (mostly rock fragm.)	(From 55.0 to 59'3")
59								28 min
60							The same as above	(From 59'3" to 60.0 ft)
61		55		104				4 min
62							Clay stone, thinly bedded, fine grained olive gray, v. soft, v. intensely weathered	
63	10						Sandstone, massive, coarse grained	25 min
64							gray, v. hard, slightly weathered moderately fractured and jointed	
65								
66		18					Shale, fissile, medium grained	
67							black, soft, intensely weathered, organic	19 min
68	11						(carbon closures)	
69							Sandstone as above	
70								

34-0167SB-4

Caltrans | EXPLORATION BORING FIELD LOG | Date 2/21/08 | Boring No.

Location Dayle Drive, High Viaduct, Crissy Field | Log No. | EA No. 163701 | Page 3 of 3

Dist. 04 Co. SF Rt. 101 P.M. Br. No. Purpose of Work

Rt. Ft. Lt. Line. Sta. Northings. Eastings. Elev.

Ground Water Data: Date / Time | Water Level | Bot. of Boring

Logged By : R Nashed | Drill Crew :

Drill rig : CME 750 | Hammer Type and Weight :

Drilling Method : Rotary Wash - Coring | Casing :

Hole Completion : 2/21/08

Depth	Sample Interval	Type	Blows ROD	Sample I.D.	% Rec.	Strength	Graphic Log	Description	Remarks
71	2½		18		88			sandstone, massive, coarse grained, gray, v. hard, slightly weathered, fractured and jointed	
72									19 min
73									
74									
75									
76	3½		1		72			shaly sandstone, thinly bedded, coarse grained, gray, intensely weathered, intensely fractured and sheared	
77									
78									27 min
79									
80									
81	4½		1.1		90			sandstone, massive, coarse grained, gray to yellowish gray, v. hard, sheared, slightly to intensely weathered, intensely fractured and completely crushed	
82									23 min
83									
84									
85									
86	5½		57		93			Sandstone, massive, coarse grained, dark gray, hard, slightly weathered, moderately fractured and jointed	
87									13 min
88									
89									
90									
11	6½		1.1		89			Sandstone, massive, coarse grained, yellowish gray, moderately hard, sheared, intensely weathered, intensely fractured	
12									15 min
13									
14									
15	7½		52		109			shale, thinly bedded, medium grained, black, v. soft, intensely weathered and sheared	
16									12 min
17									
18									
19									
20								Sandstone, massive, coarse grained, gray, v. hard, slightly weathered, moderately fractured and jointed	

Appendix B

Results of Laboratory Testing

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Table B-13 Summary of Petrographic Analysis (Thin Section Microscopy) Test Results

1 Introduction

An extensive laboratory testing program was performed to determine the index and engineering properties of the major subsurface strata encountered at the site. The laboratory testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to refine some of the engineering parameters where it was deemed appropriate.

Tests on overburden soil specimens were performed at the Signet Testing Laboratories in Hayward, California.

Tests on Mélange Matrix specimens were performed at the Signet Testing Laboratories in Hayward, California.

Tests on rock specimens were performed at Advanced Terra Testing, Inc., in Lakewood, Colorado and the Arup laboratory in San Francisco, California.

This appendix briefly describes the testing program and procedures used for the different test types and presents summary tables and data plots of the test results.

1.1 Tests Performed on Soil and Rock Samples

In order to adequately determine the engineering properties of the soil and rock, a series of laboratory tests were performed on various samples of Fill, , Buried Soil Horizon, Sandy Clay, Sandy Silt, Colma Sand, Colluvium, Residual Soil, and the underlying bedrock.

1.2 Index Tests

Index tests were performed on both soil and rock samples to aid in classification and correlation with other engineering parameters. Index tests included Atterberg limits, grain size analyses, organic content, and moisture content and density determinations. Atterberg limits tests were performed in accordance with standard test method ASTM D 4318-00 (wet method). Grain-size analyses were performed in accordance with standard test method ASTM D 422-63. Organic content tests were performed in accordance with the standard test method ASTM D 2974-87. Moisture content tests were performed in accordance with standard test method ASTM D 2216-98. Total density tests were performed following the standard test method ASTM D 2216-98. In addition to tests performed to directly measure the properties stated above, moisture and density measurements were performed on samples for One-Dimensional Consolidation, Direct Shear, and Unconsolidated Undrained Triaxial Compression tests.

A summary of the results of index tests performed on soil and rock is presented in Table B-1. The individual laboratory reports for Atterberg limits, sieve analyses and moisture and density tests are presented in Attachment B-1 of the accompanying CD.

1.3 One-Dimensional Consolidation Tests

One-Dimensional Consolidation Tests were performed on samples of Sandy Clay to evaluate their compressibility characteristics and past geologic-stress history. Consolidation tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 2435-04.

The maximum past pressure values (σ'_p) were estimated from end-of-primary consolidation compression curves using the Pacheco-Silva (1970) and Casagrande

(1934) constructions, as well as the Becker et al. (1987) work method. The overconsolidation ratio (OCR) was then computed from an estimated maximum past pressure (σ'_p) and the calculated in situ vertical effective stress (σ'_{vo}) at the depth from which the sample was taken using the following expression:

$$OCR = (\sigma'_p)/(\sigma'_{vo})$$

A summary of the results from the consolidation tests performed on overburden soils is presented in Table B-2. The laboratory consolidation test reports showing the compression curves (vertical strain at the end of load increment versus log effective stress) are included in Attachment B-2 of the accompanying CD.

1.4 Direct Shear Test

Direct Shear Tests were performed on samples of Fill, Buried Soil Horizon, and Colma Sand to determine the drained strength parameters of these materials.

A summary of the results from the Direct Shear Tests is presented in Table B-3. The laboratory reports are included in Attachment B-3 of the accompanying CD.

1.5 Organic Content Tests

An Organic Content Test was performed on a Buried Soil Horizon sample in general accordance with the procedures outlined in the standard test method ASTM D 2974-87.

A summary of the results from the Organic Content Test is presented in Table B-4. The laboratory reports are included in Attachment B-4 of the accompanying CD.

1.6 Unconsolidated Undrained Triaxial Compression Test

Unconsolidated Undrained (UU) Triaxial Compression Tests were performed on samples of Buried Soil Horizon, Sandy Clay, Colma Sand, Serpentinite, Mélange Matrix, Sandstone, and Gabbro to evaluate the undrained shear strength of the material. The undrained Young's Modulus can also be determined from this test. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 2850-95.

A summary of the results of UU Triaxial Compression Tests is presented in Table B-5. Before testing and after testing photographs of selected samples and the laboratory reports for all samples for these tests are included in Attachment B-5 of the accompanying CD.

1.7 Isotropically consolidated Undrained Triaxial Compression Test

Isotropically Consolidated Undrained (ICU) Triaxial Compression Tests were performed on Colma Sand samples to determine the effective friction angle. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 4767-95 with pore pressure measurements.

A summary of the results of ICU Triaxial Compression Tests is presented in Table B-6. Before testing and after testing photographs of selected samples and the laboratory reports for all samples for these tests are included in Attachment B-6 of the accompanying CD.

1.8 Uniaxial Compressive Strength Tests with Stress Strain Measurements

Uniaxial Compressive Strength Tests were performed on intact rock samples of four to six inches long to determine the compressive strength. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 3148-02. Stress-strain measurements during the tests were used to determine the elastic stiffness parameters of the rock specimen, namely the Young's modulus and the Poisson's ratio.

A summary of the results from the Uniaxial Compressive Strength Tests performed is presented in Table B-7. The laboratory stress-strain curves and photographs for these tests are included in Attachment B-7 of the accompanying CD.

1.9 Point Load Index Tests

Diametral Point Load Index Tests were performed to determine point load index strength of intact rock core specimens. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 5731-02. This index test is an inexpensive way to measure the strength of the rock specimens without the specimen preparation and setup required for the Uniaxial Compressive Strength Test. Point load tests were performed on portions of rock core having a length-to-diameter ratio of at least 1.0, with appropriate corrections being made to account for size effects. In the point load test, rock specimens are loaded between steel cone tips and the load at the time of rupture is recorded. The corrected point load strength, $I_{s-(50)}$, is given by the expression:

$$I_{s(50)} = F(P/D_e^2)$$

Where:

P = load at rupture

D_e = distance between the steel points at failure (typically slightly smaller than the core diameter)

F = specimen size correction factor to standardize the results to 50 mm core size.

The uniaxial compressive strength, σ_a, is computed from:

$$\sigma_a = C \times I_{s(50)}$$

Where:

C = factor that depends on the core size.

A summary of the results from Point Load Index Tests performed is presented in Table B-8. Plots of uniaxial compressive strength versus elevation for each borehole tested are included in Attachment B-8 of the accompanying CD.

1.10 Indirect Tensile Strength (Brazilian) Tests

Indirect Tensile Strength Tests, also referred to as the Brazilian Test Method, were performed on five rock core samples to determine the tensile strength of the rock. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 3967-95a. The significant advantage of this test is that it is a simple and inexpensive way to measure the tensile strength.

A summary of the results from the Indirect Tensile Strength Tests performed is presented in Table B-9. The laboratory reports, photographs and stress curves for these tests are included in Attachment B-9 of the accompanying CD.

1.11 Punch Penetration Test

A Punch Penetration Test was performed on one intact rock core specimen indicating relative boreability and excavatability of the rock formation, i.e., the energy needed for efficient chipping. This is affected by the stiffness, brittleness, and porosity of the sample. The rock sample was broken in the same way that a disc cutter will during tunnel construction. The test takes into account both the crushing strength of the rock (failure mechanism beneath the cutter edge) and its resistance to chipping (failure mechanism between cutters).

A summary of the results from the Punch Penetration Test performed is presented in Table B-10. The laboratory report for this test, which includes a summary sheet, load versus penetration plots and before and after test photographs, is presented in Attachment B-10 of the accompanying CD.

1.12 Cerchar Abrasivity Index Tests

Cerchar Abrasivity Index Tests were performed on three rock specimens to determine rock abrasivity for cutter wear. A series of sharpened steel pins of a known hardness are pulled across a freshly broken surface of the rock. The average dimensions of the resultant wear can be related directly to cutter life in field operation. The geometry of the planned excavation then allows calculation of the expected cutter wear per unit distance of cutter travel.

A summary of the results from the Cerchar Abrasivity Index Tests performed is presented in Table B-11. The laboratory data sheet and before and after test photographs are presented in Attachment B-11 of the accompanying CD.

1.13 Slake Durability Tests

Slake Durability Tests were performed on three rock core specimens in order to quantitatively estimate the durability of weak rocks and their resistance to weathering. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 4644-87. Serpentinite and similar weak rocks absorb moisture when subjected to a simulated weathering process. Moisture absorption may cause disaggregation in the form of powdering, spalling, flaking of the sample surface, or separations along bedding planes.

A summary of the results from the Slake Durability Tests performed is presented in Table B-12. Laboratory data reports and before and after test photographs are presented in Attachment B-12 of the accompanying CD.

1.14 Thin-Section Petrographic Analyses

Thin-Section Petrographic Analyses were performed on four rock samples to provide insight into the microscopic properties of the different rock types that may significantly impact its boreability behavior. Such features include grain suturing/interlocking, certain alignment/ orientation of hard minerals, tight matrix, micro fractures, etc.

A summary of the results from the Thin-Section Petrographic Analyses performed is presented in Table B-13. The report prepared by the laboratory, and thin-section photographs are included in Attachment B-13 of the accompanying CD.

TABLES

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	22	15	7	-0.67	135.6	
BTNB-R3	11.6	74.7	Sandy Clay	18.9	130.0	41	17	24	0.08	109.4	
BTNB-R3	18.3	68.0	Colma Sand	18.2							
BTNB-R3	31.7	54.6	Colma Sand	23.1	125.6					102.1	12.6
BTNB-R4-PZ	8.3	62.2	Sandy Clay	13.7	130.7	32	16	16	-0.14	114.9	81.1
BTNB-R4-PZ	13.4	57.1	Sandy Silt	14.1	136.8					119.8	54.4
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.5	131.9					110.4	14.3
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.4	129.0					108.0	
BTNB-R4-PZ	23.5	47.0	Colma Sand	18.8	127.8					107.6	
BTNB-R4-PZ	33.1	37.4	Colma Sand	20.1	132.9					110.7	9.5
BTNB-R4-PZ	48.1	22.4	Colma Sand	21.2	134.2					110.8	14.2
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	Non-Plastic	Non-Plastic	Non-Plastic		119.7	
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.2							
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.0							
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	Non-Plastic	Non-Plastic	Non-Plastic		118.6	
BTNB-R4-PZ	96.5	-26.1	Serpentinite		142.4						
BTNB-R5A-PZ-S	25.1	54.3	Sandstone		167.5						
BTNB-R5A-PZ-S	25.1	54.3	Sandstone								
BTNB-R5A-PZ-S	25.5	53.9	Sandstone		165.6						
BTNB-R5-PZ-D	54.5	25.1	Mélange Matrix	9.3	158.6	27	16	11	-0.61	145.1	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTNB-R5-PZ-D	88.4	-8.7	Sandstone		163.8						
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8					73.1	31.8
BTNB-R6-PZ-D	8.2	75.4	Fill	14.7	124.3					108.3	9.5
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	34	17	17	0.21	107.3	
BTNB-R6-PZ-D	18.3	65.3	Sandy Silt	18.0	134.0					113.5	59.1
BTNB-R6-PZ-D	23.6	60.0	Colma Sand	15.7	136.3					117.8	17.9
BTNB-R6-PZ-D	27.6	56.0	Colma Sand	14.9	124.4					108.3	10.9
BTNB-R6-PZ-D	47.7	35.9	Serpentinite		132.1						
BTNB-R6-PZ-D	83.8	-0.2	Serpentinite		151.1						
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	39	33	6	-3.02	122.2	
BTNB-R7A-PZ-S	9.8	69.2	Buried Soil Horizon	20.4		30	15	15	0.36		
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1					107.7	52.5
BTNB-R7A-PZ-S	19.8	59.2	Sandy Clay	23.6		30	14	16	0.60		
BTNB-R7A-PZ-S	23.1	55.9	Colma Sand	19.9	133.6					111.5	17.6
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand	20.9	132.1					109.3	18.2
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	23	15	8	0.23	115.1	
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	30	28	2	-6.60	122.2	
BTSB-R1-PZ	13.3	87.8	Fill	15.0	121.7					105.8	3.3
BTSB-R1-PZ	22.8	78.3	Fill	26.4	127.0					100.5	2.1
BTSB-R1-PZ	22.8	78.3	Fill	25.3	126.2					100.7	
BTSB-R1-PZ	22.8	78.3	Fill	30.8	125.4					95.9	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTSB-R1-PZ	27.5	73.5	Sandy Clay	22.0	129.9					106.5	
BTSB-R1-PZ	28.8	72.3	Sandy Clay	22.8	123.5					100.6	
BTSB-R1-PZ	28.8	72.3	Sandy Clay			37	16	21			
BTSB-R1-PZ	28.8	72.3	Sandy Clay			39	18	21			
BTSB-R1-PZ	36.3	64.8	Sandstone		164.6						
BTSB-R1-PZ	36.6	64.4	Sandstone		165.3						
BTSB-R1-PZ	45.2	55.9	Sandstone, Shale		166.4						
BTSB-R2	3.3	88.9	Fill	5.3	118.8					112.9	
BTSB-R2	12.8	79.3	Sandy Clay	22.5	128.2	38	18	20	0.23	104.6	
BTSB-R2	17.8	74.3	Colma Sand	19.1	135.8					114.0	48.3
BTSB-R2	28.3	63.9	Colma Sand	21.8	130.1					106.8	11.4
BTSB-R2	28.3	63.9	Colma Sand	20.7	129.9					107.6	
BTSB-R2	28.3	63.9	Colma Sand	20.6	130.0					107.8	
BTSB-R2	33.6	58.6	Colma Sand	21.2	128.5					106.0	13.0
BTSB-R2	37.8	54.3	Sandy Clay	20.7	130.4	30	17	13	0.28	108.1	
BTSB-R2	38.3	53.8	Sandy Clay	22.3	127.6	45	21	24	0.05	104.3	
BTSB-R2	42.8	49.3	Sandy Clay	19.4	132.4	40	20	20	-0.03	110.9	
BTSB-R3A-PZ-S	3.1	95.0	Fill	6.7	115.6					108.4	1.8
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.2	109.1					99.9	1.4
BTSB-R3A-PZ-S	9.3	88.8	Fill	10.4	112.9					102.3	
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.3	109.7					100.4	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTSB-R3A-PZ-S	12.8	85.2	Buried Soil Horizon	18.6	131.8	23	16	7	0.37	111.2	
BTSB-R3A-PZ-S	17.8	80.2	Sandstone	10.5	142.2					128.7	33.1
BTSB-R3-PZ-D	24.8	73.1	Sandstone								
BTSB-R3-PZ-D	25.1	72.8	Sandstone		158.2						
BTSB-R3-PZ-D	25.5	72.5	Sandstone								
BTSB-R3-PZ-D	30.2	67.7	Sandstone		159.5						
BTSB-R3-PZ-D	44.5	53.5	Sandstone		161.3						
BTSB-R3-PZ-D	44.9	53.1	Sandstone		166.7						
BTSB-R3-PZ-D	50.4	47.5	Sandstone		164.9						
BTSB-R3-PZ-D	81.7	16.3	Sandstone		166.2						
RW5-R1	3.3	89.8	Colma Sand	13.8	134.0					117.7	49.9
RW6-R1-PZ	3.1	105.5	Fill	15.4	124.3					107.7	49.5
RW6-R1-PZ	7.9	100.7	Sandy Clay	15.7		28	15	13	0.05		75.6
RW6-R1-PZ	12.9	95.7	Colma Sand	16.6	128.7					110.4	21.5
RW6-R1-PZ	12.9	95.7	Colma Sand	16.8	127.2					108.9	
RW6-R1-PZ	12.9	95.7	Colma Sand	16.3	129.1					111.0	
RW6-R1-PZ	17.3	91.3	Colma Sand	21.2	131.1					108.2	27.4
RW6-R1-PZ	17.3	91.3	Colma Sand	22.1	131.0					107.3	
RW6-R1-PZ	17.3	91.3	Colma Sand	18.7	134.1					113.0	
RW6-R1-PZ	26.6	81.9	Sandstone								
RW6-R1-PZ	26.9	81.6	Sandstone		152.6						

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
RW6-R1-PZ	45.3	63.2	Sandstone		163.4						
RW6-R1-PZ	49.9	58.7	Sandstone		166.5						
RW6-R2A-PZ-S	3.8	104.6	Fill	4.5	104.2					99.7	4.5
RW6-R2A-PZ-S	8.1	100.3	Fill	24.3	126.3					101.6	2.7
RW6-R2A-PZ-S	8.1	100.3	Fill	21.7	131.2					107.8	
RW6-R2A-PZ-S	8.1	100.3	Fill	18.2	124.7					105.5	
RW6-R2A-PZ-S	18.6	89.8	Colma Sand	13.2	129.6					114.5	16.4
RW6-R2-PZ-D	31.0	77.7	Sandstone		160.5						
RW8-R1-PZ	8.8	81.9	Fill	9.6	109.0					99.5	
RW8-R1-PZ	13.3	77.4	Sandy Clay	22.4	127.3	24	17	7	0.77	104.0	83.4
RW8-R1-PZ	18.8	71.9	Sandy Clay	19.0	131.3	29	19	10	-0.004	110.4	
RW8-R1-PZ	23.1	67.5	Sandy Clay	19.6	126.4	25	13	12	0.55	105.7	60.1
RW8-R1-PZ	24.4	66.2	Colma Sand	18.2	131.0	23	16	7	0.31	110.8	47.2
RW8-R1-PZ	29.8	60.9	Colma Sand	15.3							20.4
RW8-R1-PZ	33.3	57.4	Colma Sand	19.6	130.3					108.9	21.3
RW8-R1-PZ	33.3	57.4	Colma Sand	20.0	130.3					108.6	
RW8-R1-PZ	33.3	57.4	Colma Sand	19.5	133.2					111.5	
RW8-R1-PZ	43.3	47.4	Sandy Clay	23.1	126.9	29	16	13	0.55	103.1	
RW8-R1-PZ	43.8	46.9	Sandy Clay	21.1	124.0	29	18	11	0.28	102.4	
RW8-R1-PZ	76.5	14.1	Serpentinite	7.7							
RW8-R1-PZ	121.9	-31.3	Serpentinite		150.5						

TABLE B-2
SUMMARY OF THE RESULTS OF INCREMENTAL LOADING (IL) CONSOLIDATION TESTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Initial Moisture Content, w_i (%)	Initial Total Unit Weight, γ_t (pcf)	In-Situ Effective Vertical Stress, σ'_{vo} (psf)	Maximum Past Pressure, σ'_p (psf)	Over Consolidation Ratio, OCR	Compression Ratio, CR	Recompression Ratio, RR	Swelling Ratio, SR
BTSB-R1-PZ	28.75	72.3	Sandy Clay	22.8	123.5	1,850	7,500	4.1	0.124	0.006	0.017
RW8-R1-PZ	23.125	67.5	Sandy Clay	19.8	124.5	2,850	13,500	4.7	0.126	0.008	0.008
RW8-R1-PZ	43.75	46.9	Sandy Clay	21.1	124.0	5,580	4,400	0.8	0.094	0.007	0.007

TABLE B-3
SUMMARY OF DIRECT SHEAR TEST RESULTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Normal Consolidation Stress, σ'_{vc} (psf)	Peak Shear Stress, τ_{max} (psf)	Residual Shear Stress, τ_{res} (psf)	Peak Strength	
									Peak Friction Angle, ϕ' (degrees)	Cohesion Intercept, c' (psf)
BTSB-R1-PZ	22.8	78.3	Buried Soil Horizon (SP)	26.4	127.0	2,650	2,208	1,680	38	0
				25.3	126.2	3,300	2,508	1,932		
				30.8	125.4	4,000	3,012	2,304		
BTNB-R4-PZ	23.5	47.0	Colma Sand (SP-SM)	19.5	131.9	2,700	2,640	1,788	45	0
				19.4	129.0	3,300	3,336	2,220		
				18.8	127.8	4,000	4,020	2,628		
BTSB-R2	28.3	63.9	Colma Sand (SP-SM)	21.8	130.1	3,200	3,120	2,064	43	0
				20.7	129.9	4,000	3,744	2,532		
				20.6	130.0	4,800	4,404	3,156		
RW6-R1-PZ	12.9	95.7	Colma Sand (SP-SM)	16.6	128.7	1,000	1,236	852	50	0
				16.8	127.2	1,200	1,320	912		
				16.3	129.1	1,400	1,764	1,116		
RW6-R1-PZ	17.3	91.3	Colma Sand (SP-SM)	21.2	131.1	2,000	1,884	1,464	41	0
				22.1	131.0	2,500	2,100	1,668		
				18.7	134.1	3,000	2,652	1,980		
BTSB-R3A-PZ-S	9.3	88.8	Fill (SP)	9.2	109.1	1,000	936	804	42	0
				10.4	112.9	1,300	1,044	864		
				9.3	109.7	1,600	1,500	1,176		
RW6-R2A-PZ-S	8.1	100.3	Fill (SP)	24.3	126.3	1,000	972	780	42	0
				21.7	131.2	1,200	1,092	888		
				18.2	124.7	1,400	1,200	996		
RW8-R1-PZ	33.3	57.4	Colma Sand (SC)	19.6	130.3	4,150	3,852	2,856	31	1,350
				20.0	130.3	5,200	4,476	3,192		
				19.5	133.2	6,225	5,124	4,116		

TABLE B-4

SUMMARY OF ORGANIC CONTENT TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Organic Content (%)	Remarks
RW8-R1-PZ	13.3	77.4	Buried Soil Horizon	22.4	3.5	

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TABLE B-5

SUMMARY OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Unit	Water Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Effective Vertical Stress, $\sigma'_{v,o}$ (ksf)	Total Confining Stress, σ_c (ksf)	Deviator Stress, σ_1-σ_3 (ksf)	Undrained Shear Strength, s_u (ksf)	$s_u/\sigma'_{v,o}$	Axial Strain at Failure, σ_f (%)	Undrained Young's Modulus at 50% Strain, $E_{u,50}$ (ksf)	$E_{u,50}/s_u$	Material Description (From Lab Records)	Remarks
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	4.8	9.5	1.9	0.935	0.19	8.1	125	133	Very dark gray silty clayey gravel	
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	6.0	10.5	1.5	0.729	0.12	19.6	178	245	Bluish gray clayey sand	
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	8.2	16.0	1.7	0.832	0.10	20.0	1157	1390	Bluish gray clayey sand	
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8	3.5	4.9	3.0	1.487	0.42	1.9	218	147	Olive brown clayey sand	
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	1.6	2.3	4.9	2.442	1.56	9.4	86	35	Brown clay	
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	8.6	17.0	1.8	0.875	0.10	1.8	2097	2397	Dark bluish gray silt	
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1	2.2	3.1	2.5	1.240	0.56	10.3	50	40	Reddish brown sandy clay	
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	1.6	2.3	3.5	1.740	1.10	9.6	58	33	Brown sandy clay	
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	8.1	16.0	1.1	0.570	0.07	1.0	1615	2836	Bluish gray gravelly silt	
BTSB-R1-PZ	27.5	73.5	Sandy Clay	22.0	129.9	2.6	5.2	3.0	1.480	0.57	4.0	81	55	Olive brown clay with sand	
BTSB-R2	12.8	79.3	Sandy Clay	22.5	128.2	1.6	2.3	3.7	1.854	1.18	15.1	74	40	Reddish brown clay	
BTSB-R2	17.8	74.3	Colma Sand	19.1	135.8	2.2	3.1	3.7	1.854	0.84	10.9	44	24	Reddish brown clayey sand	
BTSB-R2	37.8	54.3	Sandy Clay	20.7	130.4	4.8	6.6	4.6	2.296	0.48	13.9	105	46	Reddish brown clay	
BTSB-R2	38.3	53.8	Sandy Clay	22.3	127.6	4.8	6.6	7.4	3.675	0.76	20.0	288	78	Yellowish brown clay	
BTSB-R2	42.8	49.3	Sandy Clay	19.4	132.4	5.3	7.4	12.5	6.274	1.19	9.6	269	43	Yellowish brown clay	
BTSB-R3A-PZ-S	12.8	85.2	Buried Soil Horizon	18.6	131.8	1.6	2.3	1.5	0.775	0.50	12.8	24	30	Dark brown sandy clay	
BTSB-R3A-PZ-S	17.8	80.2	Sandstone	10.5	142.2	2.2	3.1	5.1	2.561	1.16	2.3	220	86	Yellowish brown clayey sand	
RW8-R1-PZ	22.5	68.1	Sandy Clay	19.6	126.4	2.9	4.2	2.9	1.457	0.51	6.6	45	31	Brown sandy clay	
RW8-R1-PZ	43.3	47.4	Sandy Clay	23.1	126.9	5.5	8.2	2.6	1.282	0.24	15.3	51	40	Brown clay with gravel	

TABLE B-6
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TESTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Effective Confining Stress, σ'_c (psf)	Parameters at 10% Strain			Parameters at Max Obliquity			
							p' (psf)	q' (psf)	ϕ' [1] (degrees)	ε_a (%)	p' (psf)	q' (psf)	ϕ' [1] (degrees)
BTNB-R6-PZ-D	27.6	56.0	Colma Sand (SP-SC)	14.9	124.4	4,650	39,641	24,973	39.0	5.4	33,703	21,382	39.4
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand (SP)	20.9	132.1	5,800	10,460	6,492	38.4	5.4	6,033	3,732	38.2
BTSB-R2	33.6	58.6	Colma Sand (SP-SC)	21.2	128.5	5,700	6,268	3,562	34.6	11.1	6,343	3,596	34.5
RW8-R1-PZ	24.4	66.2	Colma Sand (SC-SM)	18.2	131.0	4,650	6,271	3,562	34.6	4.6	5,181	2,991	35.3
								Average	**36.7**			**Average**	**36.8**

[1] ϕ' calculated assuming c = 0

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TABLE B-7
SUMMARY OF THE RESULTS OF UNIAXIAL COMPRESSION TESTS ON ROCK

Borehole ID	Depth (ft)	Elevation (NAVD88) (ft)	Rock Type	Diameter, D (in)	Length, L (in)	L/D	Mass (g)	Wet Density (pcf)	Failure Load (lb)	Failure Type		Compressive Strength (psi)	Young's Modulus (psi)	Poisson's Ratio
BTNB-R4-PZ	96.5	-26.1	Serpentinite	2.401	5.036	2.1	852.00	142.4	5,800	F/S		1,280	7.20E+05	0.171
BTNB-R5-PZ-D	88.4	-8.7	Sandstone	2.389	5.011	2.1	965.60	163.8	39,500	F		8,810	1.33E+06	0.089
BTNB-R5A-PZ-S	25.5	53.9	Sandstone	2.405	5.193	2.2	1025.70	165.6	44,500	F		9,800	4.92E+06	0.108
BTNB-R6-PZ-D	83.8	-0.2	Gabbro	2.398	5.326	2.2	954.10	151.1	16,500	F/S		3,650	1.10E+06	0.177
BTNB-R6-PZ-D	47.7	35.9	Serpentinite	2.399	5.076	2.1	795.40	132.1	1,800	F		400	1.50E+05	0.095
BTSB-R1-PZ	36.3	64.8	Sandstone	2.400	5.227	2.2	1021.60	164.6	49,050	S/F		10,840	4.23E+06	0.184
BTSB-R1-PZ	45.2	55.9	Sandstone	2.399	5.326	2.2	1051.40	166.4	57,000	F/S		12,610	6.63E+06	0.202
BTSB-R3-PZ-D	25.1	72.8	Sandstone	2.398	4.850	2.0	909.50	158.2	22,000	F		4,870	1.35E+06	0.086
BTSB-R3-PZ-D	30.2	67.7	Sandstone	2.401	3.880	1.6	735.50	159.5	15,600	F	*	3,350	1.78E+06	0.197
BTSB-R3-PZ-D	44.5	53.5	Sandstone	2.395	5.437	2.3	1037.00	161.3	42,500	F		9,430	4.96E+06	0.109
BTSB-R3-PZ-D	50.4	47.5	Sandstone	2.408	5.220	2.2	1029.00	164.9	76,500	S/F		16,800	5.45E+06	0.136
BTSB-R3-PZ-D	81.7	16.3	Sandstone	2.410	5.053	2.1	1005.70	166.2	16,000	F		3,510	3.30E+06	0.193
RW6-R1-PZ	26.9	81.6	Sandstone	2.403	5.816	2.4	1056.60	152.6	14,000	F/S		3,090	4.60E+05	0.131
RW6-R1-PZ	45.3	63.2	Sandstone	2.394	5.891	2.5	751.40	163.4	67,000	S/F	*	14,480	4.17E+06	0.114
RW6-R2-PZ-D	31.0	77.7	Sandstone	2.396	5.330	2.2	1012.50	160.5	17,000	F		3,770	1.25E+06	0.121
RW8-R1-PZ	121.9	-31.3	Serpentinite	2.398	5.219	2.2	931.10	150.5	8,000	F		1,770	7.60E+05	0.200

Failure Types - S: Shear Failure, M: Matrix Failure, F: Failure through Fracture/Bedding, V: Void Collapse, C: Combination

* Strength values were corrected to account for short sample (L/D < 2.0)

** Not Testable, short sample L/D < 1.5

*** Due to pre-existing conditions of the sample, meaningful measurements for the calculation of Young's modulus and Poisson's ratio were not possible

TABLE B-8
SUMMARY OF DIAMETRAL POINT LOADS INDEX TESTS

Borehole ID	Test No.	Test Depth (ft)	Test Elevation, (NAVD88) (ft)	Rock Type	Test Type	D_c (mm)	D' (mm)	Max. Pressure (bars)	Max. Pressure (psi)	Load, P (lbf)	D_e (mm)	$(D_e)^2$ (in2)	I_s (psi)	I_s (tsf)	F	$I_{s(50)}$ (psi)	$I_{s(50)}$ (tsf)	σ_a (psi)	Average σ_a from Valid Tests (psi)	Remarks
BTNB-R5-PZ-D		10.95	68.7	Sandstone	Diametral	71.0	67.5	72.4	1,050	1,574	69.2	7.43	211.9	15.3	1.158	245.3	17.7	6,010	6,010	
BTNB-R5-PZ-D		29.85	49.8	Sandstone	Diametral	71.0	67.0	168.2	2,440	3,657	69.0	7.37	496.0	35.7	1.156	573.2	41.3	14,044	14,044	
BTNB-R5-PZ-D		32.55	47.1	Sandstone	Diametral	71.0	67.0	110.8	1,607	2,409	69.0	7.37	326.7	23.5	1.156	377.6	27.2	9,251	-	Invalid test-- broke through pre-existing fracture
BTNB-R5-PZ-D		87.53	-7.9	Sandstone	Diametral	71.0	60.0	88.4	1,282	1,922	65.3	6.60	291.1	21.0	1.127	328.2	23.6	8,040	8,040	
BTNB-R5A-PZ-S		4.56	74.8	Sandstone	Diametral	71.0	68.5	114.8	1,665	2,496	69.7	7.54	331.1	23.8	1.162	384.6	27.7	9,422	9,422	
BTNB-R5A-PZ-S		12.71	66.7	Sandstone	Diametral	71.0	66.0	152.2	2,208	3,309	68.5	7.26	455.6	32.8	1.152	524.8	37.8	12,857	12,857	
BTNB-R5A-PZ-S		22.65	56.7	Sandstone	Diametral	71.0	67.0	146.6	2,126	3,187	69.0	7.37	432.3	31.1	1.156	499.6	36.0	12,240	12,240	
BTNB-R5-PZ-D		88.00	-8.4	Sandstone	Axial	61.0	44.2	33.3	484	725	51.9	4.18	173.5	12.5	1.017	176.5	12.7	4,323	-	*Test performed axially*
BTNB-R6-PZ-D		68.73	14.9	Sandstone	Diametral	71.0	71.0	55.6	806	1,209	71.0	7.81	154.7	11.1	1.171	181.2	13.0	4,438	-	Invalid test-- broke through pre-existing fracture
BTSB-R1-PZ		35.43	65.6	Sandstone	Diametral	71.0	64.0	202.6	2,939	4,405	67.4	7.04	625.4	45.0	1.144	715.4	51.5	17,527	17,527	
BTSB-R1-PZ		38.80	62.2	Sandstone	Diametral	71.0	59.0	230.6	3,345	5,014	64.7	6.49	772.2	55.6	1.123	867.3	62.4	21,248	21,248	
BTSB-R1-PZ		45.98	55.1	Sandstone	Diametral	71.0	54.0	230.6	3,345	5,014	61.9	5.94	843.7	60.7	1.101	928.9	66.9	22,757	22,757	
BTSB-R3-PZ-D		25.78	72.1	Sandstone	Diametral	71.0	49.0	109.0	1,581	2,370	59.0	5.39	439.5	31.6	1.077	473.4	34.1	11,598	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		32.38	65.5	Sandstone	Diametral	71.0	66.0	20.2	293	439	68.5	7.26	60.5	4.4	1.152	69.6	5.0	1,706	1,706	
BTSB-R3-PZ-D		37.37	60.5	Sandstone	Diametral	70.5	60.0	85.4	1,239	1,857	65.0	6.56	283.2	20.4	1.126	318.8	23.0	7,810	7,810	
BTSB-R3-PZ-D		49.70	48.2	Sandstone	Diametral	71.0	59.5	194.8	2,825	4,235	65.0	6.55	646.8	46.6	1.125	727.8	52.4	17,832	17,832	
BTSB-R3-PZ-D		53.35	44.6	Sandstone	Diametral	71.0	56.0	231.8	3,362	5,040	63.1	6.16	817.8	58.9	1.110	907.7	65.4	22,240	22,240	
BTSB-R3-PZ-D		55.55	42.4	Sandstone	Diametral	71.0	63.0	261.2	3,788	5,679	66.9	6.93	819.1	59.0	1.140	933.6	67.2	22,874	22,874	
BTSB-R3-PZ-D		57.78	40.1	Sandstone	Diametral	71.0	64.0	287.8	4,174	6,257	67.4	7.04	888.4	64.0	1.144	1016.2	73.2	24,898	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		59.93	38.0	Sandstone	Diametral	71.0	64.0	190.8	2,767	4,148	67.4	7.04	589.0	42.4	1.144	673.7	48.5	16,506	16,506	
BTSB-R3-PZ-D		62.43	35.5	Sandstone	Diametral	71.0	64.5	145.2	2,106	3,157	67.7	7.10	444.7	32.0	1.146	509.6	36.7	12,486	12,486	
BTSB-R3-PZ-D		64.75	33.2	Sandstone	Diametral	71.0	68.5	33.2	482	722	69.7	7.54	95.8	6.9	1.162	111.2	8.0	2,725	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		67.41	30.5	Sandstone	Diametral	70.5	62.0	258.6	3,751	5,622	66.1	6.78	829.9	59.8	1.134	941.0	67.8	23,055	23,055	
BTSB-R3-PZ-D		91.80	6.1	Sandstone	Diametral	70.0	68.0	1.6	23	35	69.0	7.38	4.7	0.3	1.156	5.4	0.4	134	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		98.85	-0.9	Sandstone	Diametral	71.0	69.0	5.4	78	117	70.0	7.59	15.5	1.1	1.163	18.0	1.3	441	-	Invalid test-- broke through pre-existing fracture
RW5-R1		10.20	82.9	Sandstone	Diametral	71.0	65.0	31.8	461	691	67.9	7.15	96.7	7.0	1.148	110.9	8.0	2,718	2,718	
RW5-R1		15.50	77.6	Sandstone	Diametral	71.0	67.0	79.8	1,157	1,735	69.0	7.37	235.3	16.9	1.156	272.0	19.6	6,663	6,663	
RW5-R1		27.18	65.9	Sandstone	Diametral	71.0	68.0	44.0	638	957	69.5	7.48	127.8	9.2	1.160	148.2	10.7	3,632	-	Invalid test-- broke through pre-existing fracture
RW6-R1-PZ		34.48	74.0	Sandstone	Diametral	70.0	64.0	87.0	1,262	1,892	66.9	6.94	272.4	19.6	1.140	310.6	22.4	7,610	7,610	

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TABLE B-8
SUMMARY OF DIAMETRAL POINT LOADS INDEX TESTS

Borehole ID	Test No.	Test Depth (ft)	Test Elevation, (NAVD88) (ft)	Rock Type	Test Type	D_c (mm)	D' (mm)	Max. Pressure (bars)	Max. Pressure (psi)	Load, P (lbf)	D_e (mm)	$(D_e)^2$ (in2)	I_s (psi)	I_s (tsf)	F	$I_{s(50)}$ (psi)	$I_{s(50)}$ (tsf)	σ_a (psi)	Average σ_a from Valid Tests (psi)	Remarks
RW6-R1-PZ		37.21	71.3	Sandstone	Diametral	70.5	64.0	95.0	1,378	2,065	67.2	6.99	295.3	21.3	1.142	337.3	24.3	8,264	8,264	
RW6-R1-PZ		40.13	68.4	Sandstone	Diametral	70.0	60.0	250.0	3,626	5,435	64.8	6.51	834.9	60.1	1.124	938.3	67.6	22,988	22,988	
RW6-R1-PZ		49.68	58.8	Sandstone	Diametral	60.2	60.2	194.7	2,824	4,233	60.2	5.62	753.6	54.3	1.087	819.2	59.0	20,071	20,071	
RW6-R1-PZ		53.03	55.5	Sandstone	Diametral	70.0	64.0	74.0	1,073	1,609	66.9	6.94	231.7	16.7	1.140	264.2	19.0	6,473	-	Invalid test-- broke through pre-existing fracture
RW6-R1-PZ		61.03	47.5	Sandstone	Diametral	71.0	65.0	202.0	2,930	4,392	67.9	7.15	614.0	44.2	1.148	704.8	50.7	17,267	-	Invalid test-- broke through pre-existing fracture
RW6-R2-PZ-D		30.15	78.5	Sandstone	Diametral	71.0	70.5	33.6	487	731	70.7	7.76	94.2	6.8	1.169	110.1	7.9	2,697	2,697	
RW6-R2-PZ-D		32.05	76.6	Sandstone	Diametral	71.0	67.0	101.4	1,471	2,205	69.0	7.37	299.0	21.5	1.156	345.6	24.9	8,466	8,466	
RW6-R2-PZ-D		37.50	71.2	Sandstone	Diametral	71.0	67.5	71.6	1,038	1,557	69.2	7.43	209.6	15.1	1.158	242.6	17.5	5,944	5,944	
RW6-R2-PZ-D		72.50	36.2	Sandstone	Diametral	71.0	54.0	157.2	2,280	3,418	61.9	5.94	575.1	41.4	1.101	633.2	45.6	15,513	-	Invalid test-- broke through pre-existing fracture
RW6-R2-PZ-D		79.43	29.2	Sandstone	Diametral	71.0	68.5	53.6	777	1,165	69.7	7.54	154.6	11.1	1.162	179.6	12.9	4,399	4,399	
RW6-R2-PZ-D		82.33	26.3	Sandstone	Diametral	71.0	68.0	94.8	1,375	2,061	69.5	7.48	275.4	19.8	1.160	319.4	23.0	7,825	7,825	
RW6-R2-PZ-D		99.15	9.5	Sandstone	Diametral	71.0	55.5	232.8	3,377	5,061	62.8	6.11	828.7	59.7	1.108	918.0	66.1	22,491	22,491	
RW8-R1-PZ		54.70	35.9	Sandstone	Diametral	70.5	69.0	3.0	44	65	69.7	7.54	8.7	0.6	1.162	10.0	0.7	246	-	Invalid test
RW8-R1-PZ		68.18	22.4	Sandstone	Diametral	70.5	64.0	54.0	783	1,174	67.2	6.99	167.9	12.1	1.142	191.7	13.8	4,697	-	Invalid test-- broke through pre-existing fracture
RW8-R1-PZ		122.25	-31.6	Serpentinite	Diametral	60.1	60.0	8.2	119	178	60.0	5.59	31.8	2.3	1.086	34.6	2.5	847	1,643	
BTNB-R7-PZ-D		73.25	6.1	Greenstone	Diametral	69.0	60.0	42.6	618	926	64.3	6.42	144.3	10.4	1.120	161.7	11.6	3,961	3,961	
BTNB-R7-PZ-D		98.70	-19.3	Serpentinite	Diametral	70.0	66.0	1.4	20	30	68.0	7.16	4.3	0.3	1.148	4.9	0.4	120	1,643	
M-9/RW7-A1A		48.03	-30.1	Gabbro	Diametral	70.5	68.0	114.8	1,665	2,496	69.2	7.43	335.9	24.2	1.158	388.9	28.0	9,528	9,528	

TABLE B-9
SUMMARY OF BRAZILIAN (INDIRECT TENSILE STRENGTH) TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Diameter, D (in)	Length, L (in)	Mass (g)	Wet Density, γ_t (pcf)	Failure Load (lb)	Failure Type	Splitting Tensile Strength (psi)
BTSB-R1-PZ	36.6	64.4	Sandstone	2.385	1.209	234.40	165.3	2,753	S	610
BTSB-R3-PZ-D	44.9	53.1	Sandstone	2.388	1.379	270.30	166.7	4,071	S	790
BTNB-R5A-PZ-S	25.1	54.3	Sandstone	2.389	1.215	239.50	167.5	3,165	S	690
RW6-R1-PZ	49.9	58.7	Sandstone	2.369	1.126	216.90	166.5	4,584	S	1,090

Failure Types - S: Single Failure Plane, M: Multiple Failure Planes

TABLE B-10
SUMMARY OF PUNCH PENETRATION TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Peak Slope (kips/in)
BTSB-R3-PZ-D	25.5	72.5	Sedimentary	61

TABLE B-11
SUMMARY OF CERCHAR ABRASIVITY TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Abrasivity Index
BTSB-R3-PZ-D	24.8	73.1	Sedimentary	1.0
BTNB-R5A-PZ-S	25.1	54.3	Sedimentary	1.2
RW6-R1-PZ	26.6	81.9	Sedimentary	0.4

TABLE B-12
SUMMARY OF SLAKE DURABILITY TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Moisture Content (%)	First Cycle Slake Durability Index, $I_{d(2)}$ (%)	Second Cycle Slake Durability Index, $I_{d(2)}$ (%)	Slake Durability Index, $I_{d(2)}$ (%)	Type
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.20	94.2	91.8	94.2	I
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.03	67.4	64.7	65.2	II
RW8-R1-PZ	76.5	14.1	Serpentinite	7.69	32.6	23.9	61.8	III

TABLE B-13
SUMMARY OF PETROGRAPHIC ANALYSIS (THIN SECTION MICROSCOPY) TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Mineral Composition							
				Quartz	Feldspar (albite)	Chlorite	Muscovite/ Illite	Kaolinite	Clinochrysotile	Lizardite	Hydotalcite
BTSB-R3-PZ-D	44.2	97.9	ss	63%	21%	5%	4%	7%	0%	0%	0%
BTNB-R4-PZ	96.4	70.4	sp	0%	0%	0%	0%	0%	56%	0%	44%
BTNB-R6-PZ-D	84.1	83.6	ga	0%	0%	0%	0%	0%	87%	13%	0%
RW6-R1-PZ	27.3	108.5	ss	63%	30%	5%	2%	0%	0%	0%	0%

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Appendix C

In-Situ Geophysical Tests

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1.2 Acoustic Televiewer 2

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Figure C-2 Shear Wave Velocity Profile: BTSB-R3-PZ-D
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Figure C-4 Shear Wave Velocity Profile: BTNB-R5-PZ-D
Figure C-5 Shear Wave Velocity Profile: BTNB-R7-PZ-D
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Figure C-7 Shear Wave Velocity Profile: RW6-R2-PZ-D
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Figure C-9 Appearance of a Fracture Intersecting a Borehole on a Televiewer Log

1 In-situ Geophysical Tests

This appendix presents the results of in-situ geophysical tests performed as part of the exploration program for the southbound Battery Tunnel of the Doyle Drive Replacement Project. Geophysical tests performed included suspension velocity and acoustic televiewer logging methods.

Suspension velocity testing enables measurements of shear wave and compression wave velocities of soils and rocks. The acoustic televiewer (BHTV) provides a continuous high-resolution image in pseudo-color of the borehole wall that is capable of providing detailed information on the location and orientation of planar features such as fractures and bedding planes.

A summary matrix of the type of geophysical testing performed in the southbound Battery Tunnel boreholes is presented in Table C-1.

1.1 Suspension Velocity Testing

Suspension velocity tests were performed in boreholes drilled as part of the geotechnical investigation program after the drilling and sampling was completed. To begin a test, the suspension velocity testing apparatus is lowered to the bottom of the hole. It is raised in short depth intervals and the is test repeated, until measurements are obtained over the full depth of the borehole providing information on shear and compression wave velocities approximately at 1.5-foot depth intervals. The results of the test are used to develop profiles of the variations of shear wave and compression velocity with depth. The detailed information obtained from the suspension velocity tests allows characterization of the various strata in terms of their stiffness (shear and Young's modulus), but also provides information of the variations of the velocities within each stratum.

The velocity profiles also offer an indirect way of obtaining detailed information regarding stratigraphic changes, by correlating major changes in velocity values to changes in stratigraphy. This is particularly important in cases where soft or weathered, relatively thin rock layers, may be embedded within stronger rock, or where soft soil deposits may be present within stiffer or denser soils. More important however, is that the suspension velocity tests provide information to quantify the variability of the rock conditions not only with depth but also from location to location. One of the difficulties with rock coring is that often recovery may be poor, which means that it is not possible to identify or characterize the rock within the depth interval of low or no recovery. The suspension velocity tests provide information from which the characteristics of the rock in the areas of low or no recovery can be evaluated. The shear wave velocity measurements with the suspension velocity tests provide a basis for estimating the characteristics of the rock and, equally important, to quantify the potential variability of the rock conditions along the tunnel.

The shear wave velocity measurements can be used also to calculate the small strain shear modulus of the soil deposits and rock formation. The small strain shear modulus is an important parameter that is required to evaluate the seismic site response in the event of an earthquake and, in numerical analyses to evaluate stresses and deformations that would develop around the tunnel as excavation progresses.

The suspension velocity measurements were performed by GEOVision Geophysical Services (GEOVision) of Corona, California, between January 9 and April 22, 2008. Prior to the velocity measurements, the boreholes were sampled

and drilled under supervision of an Arup/PB engineer or geologist who maintained records of the field activities, classified the soils and rock types encountered and developed a log for the borehole.

The GEOVision report presented in Attachment C-1 includes results from eight suspension velocity tests were performed in exploratory boreholes drilled for both the southbound and northbound Battery Tunnels.

Figures C-1 through C-8 present the variation of the shear wave velocity measurements with depth for tests performed only in boreholes near the southbound Battery Tunnel. The compression velocity profiles are omitted from these figures because compression velocity measurements may not be meaningful below groundwater.

1.2 Acoustic Televiewer

The principle behind acoustic logging is the use of a transducer to transmit an acoustic wave through the fluid in a borehole to obtain information about the borehole wall. The presence, character and orientation of any structural features in the borehole wall will change the reflectivity of the acoustic wave. By measuring this change in reflectivity, information can be obtained regarding the diameter and shape of the borehole; roughness of the borehole wall that may be caused by the drilling procedures or lithology, difference in rock hardness, structural features such as bedding, fractures, and solution openings. The acoustic logging also permits calculation of orientation of fractures and of bedding planes. BHTV provides a photo like image of the borehole wall.

The test apparatus is mounted at the end of an umbilical cable that is lowed along the center of the borehole. The probe uses a rotary 1.3 MHz piezoelectric transducer that functions both as a transmitter and receiver of either sound or optical waves. The probe is lowered in short increments and rotated at 3 radians per second to make a full revolution to view the entire wall of the borehole. The piezoelectric transducer sends and receives signals at a pulse rate of 800 times per second. The high frequency acoustic energy is reflected from the borehole wall, but does not penetrate the rock. A trigger pulse is transmitted to the recording equipment at the surface from a flux-gate magnetometer each time the transducer rotates past magnetic north. This pulse triggers the sweep on an oscilloscope, where each sweep represents a 360º scan of the borehole wall. The brightness of the oscilloscope trace is proportional to the amplitude of the reflected acoustic signal. The sweeps are moved across the oscilloscope or other type of graphic recorder by a depth related signal derived from the cable measuring sheave. The revealed information appears as a continuous log (image) of the borehole wall versus depth

A camera or graphic recorder, using continuous light-sensitive paper, is used to make a record of the intensity of the sweeps, thus producing a continuous image. Fractures and other openings in the borehole wall appear as dark areas; because the surfaces of fractures and other openings are not at right angles to the incident acoustic signal, therefore, only a small fraction of the transmitted energy is reflected back to the transducer.

A televiewer log can be thought of as a cylinder that has been opened along the north side and flattened as illustrated in Plate C-9. Inclined features such as fractures or bedding planes appear as undulating (often has the shape of a sinusoidal wave) features on the unfolded image of the borehole wall.

The angle of dip or strike of fractures of bedding planes is calculated as follows:

$$\text{Angle of dip} = \arctan\left(\frac{H}{D}\right)$$

Where:

H = the vertical intercept distance on the BHTV log as shown in the schematic above; and

D = the borehole diameter.

The direction of dip usually can be measured to the nearest 5º, using a 360º scale constructed to fit the width of the BHTV log, by measuring the orientation of the lower part of the sinusoid. For the schematic shown in Plate C-6, the direction of the dip is toward magnetic south.

TABLES

TABLE C-1 SUMMARY MATRIX OF IN-SITU GEOPHYSICAL TESTS		
Borehole ID	**Suspension Velocity Logging**	**Acoustic Televiewer (BHTV)**
BTSB-R2	✓	
BTSB-R3-PZ-D	✓	✓
BTNB-R4-PZ	✓	✓
BTNB-R5-PZ-D	✓	✓
BTNB-R7-PZ-D	✓	✓
RW6-R1-PZ	✓	✓
RW6-R2-PZ-D	✓	✓
RW8-R1-PZ	✓	✓

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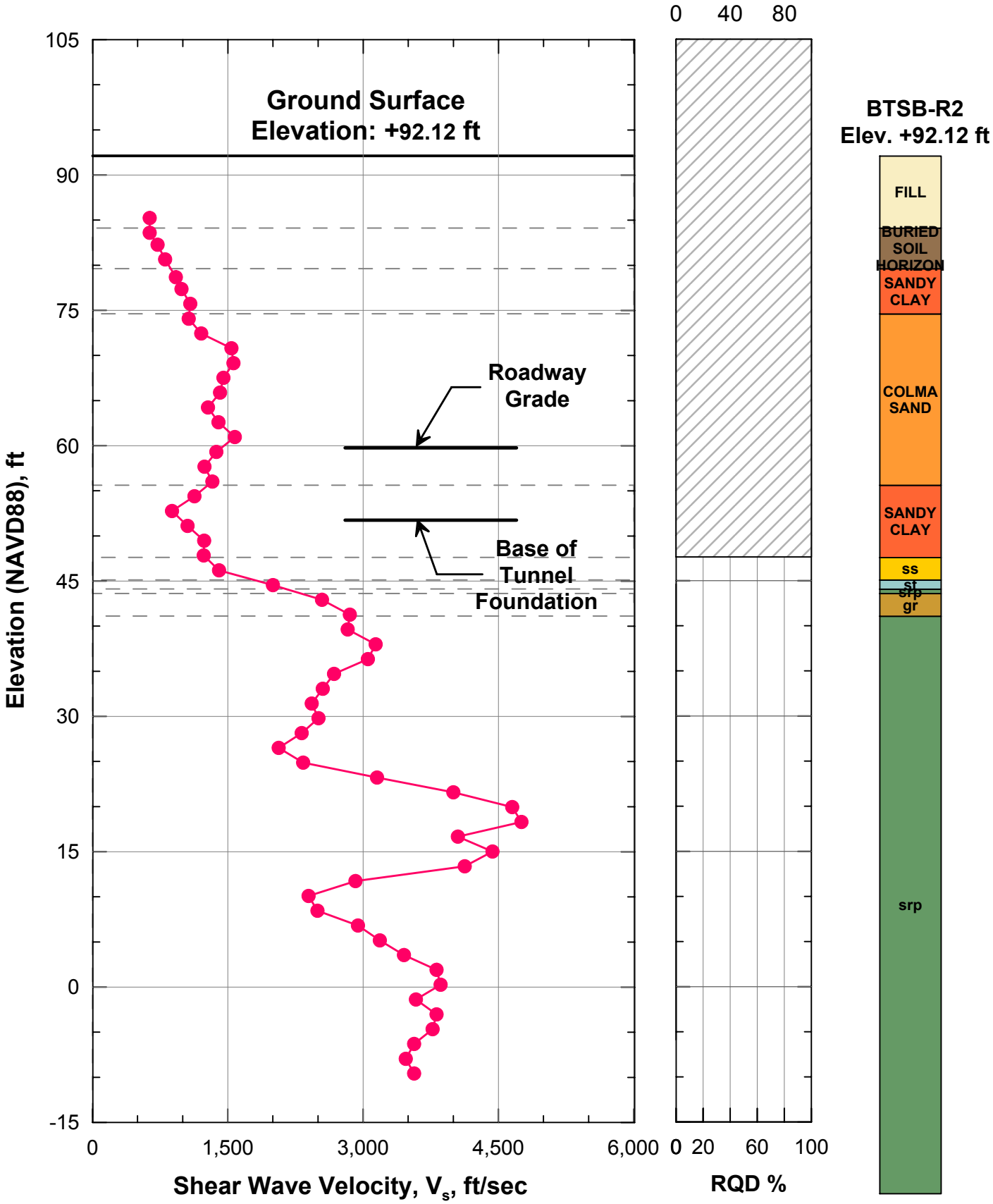
FIGURES



SHEAR WAVE VELOCITY PROFILE: BTSB-R2

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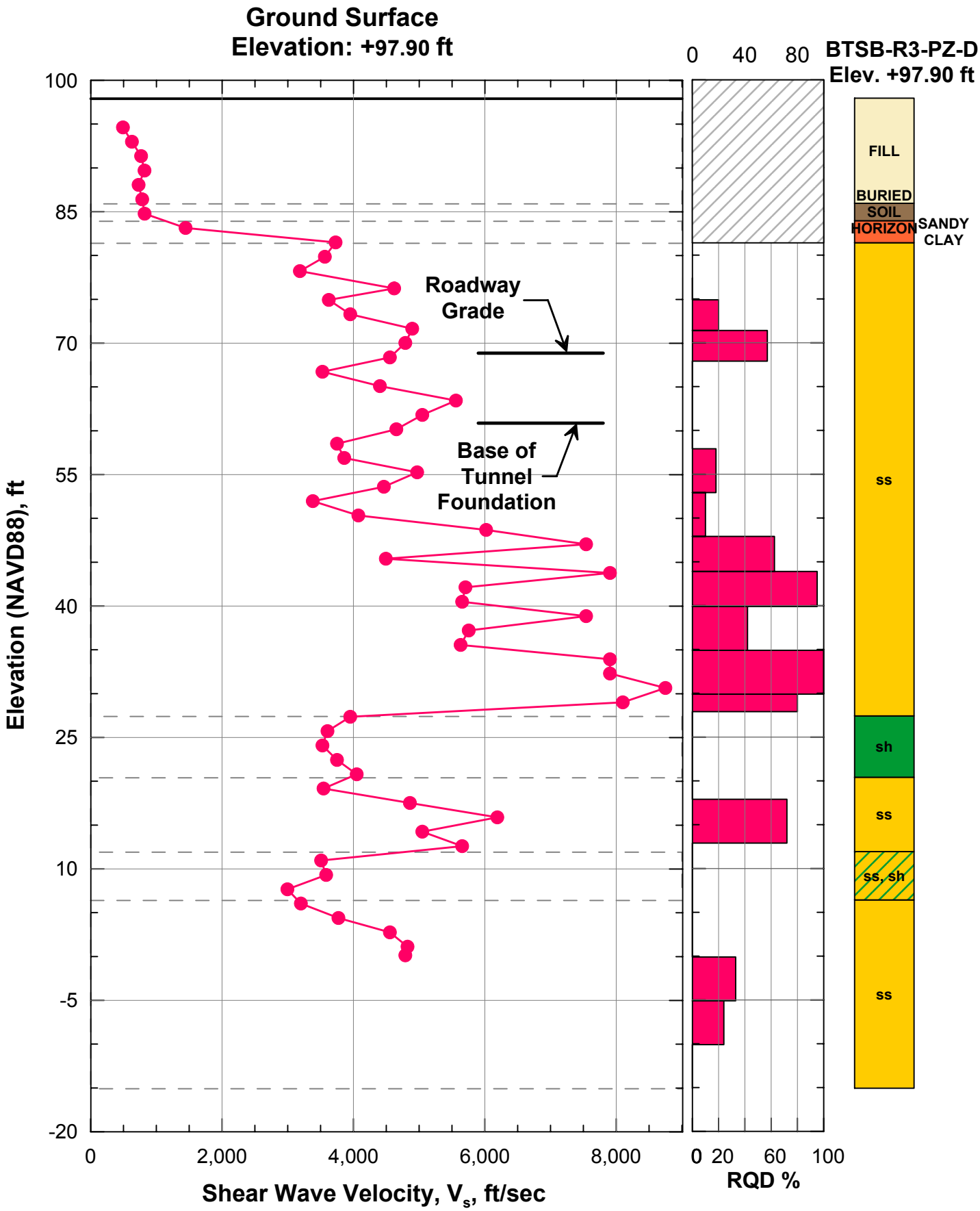
FIGURE C-1



SHEAR WAVE VELOCITY PROFILE: BTSB-R3-PZ-D

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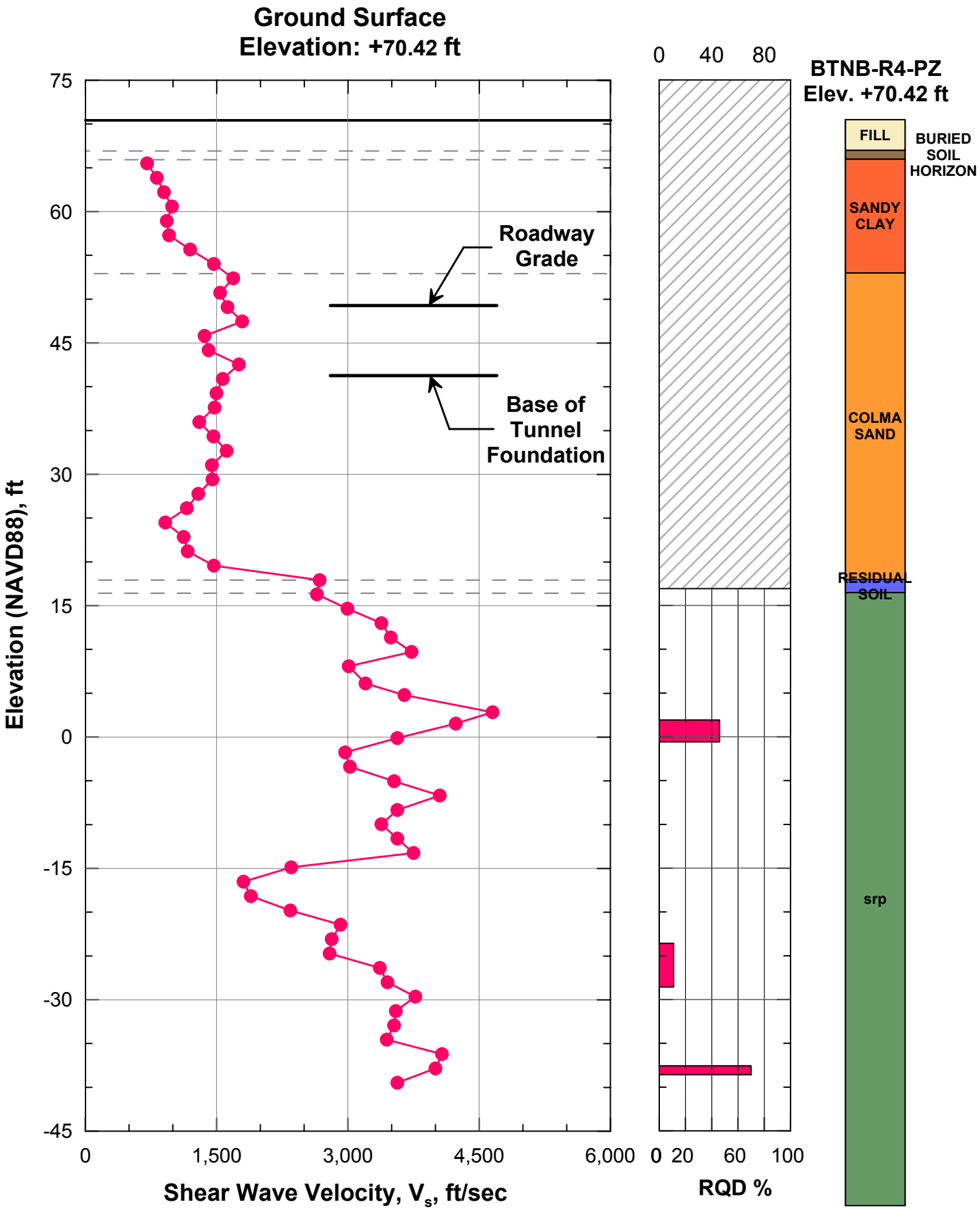
FIGURE C-2



SHEAR WAVE VELOCITY PROFILE: BTNB-R4-PZ

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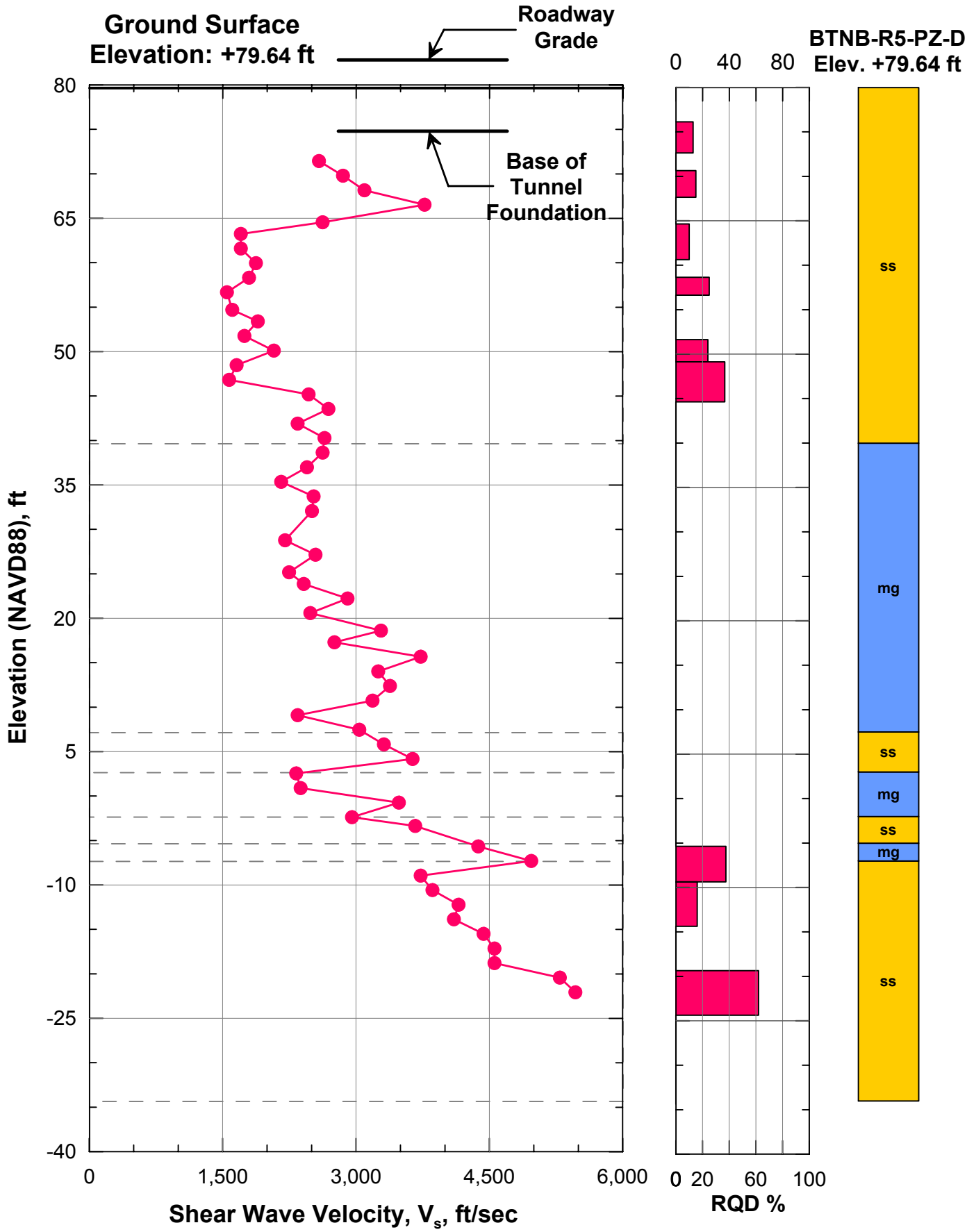
FIGURE C-3



SHEAR WAVE VELOCITY PROFILE: BTNB-R5-PZ-D

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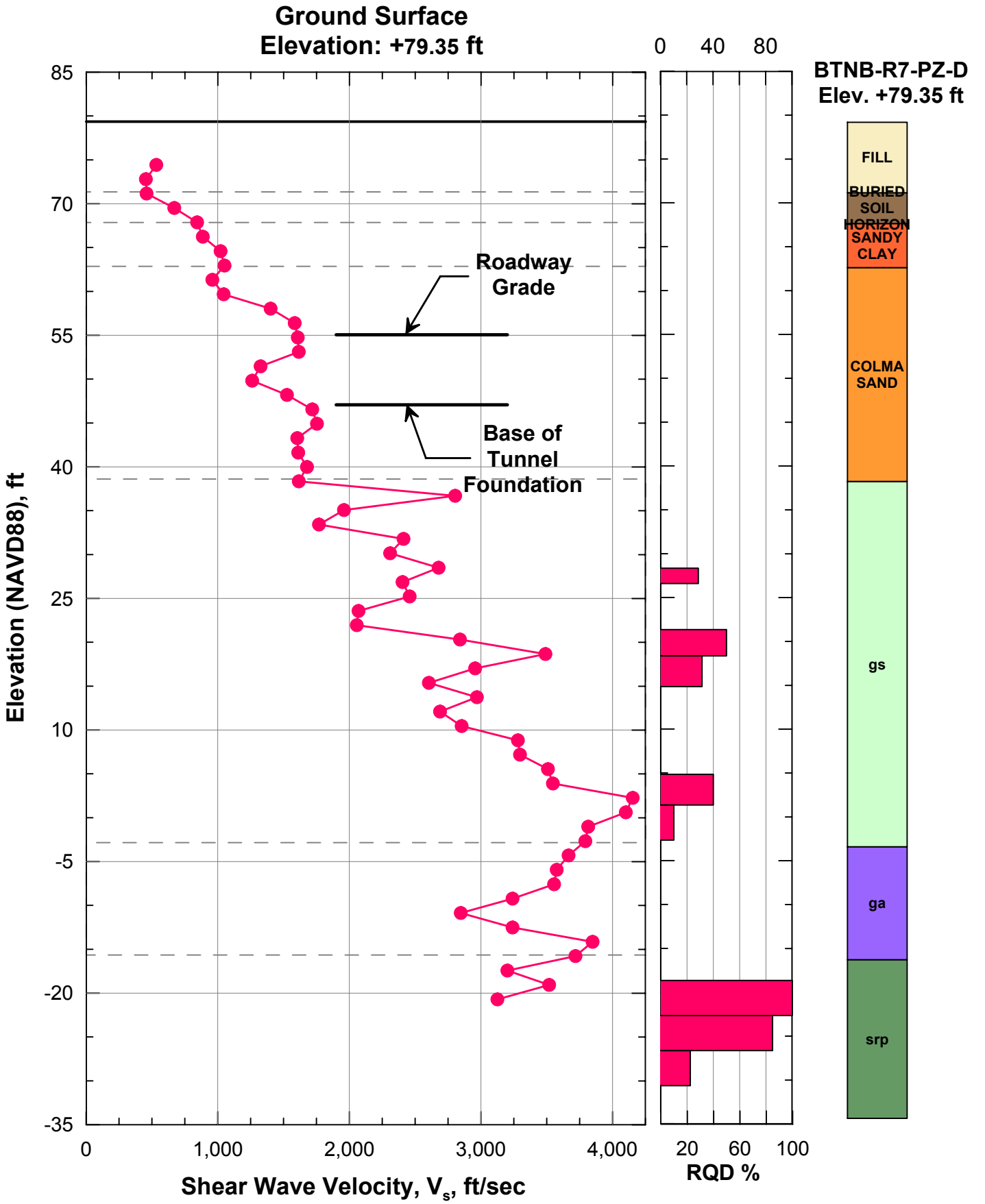
FIGURE C-4



SHEAR WAVE VELOCITY PROFILE: BTNB-R7-PZ-D

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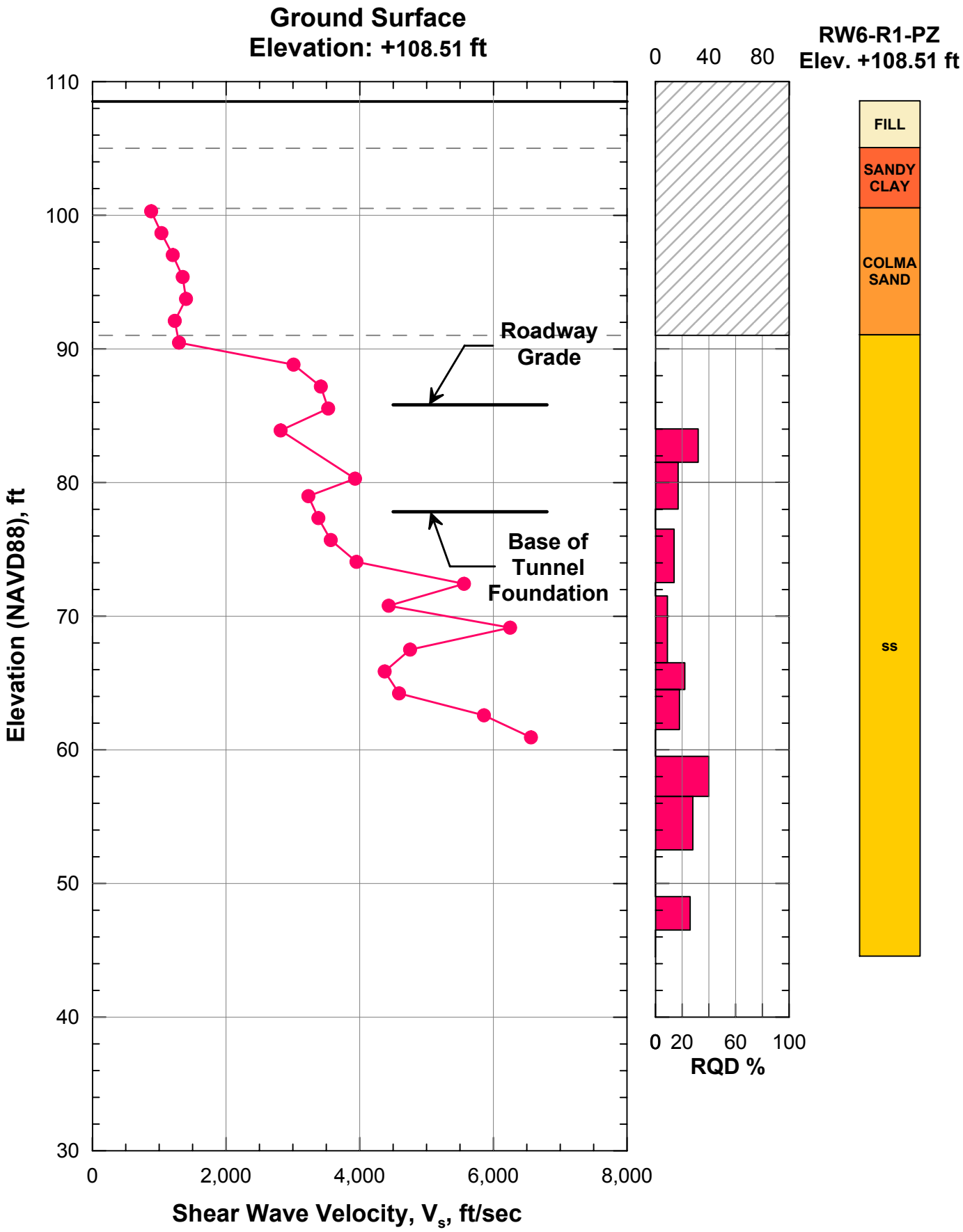
FIGURE C-5



SHEAR WAVE VELOCITY PROFILE: RW6-R1-PZ

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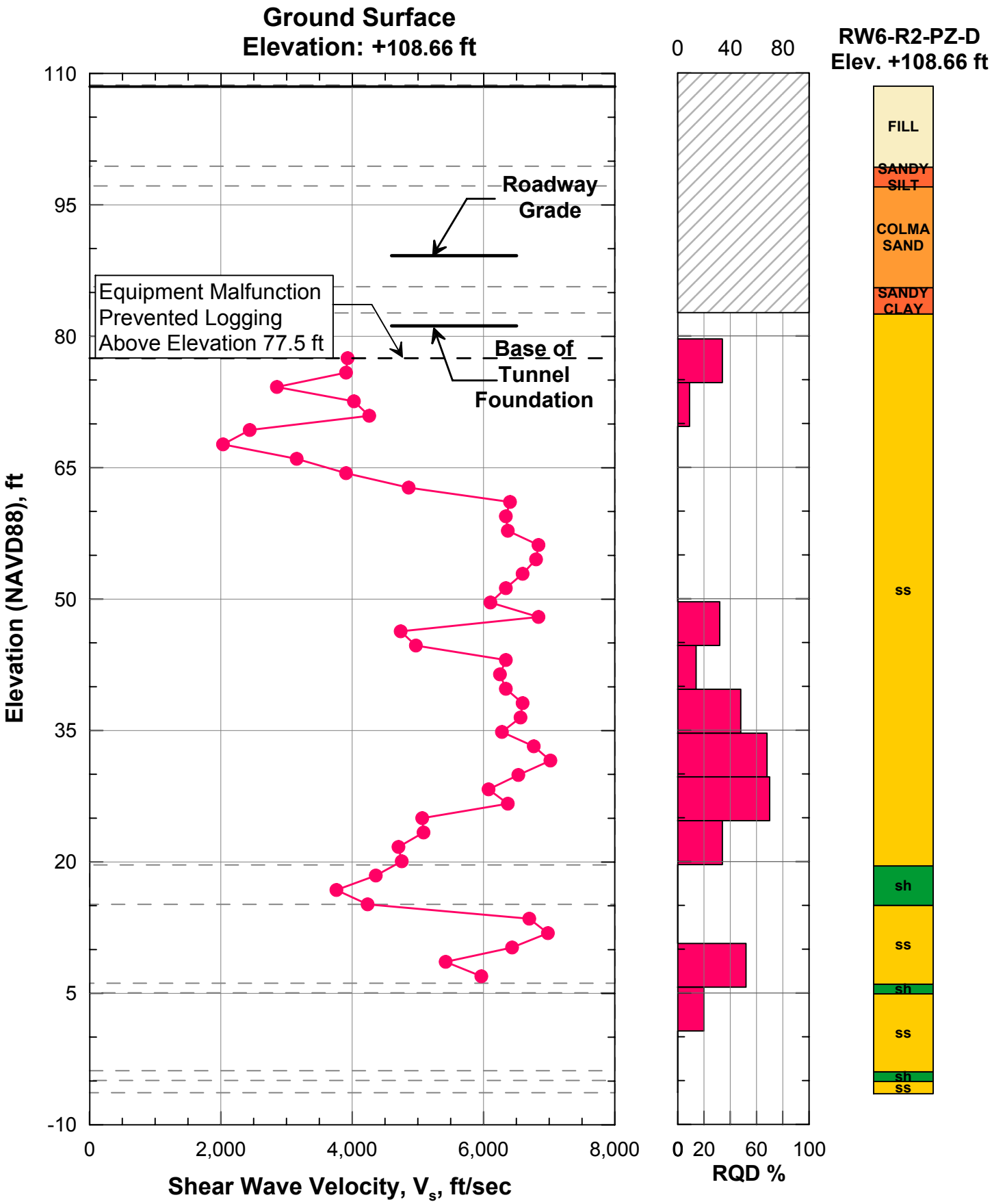
FIGURE C-6



SHEAR WAVE VELOCITY PROFILE: RW6-R2-PZ-D

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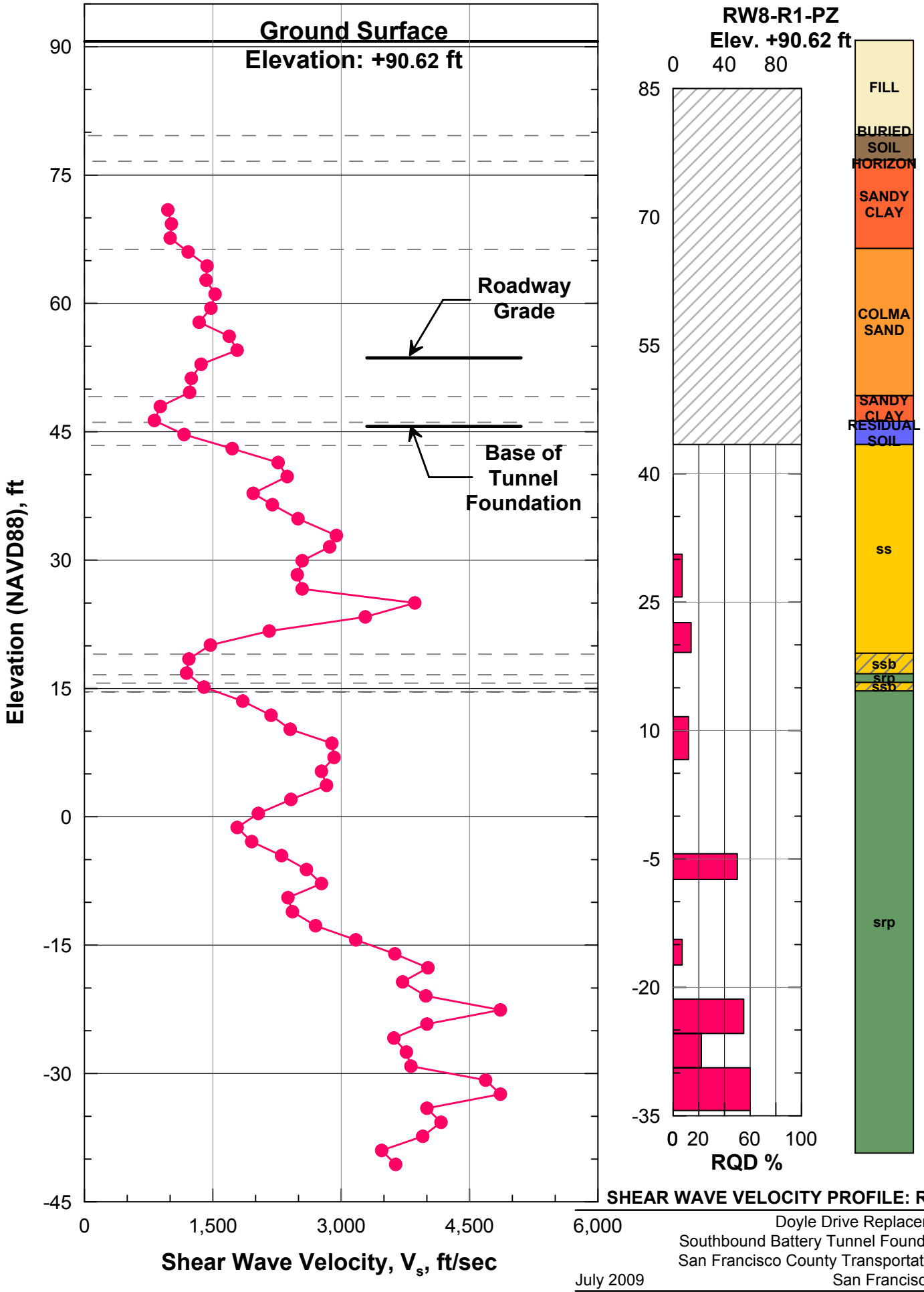
FIGURE C-7



SHEAR WAVE VELOCITY PROFILE: RW8-R1-PZ

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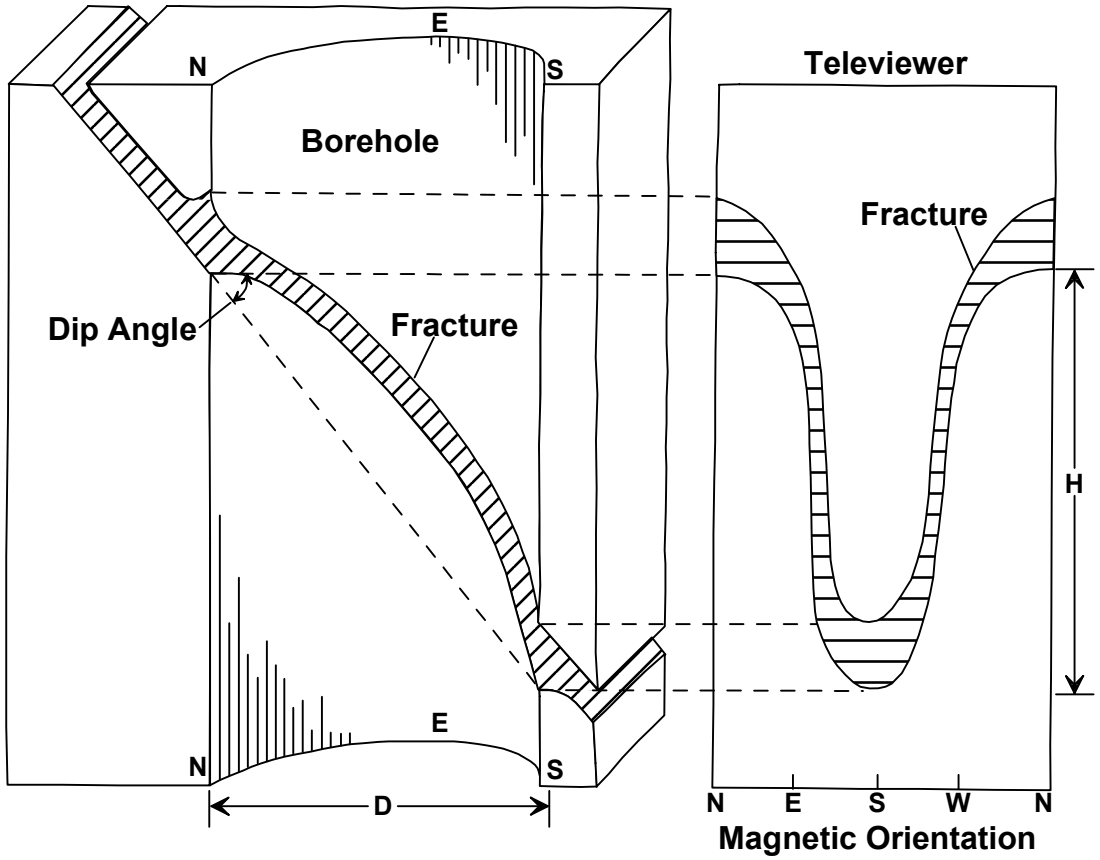
FIGURE C-8



Three-Dimensional View of Fracture Intersecting a Borehole and Appearance of the Same Fracture on an Acoustic Televiewer Log

APPEARANCE OF A FRACTURE INTERSECTING A BOREHOLE ON A TELEVIEWER LOG

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FIGURE C-9

Appendix D

In-Situ Permeability Testing (Packer Tests)

1 Introduction 1

2 Packer Tests Field Procedures 1

3 Calculation of Permeability from Double Packer Tests 2

4 Double Packer Permeability Test Results 3

Figures

Figure D-1 Typical Double Packer Test Setup
Figure D-2 Flow Versus Pressure Curves: Packer Tests at Borehole BTSB-R3-PZ-D
Figure D-3 Flow Versus Pressure Curves: Packer Tests at Borehole BTNB-R4-PZ
Figure D-4 Flow Versus Pressure Curves: Packer Tests at Borehole BTNB-R5-PZ-D
Figure D-5 Flow Versus Pressure Curves: Packer Tests at Borehole BTNB-R7-PZ-D
Figure D-6 Flow Versus Pressure Curves: Packer Tests at Borehole RW6-R1-PZ
Figure D-7 Flow Versus Pressure Curves: Packer Tests at Borehole RW6-R2-PZ-D

1 Introduction

This appendix presents the results of the packer tests performed as part of the exploration program for the southbound Battery Tunnel of the Doyle Drive Replacement Project. The tests were performed using a Double Packer System.

The packer test consists of isolating a section of the rock in a predrilled borehole, pumping water under sustained pressure, and measuring the rate of water flow into the rock formation. The test apparatus consists of a segment of pipe with a packer at each end. The apparatus is lowered down to the designated test depth, the packers are inflated to create a seal, and then water is pumped through the central pipe and allowed to flow through into the sealed section of the borehole into the rock.

The test procedure is illustrated on Figure D-1. Initially, the packer arrangement is lowered down to the lowest zone that is to be tested, and the tests performed. Then the packer assembly is lifted to the next highest level and the test repeated. This procedure is repeated as many times as deemed necessary, progressively raising the packer test apparatus in short length increments.

The permeability values for the packer test were estimated following the procedures outlined in a manual issued by the U.S. Department of Interior, Bureau of Reclamation (USBR 7310-89), entitled: "Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes" and also in "Standard Operating Procedures for Borehole Packer Testing," by Michael Royle, M.A.Sc.

Packer tests were performed at six borehole locations drilled in rock along the southbound Battery Tunnel alignment. The packer tests were performed between February 21 and April 22, 2008.

2 Packer Tests Field Procedures

The data recorded during the test consists of the flow rate and the corresponding pressure when steady-state conditions have been achieved. These data are recorded over a number of increasing and decreasing (recovery) pressure steps. The range of pressures for the pressures steps are selected based on the anticipated permeability of the rock within the test interval. The test scheduled used for this project consisted of three increasing pressure steps followed by two decrements of pressure that matched the pressures during the increasing phase of the test. The procedures for the injections tests consisted of the following steps:

1. The borehole is cleared by pumping and circulating water from the bottom up to remove all drilling mud and drill cuttings from the hole.
2. The static water level in the borehole is measured before the test is started.
3. The packer assembly is lowered inside the borehole to the depth of the lowest test interval. The selection of the test intervals is based on the stratigraphy information obtained from the exploratory borehole previously drilled at that same location.
4. The glands of the packers are inflated to the working pressure. The working pressure should be such that it ensures a proper seal of the tests section and it should include the necessary pressure to overcome the hydrostatic pressure at that depth.

5. Water injection starts for the first pressure step and observations of flow are made every minute until three consistent reading are taken. This should represent steady-state flow. The steady-state flow rate and the corresponding pressure are recorded. The injection pressure at the test interval is recorded with a vibrating wire piezometer.

6. The water injection pressure is then increased to the second pressure step and the flow rate and the corresponding pressure are recorded when the steady-state condition is reached at that pressure step.

7. The same procedure is repeated for the third pressure step and the two recovery pressure steps. At this point the test is completed for the first test interval.

8. The packer assembly is deflated and lifted to the depth of the next test interval and steps 4 through 7 are repeated.

3 Calculation of Permeability from Double Packer Tests

The permeability of the rock unit(s) within each test interval were calculated using two methods. One of the methods used the following equation, presented in the USBR 7310-89 manual; Procedure for Constant Head Hydraulic Conductivity Tests in Single Drilled Holes:

$$k = \frac{q}{(C_s + 4)rH}$$

Where:

k = Permeability of the tested interval

q = Constant rate of flow in the test interval

C_s = Conductivity coefficient

H = Differential head of water exerted at the test interval

r = Radius of the borehole

The differential head of water, H, is calculated as the combined pressure head exerted at the test interval as follows:

$$H = P_p - (h_z - h_s)$$

Where:

P_p = Injection Pressure measured by a vibrating wire piezometer

h_z = Depth to the test interval

h_s = Depth to the static water level

The permeability of the rock unit(s) within each test interval were also calculated using the following equation, presented in the “Standard Operating Procedures for Borehole Packer Testing,” by Michael Royle, M.A.Sc.:

$$k = \frac{q}{(2\pi L P_i)} \ln\left(\frac{L}{r}\right)$$

Where:

k = Permeability of the tested interval

q = Constant rate of flow in the test interval

L = Length of the test interval

P_i = Net injection pressure

r = Radius of the borehole

The net injection pressure P_i, is calculated as the combined pressure head exerted at the test interval as follows:

$$P_i = P_p - (h_z - h_s)$$

Where:

P_p = Injection Pressure measured by a vibrating wire piezometer

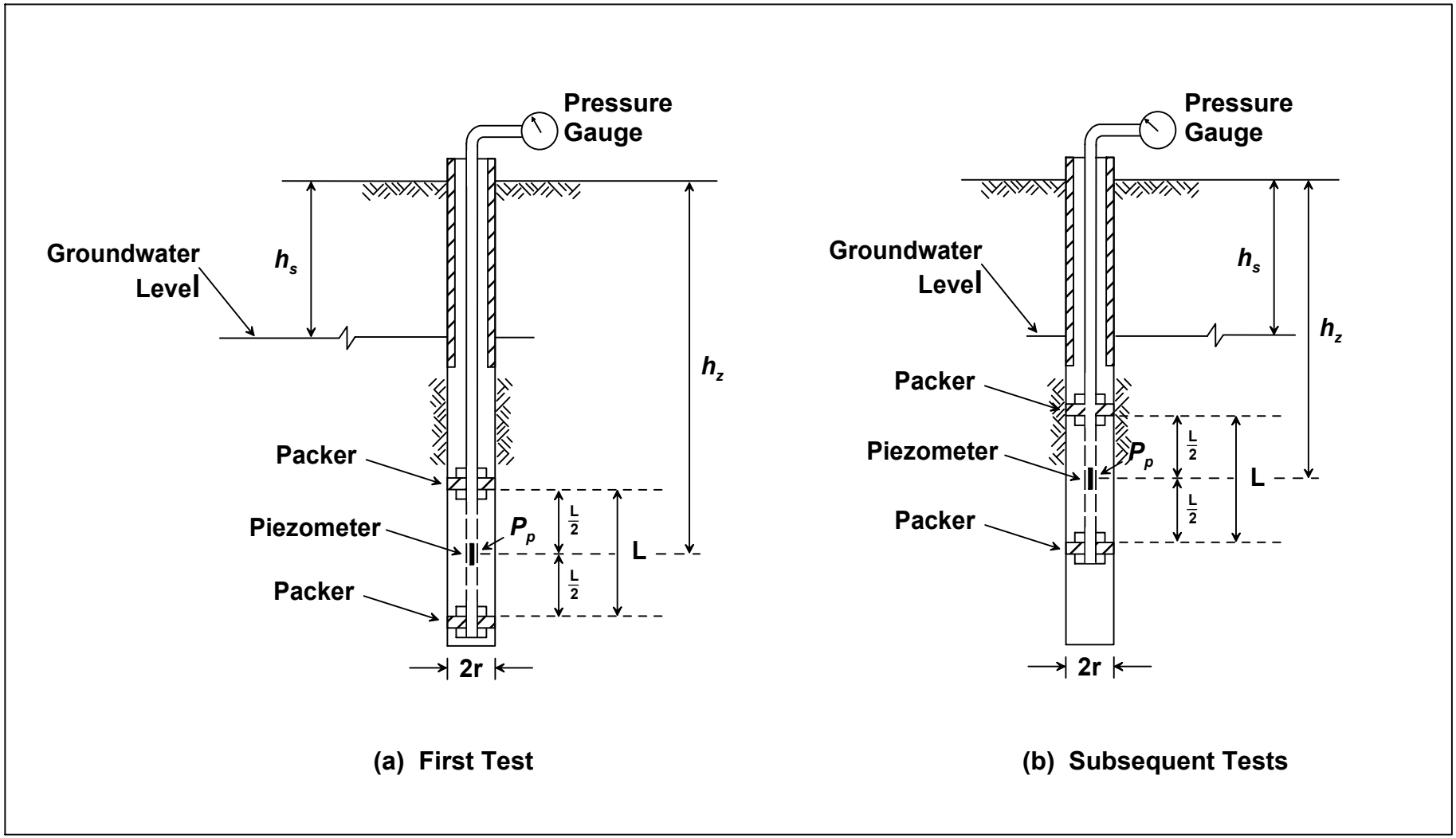
h_z = Depth to the test interval

h_s = Depth to the static water level

4 Double Packer Permeability Test Results

All packer test intervals were in the Franciscan rock. Flow versus pressure curves for the six packer tests are presented on Figures D-2 through D-4.

FIGURES



TYPICAL DOUBLE PACKER TEST SETUP

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FIGURE D-1

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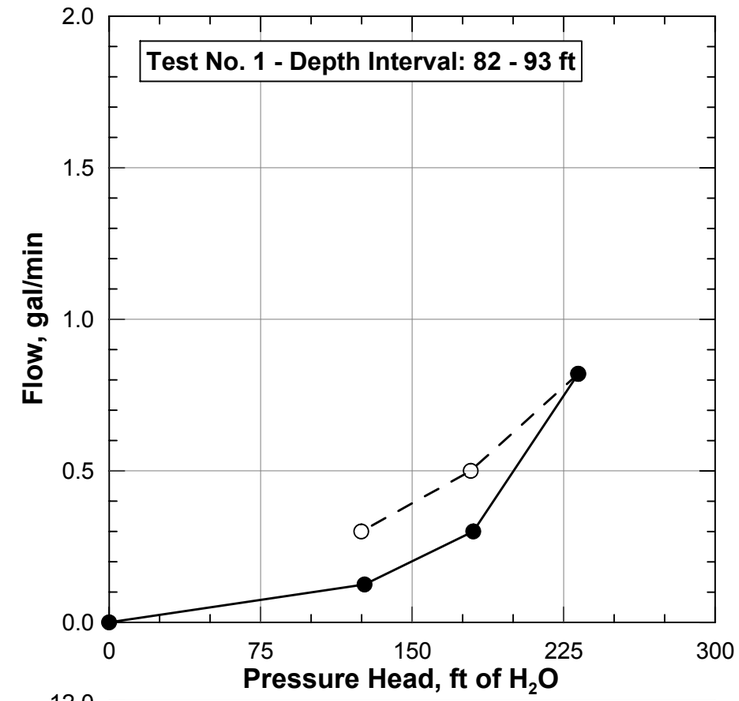

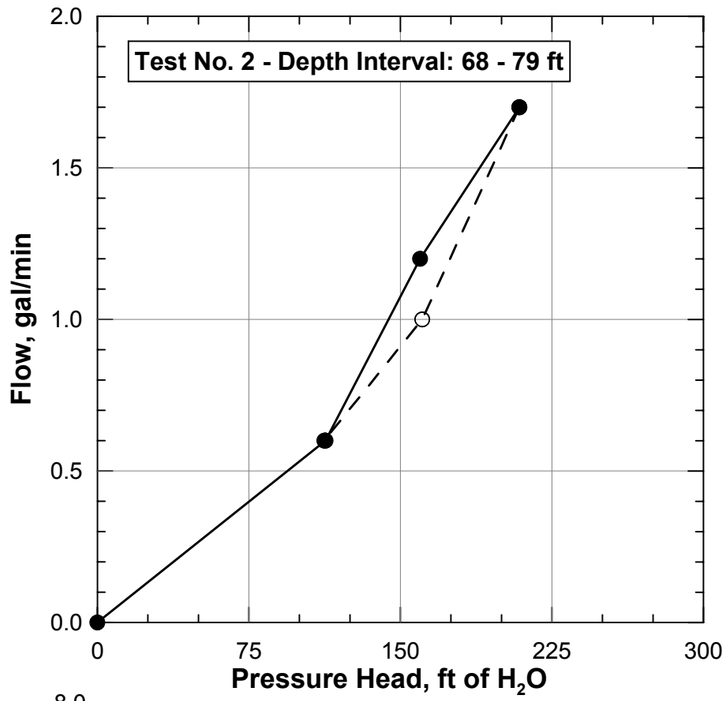

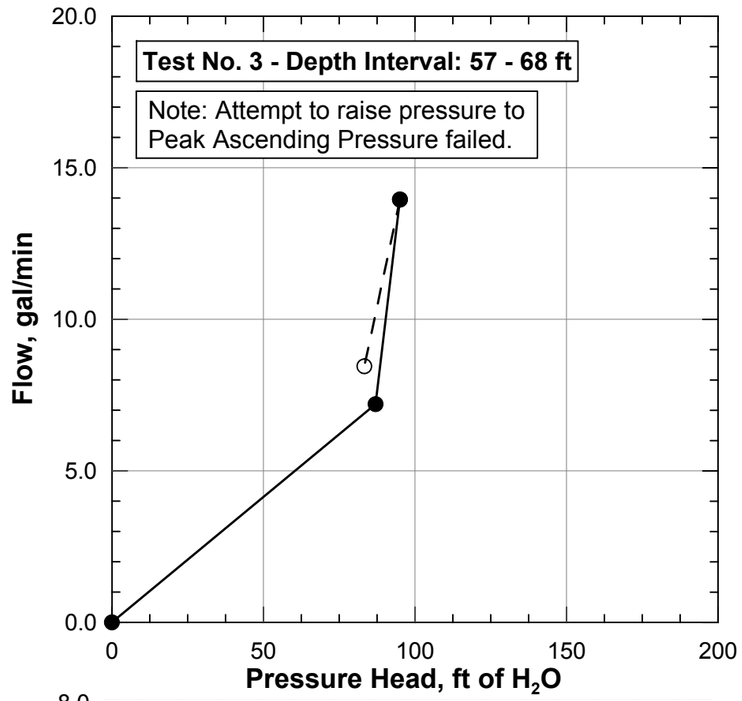

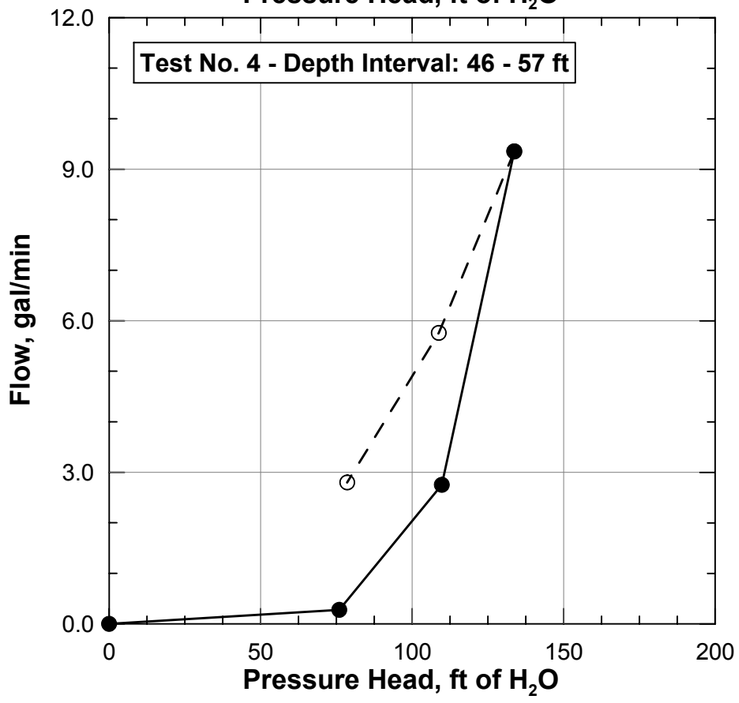

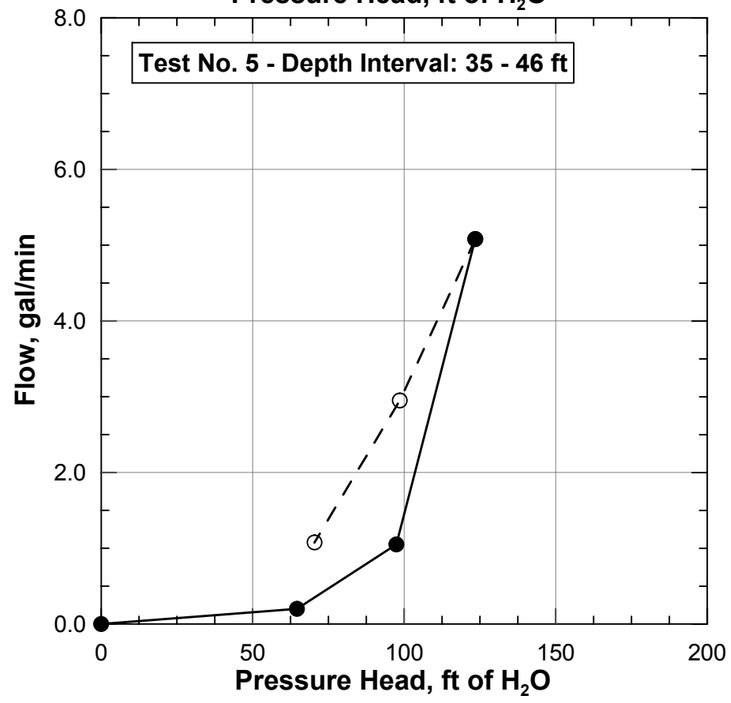

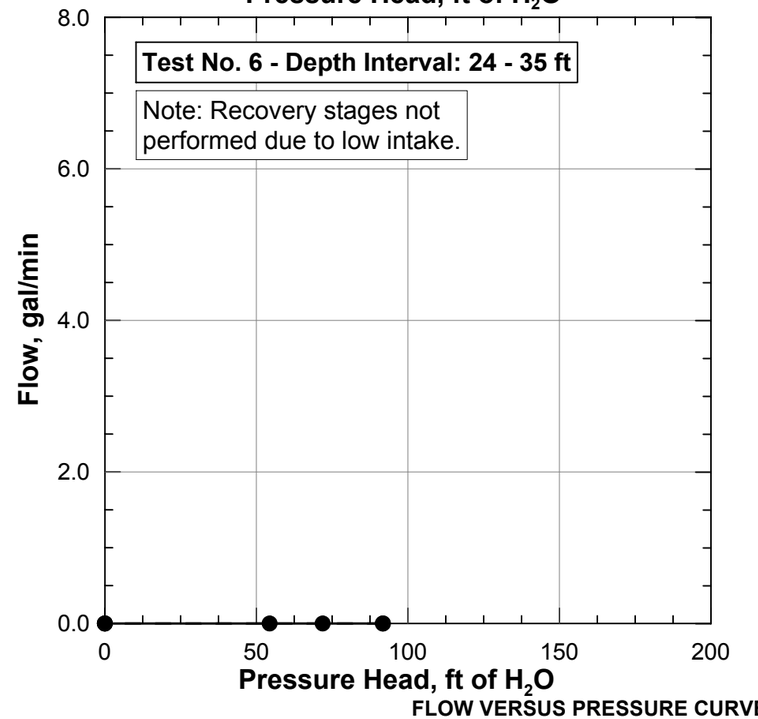

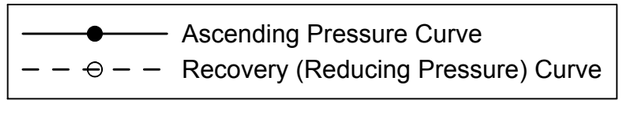

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTSB-R3-PZ-D

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FIGURE D-2

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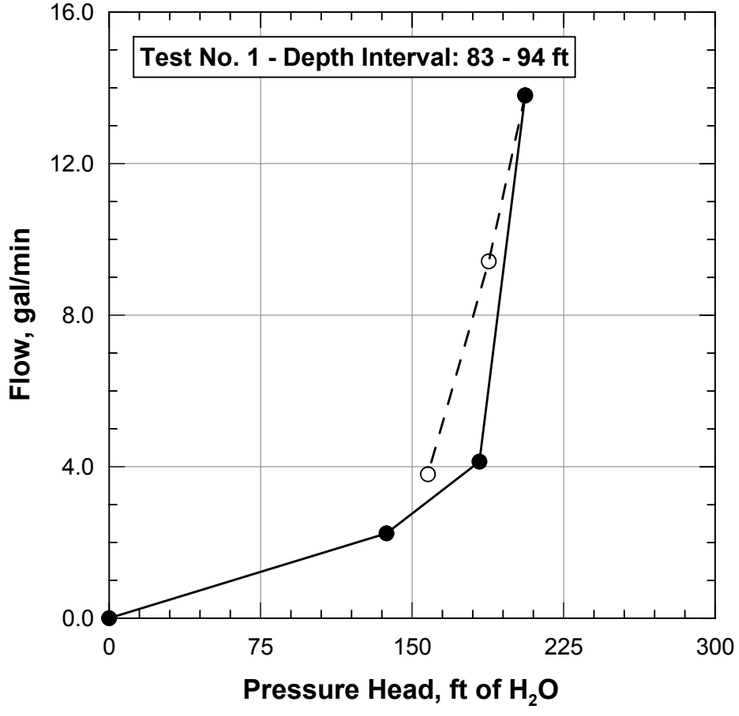

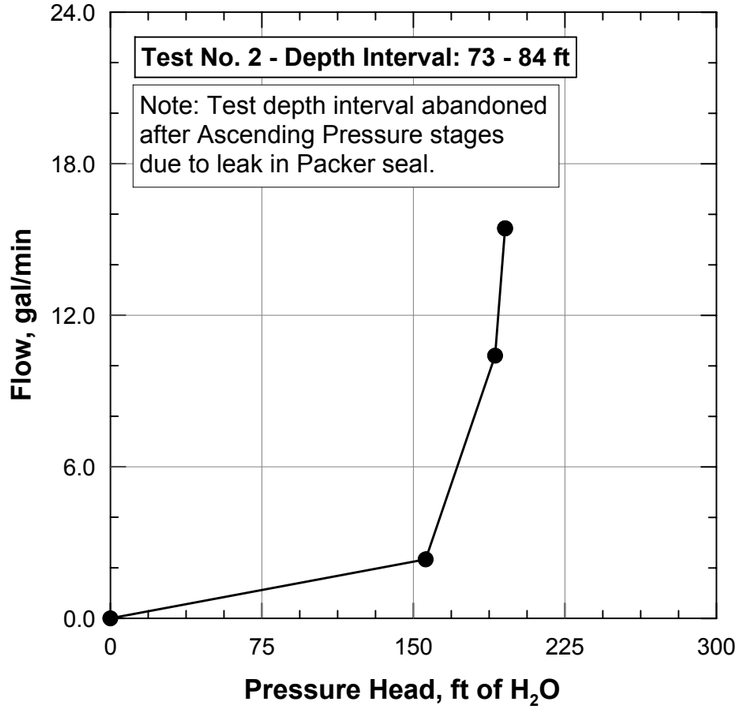

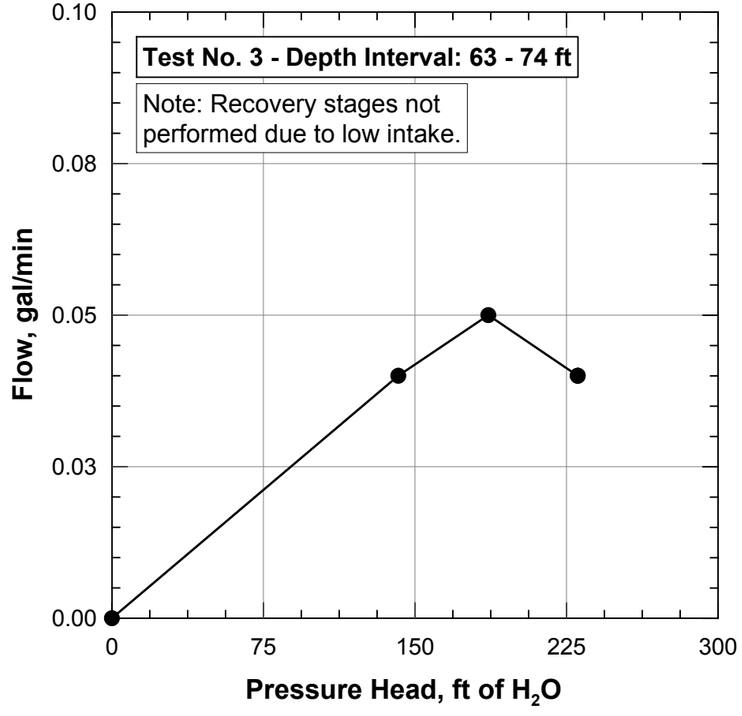

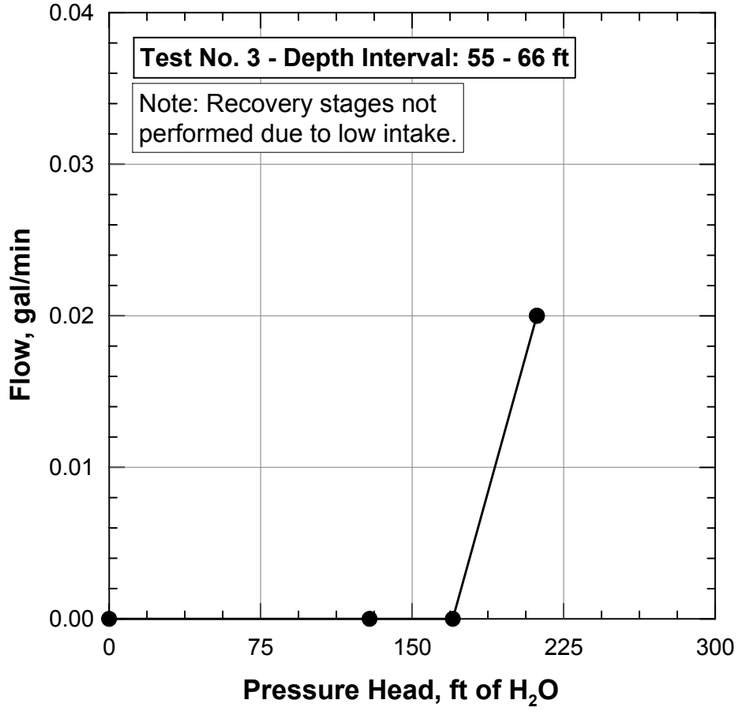

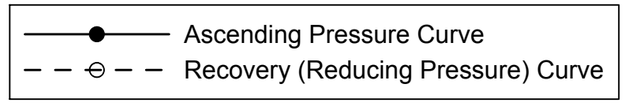

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R4-PZ

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FIGURE D-3

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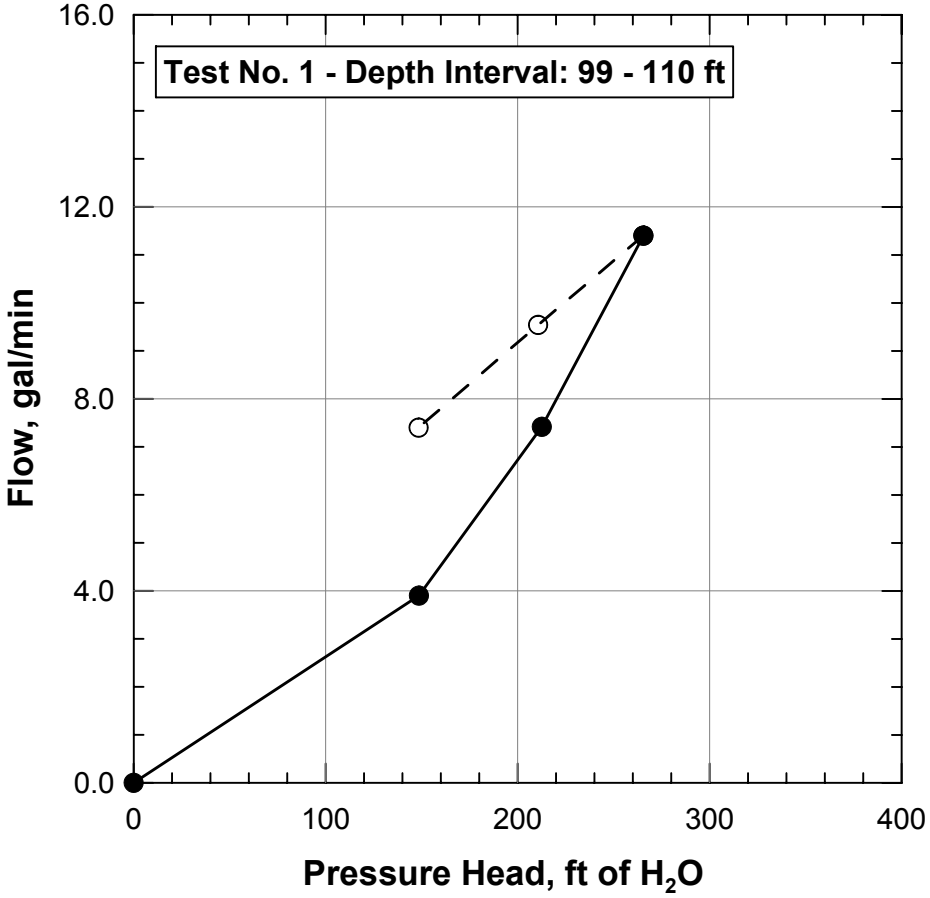

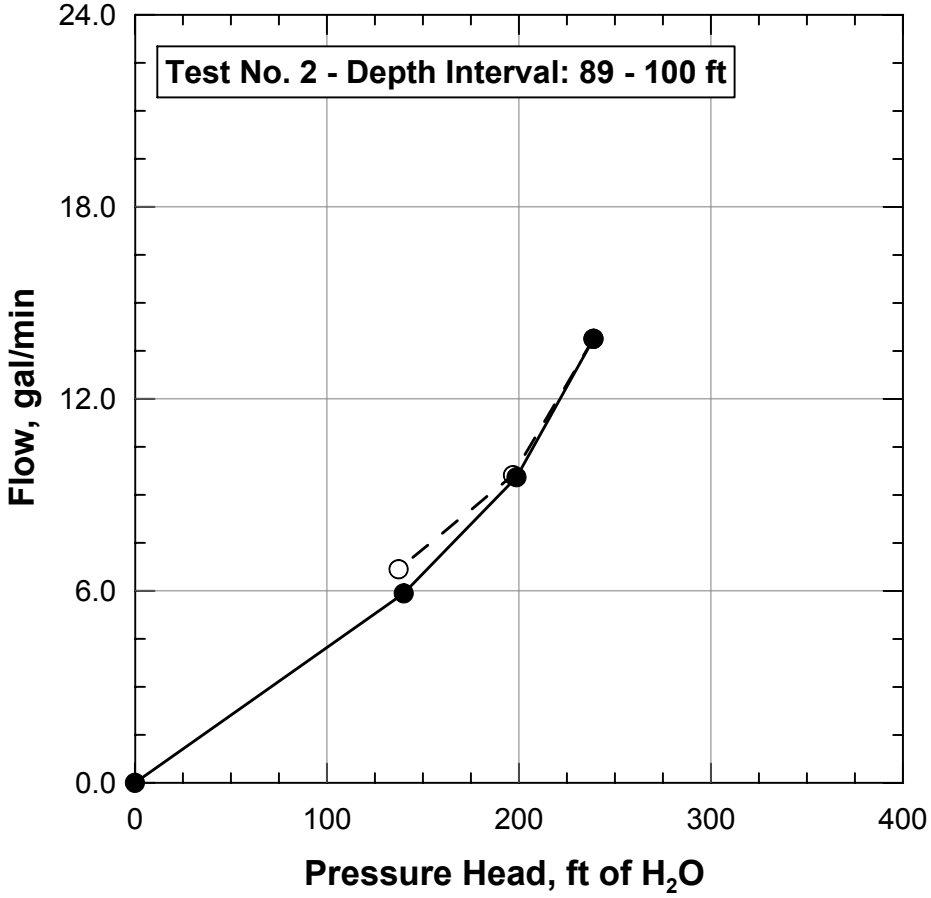

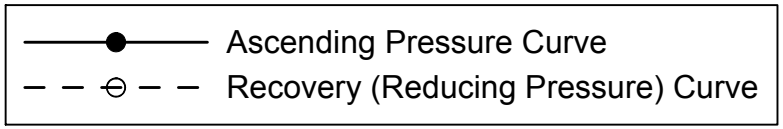

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R5-PZ-D

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FIGURE D-4

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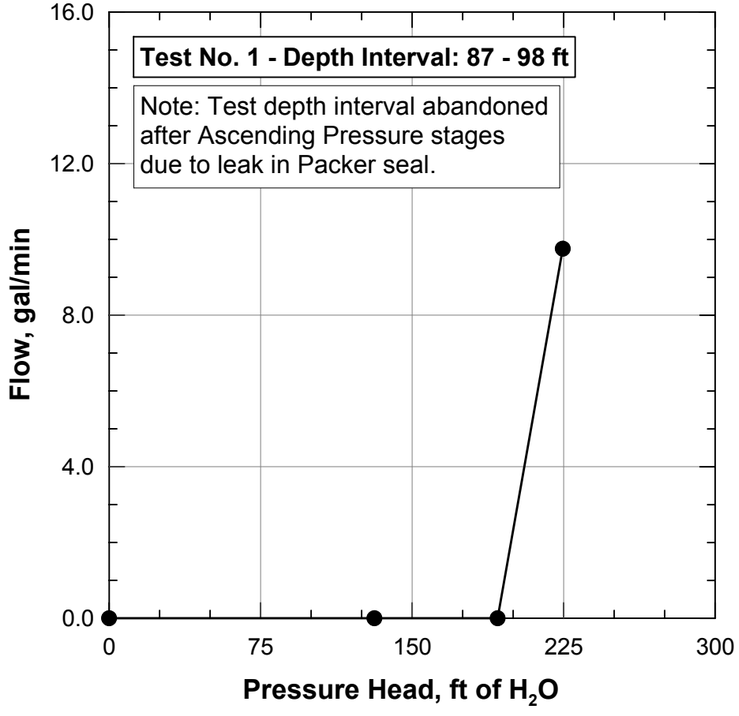

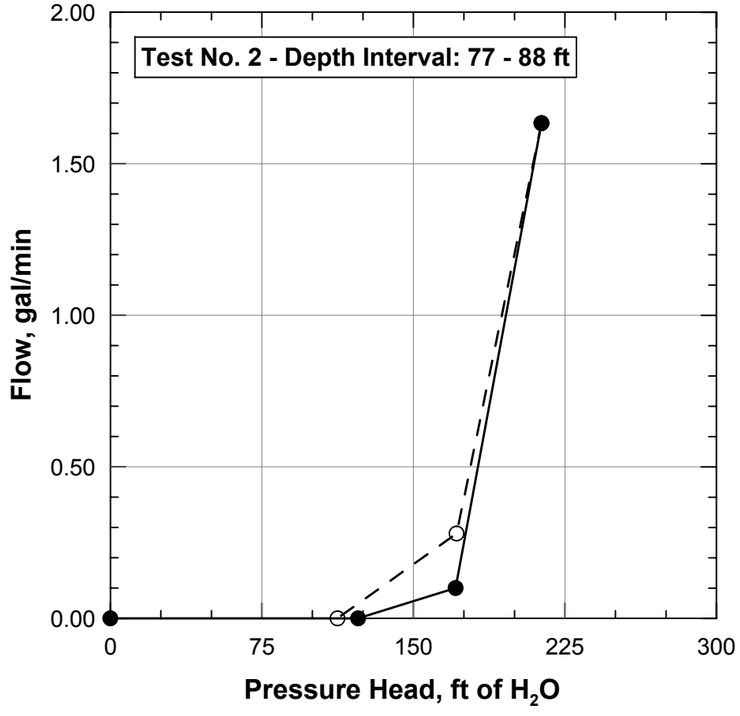

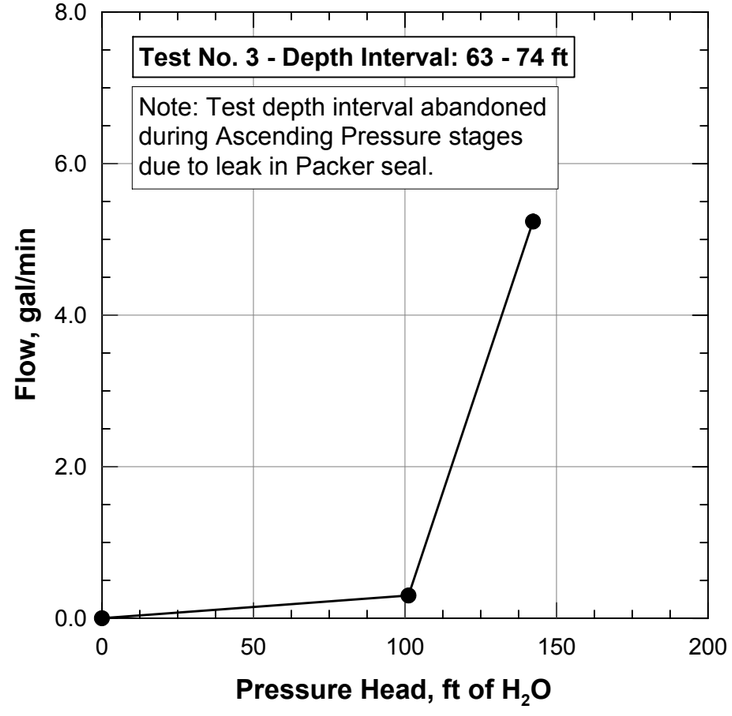

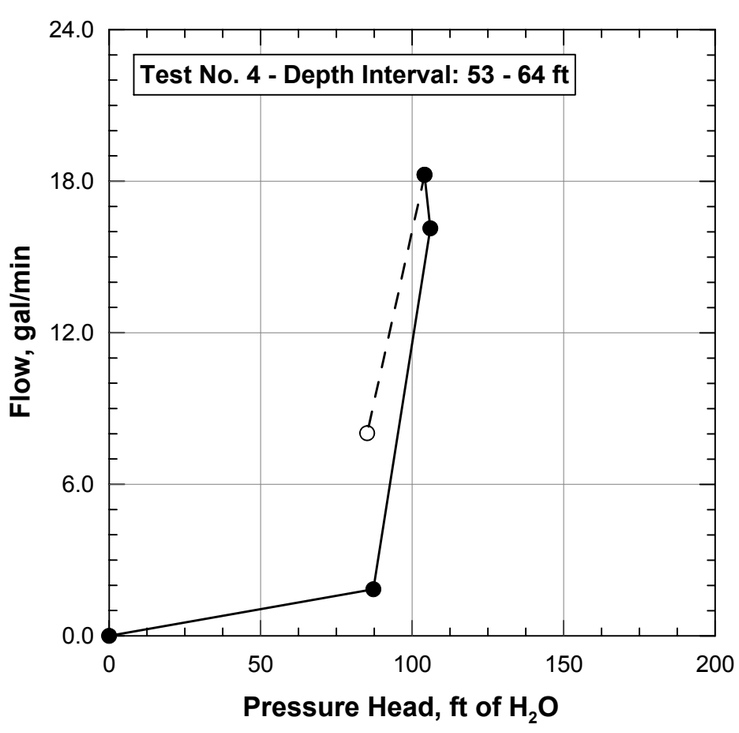

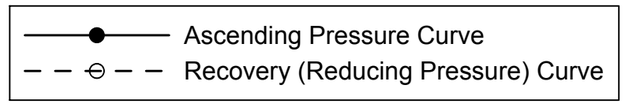

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE BTNB-R7-PZ-D

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FIGURE D-5

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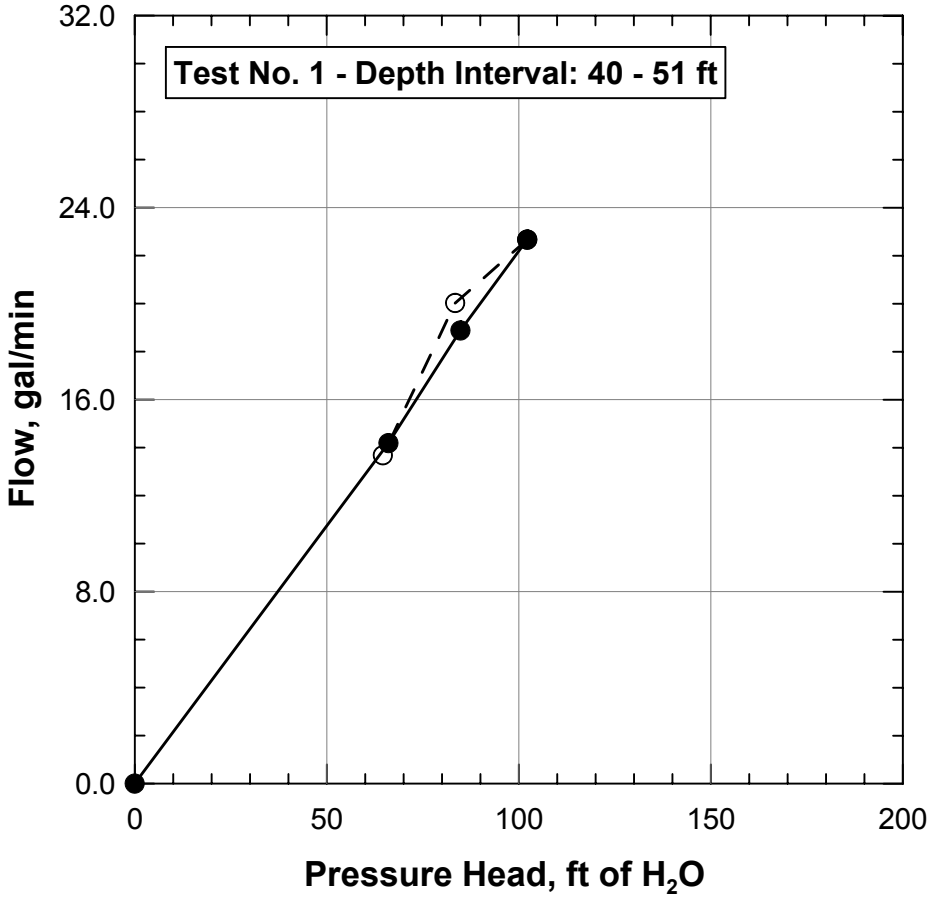

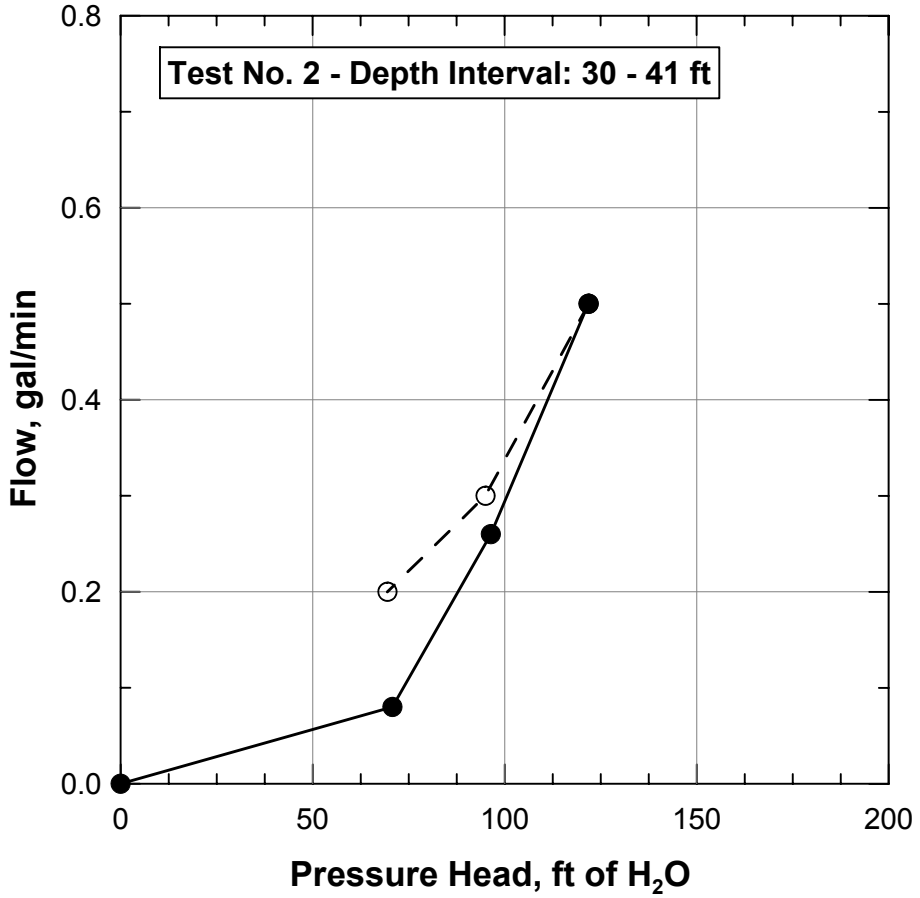

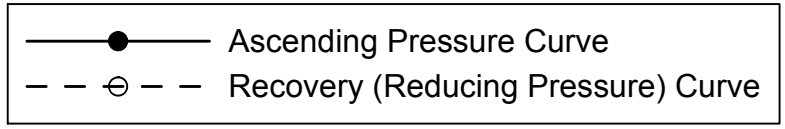

FLOW VERSUS PRESSURE CURVES:
PACKER TESTS AT BOREHOLE RW6-R1-PZ

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FIGURE D-6

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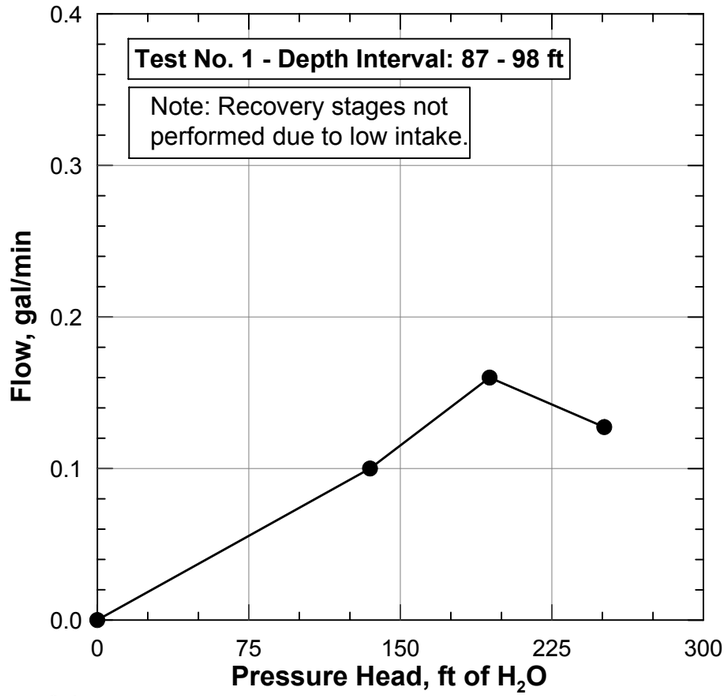

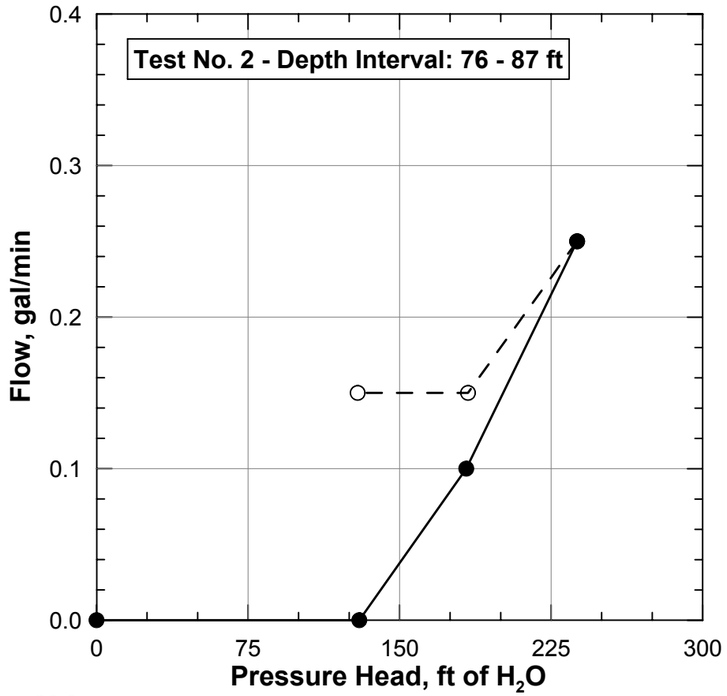

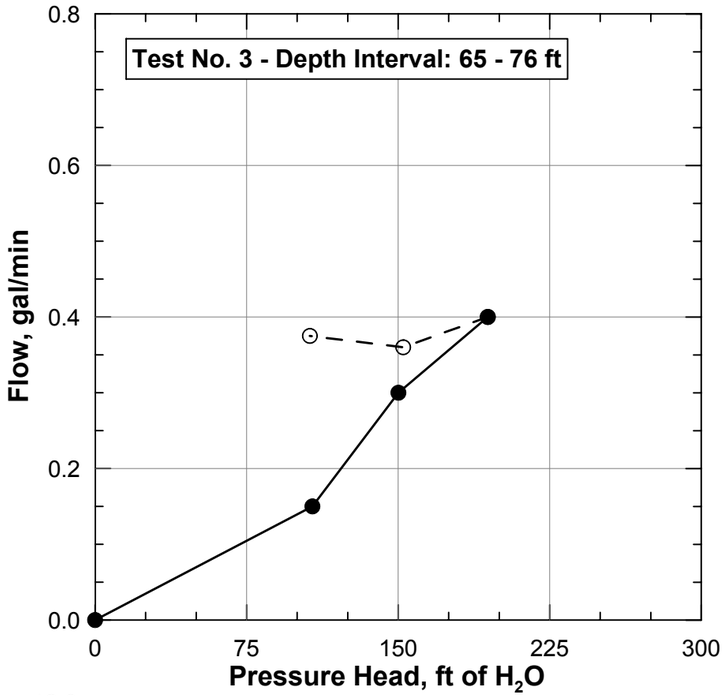

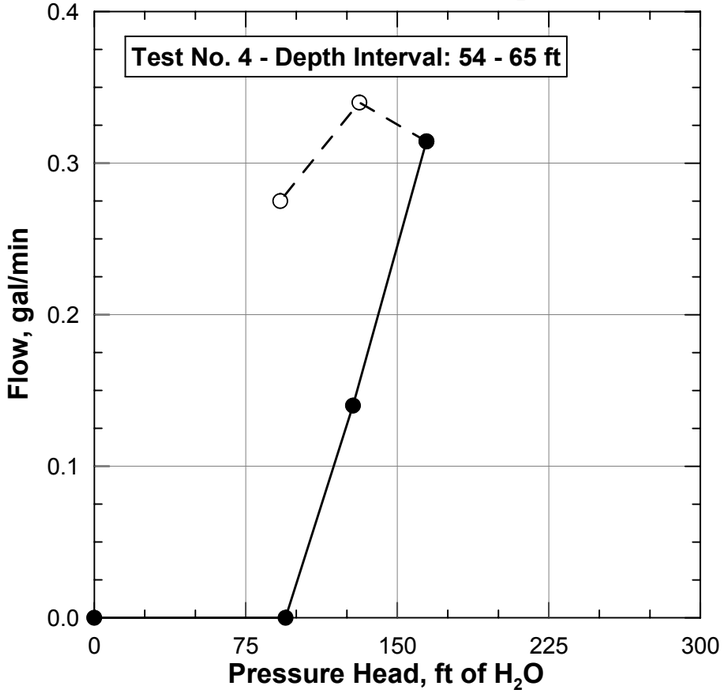

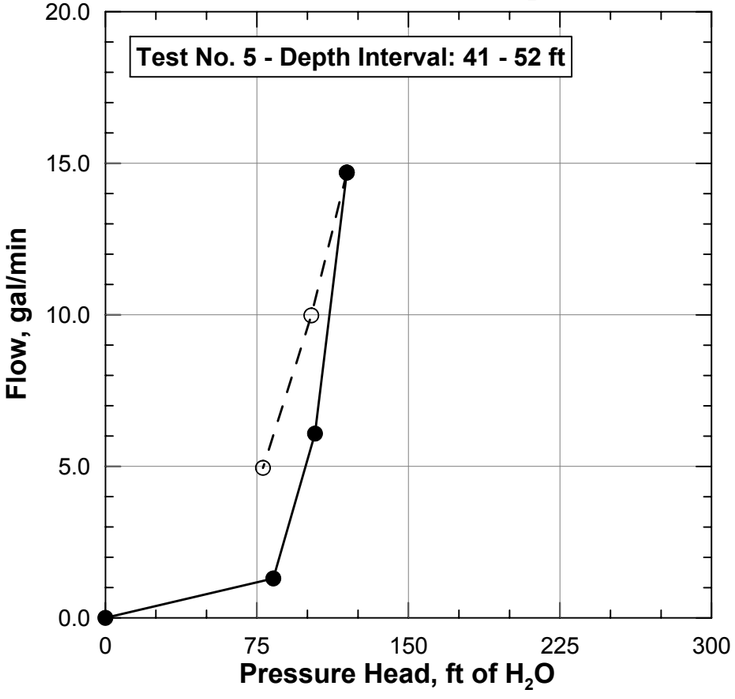

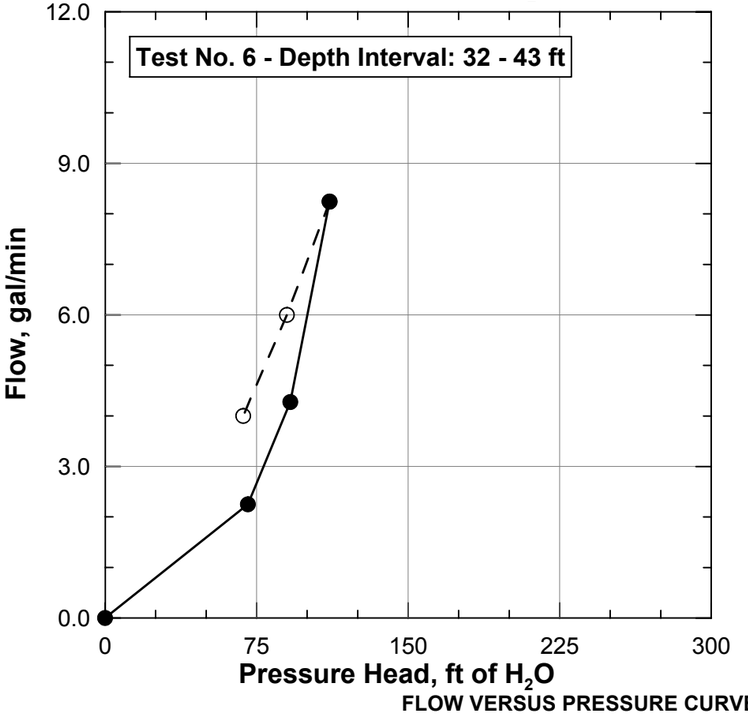

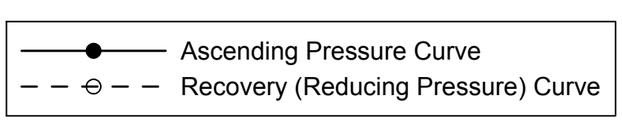

FLOW VERSUS PRESSURE CURVES: PACKER TESTS AT BOREHOLE RW6-R2-PZ-D

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FIGURE D-7

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Packer Tests\RW6-R2.grf

Appendix E

Seismic Hazard Assessment and Site Response Analysis (CD Only)

Appendix F

Calculation Packages

APPENDIX F.1

Liquefaction Triggering from Standard Penetration Tests for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Liquefaction Triggering from Standard Penetration Tests for the Southbound Battery Tunnel

June 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Liquefaction Triggering from Standard Penetration Tests

June 2009

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This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job number 131558

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Table 1 Summary of Liquefaction Analysis from Standard Penetration Tests

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Figure 1 Major Active Faults in the Bay Area
Figure 2 Locations of Geotechnical Explorations Battery Tunnels
Figure 3 SPT Based Liquefaction Triggering Correlation: Fill
Figure 4 SPT Based Liquefaction Triggering Correlation: Colma Sand

Appendices

Appendix A – Calculations
Appendix B – Copy of Amec-Geomatrix Site Response Analyses for the Battery Tunnels
Appendix C – Development of Correction Factors for Modified California Sampler

1 Introduction

The following calculation package presents an overview of the data and methods used to evaluate the probability of soil liquefaction based upon Standard Penetration Test (SPT) data collected at the location of the proposed Doyle Drive Replacement Project in the San Francisco Presidio. As site conditions change significantly across the project site, this report only considers the liquefaction hazards in the vicinity of the southbound Battery Tunnel.

The Doyle Drive Replacement Project is located within a region characterized by the seismically active San Andreas fault system, which is the principal tectonic element of the North American/Pacific plate boundary in California. In the San Francisco Bay Area, seismic slip is partitioned onto subsidiary structures, such as the San Andreas, Hayward and Calaveras faults, that are distributed across the Coast Ranges province. Figure 1 shows the major active faults in the San Francisco Bay Area. Many of these faults have been active in historical times, while earthquakes on other major faults not have been recorded.

Historically, the most active components of the fault system are: the San Andreas fault, source of the 1906 Magnitude (M_w) 7.8 earthquake and 1989 Magnitude 6.9 (Loma Prieta) earthquake; the Hayward fault, source of the 1868 Magnitude 7.0 earthquake; and the Calaveras fault, source of the 1911 Magnitude 6 and 1984 Magnitude 6.2 earthquakes.

The San Francisco Marina District, located just east of the project site, famously experienced significant damage during the Loma Prieta earthquake as a result of soil liquefaction. However, there are no known reports of damage or ground movements associated with the Loma Prieta earthquake at the project site. The large ground motions in the Marina District were a result of amplification of the motions through the deep, soft deposits in a bedrock basin below the Marina District. As these deep soft deposits do not exist at the proposed location of the southbound Battery Tunnel, similar damage did not occur.

However, because the project site is located within a seismically active area, the performance of the proposed southbound Battery Tunnel in the event of an earthquake is of concern and has to be evaluated.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Determine the probability of liquefaction triggering for Standard Penetration Tests (SPTs) run in the southbound Battery Tunnel area of the Doyle Drive Replacement Project.
- Estimate post liquefaction settlements for areas where liquefaction is likely.

3 Inputs

The following input data was required for the analyses:

3.1 Stratigraphy

Figure 2 shows the locations of the boreholes in relation to the southbound Battery Tunnel structure. In the vicinity of the southbound Battery Tunnel, the subsurface conditions typically consist of the following:

- **FILL:** At the surface is a layer of Fill that varies in thickness from 3 to 23 feet. The composition of the fill is variable and can include gravel, clay, and/or clean sand. The fill is typically loose to medium dense with SPT N-values ranging from as low as 3 to as high as 30 blows per foot.
- **BURIED SOIL HORIZON:** Below the Fill there is a thin layer of a Buried Soil Horizon. Where present, the thickness of the Buried Soil Horizon ranges from about 0.5 to 4.5 feet, but was not encountered in all boreholes. The composition of the Buried Soil Horizon is typically highly organic sandy clay. The Buried Soil Horizon deposits are typically loose with SPT N-values ranging from 0 to 11 blows per foot.
- **SANDY CLAY AND SANDY SILT:** Below the Buried Soil Horizon is a layer of Sandy Clay and Sandy Silt which is probably related to the Colma Sand layer below. The Sandy Clay and Sandy Silt layer ranged from 1.5 to 15.5 feet thick. The Sandy Clay and Sandy Silt layer is typically medium stiff to very stiff with SPT N-values ranging from 7 to 39, with occasional N-values over 50 blows per foot.
- **COLMA SAND:** Below the Sandy Clay and Sandy Silt is a fine to medium grained sand deposit known locally as Colma Sand. Where present, the Colma Sand ranged from 3.5 to 35 feet thick. The Colma Sand is typically medium dense to dense with SPT N-values ranging from 12 to over 60 blows per foot. In some areas, the Colma Sand is also underlain by another layer of Sandy Clay and Sandy Silt.
- **COLLUVIUM/RESIDUAL SOIL:** Below the Colma Sand or the lower layer of Sandy Clay and Sandy Silt and above the bedrock is a thin layer of either Colluvium or Residual Soil. These layers consisted mainly of stiff to very stiff gravelly clays.
- **BEDROCK:** Bedrock (Franciscan Complex) was encountered below the proposed southbound Battery Tunnel at depths ranging from 16.5 feet (at Borehole BTSB-R3-PZ-D) to 47.2 feet (at Borehole RW8-R1-PZ). The depth to bedrock generally decreases towards the west end of the Battery Tunnels.

3.2 Material Properties

The properties required for this analysis are blowcounts (commonly called N-values) from the Standard Penetration Test and fines contents which were determined from laboratory testing.

3.3 Water Table

Groundwater was typically encountered at or slightly above the bedrock surface. Where the bedrock level dips to the east end of the project site, the groundwater level is typically found approximately 30 feet below the ground surface.

Groundwater was determined from the site investigation, including the readings from several standpipe piezometers.

4 Site Response Analyses

Site response analyses were performed by Amec-Geomatrix for the southbound Battery Tunnel and presented in their report dated March 30, 2009. The site response analyses considered two soil conditions, a shallow and a deep profile. The shallow profile corresponds to ground conditions near the West Battery Tunnel where the depth to bedrock is relatively shallow. The deep profile corresponds to ground conditions near the East Battery Tunnel where the depth to bedrock is increased. Copies of the site response analyses for both the shallow and deep profiles are attached in Appendix B.

5 Assumptions

The following assumptions were made in these calculations:

- The depth of the blowcount was taken to be the middle of the test depth (i.e. second 6 inches of total drive);
- N values that reached refusal (50 blows for less than 6 inches) were extrapolated to a full 12 inches for the purposes of the analysis;
- When sieve analysis results were not available for a particular sample depth, fines contents were approximated from adjacent tests within the same soil layer; and
- Silt and Clay soils and granular soils above the water table were assumed to be unable to liquefy and were removed from the analysis.

6 Calculations

This section summarizes the calculations performed to estimate the likelihood of liquefaction triggering in the vicinity of the southbound Battery Tunnel and estimates of the post-liquefaction settlements. The EXCEL file containing these calculations is located at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\Liquefaction Analysis BT.xls. Printouts of excel files (created for each borehole along the southbound alignment) are attached in Appendix A.

The liquefaction analysis was performed based upon SPT correlations provided by Seed et al. (2003). These correlations were developed from SPT data applied to case histories of occurrence and non-occurrence of soil liquefaction to predict the likelihood of "triggering" soil liquefaction during seismic events. Estimates of post-liquefaction settlements were performed also using the procedure and correlations presented in Seed (2003).

6.1 Blow count correction

6.1.1 Correction for Modified California Sampler

Blowcounts from the Modified California (MC) sampler were converted to equivalent SPT blowcounts by multiplying the raw MC blowcount (N) by 0.76 for sandy soils, 0.71 for silts, and 0.52 for clays to create an equivalent SPT N-value. The correlations were determined from approximately 150 sets of consecutively driven MC and SPT samplers that were conducted during the geotechnical exploration program of this project. The development of the correction factors are discussed in Appendix C.

6.1.2 Correction to $N_{1,60,cs}$

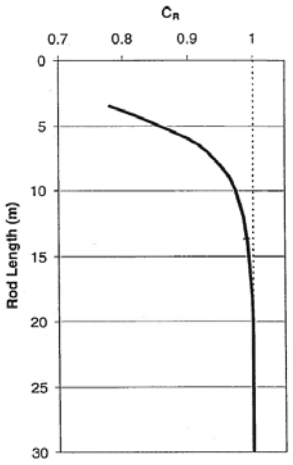
The equivalent SPT blowcounts, N, were converted to $N_{1,60}$ blowcounts so that standard correlations can be used. The equivalent SPT blowcounts, N, were normalized to $N_{1,60}$ blowcounts by the following equation:

$$N_{1,60} = N \cdot C_N \cdot C_R \cdot C_S \cdot C_B \cdot C_E \text{, where}$$

- N = The equivalent SPT blowcount
- C_N = Overburden correction = $C_N = \sqrt{\frac{1}{\sigma'_v}}$, where

  σ'_v = the effective overburden stress at the depth of the sample, in atmospheres (atm).

- C_R = Rod length correction (for short rod lengths) using the plot below:



- C_S = Correction for non-standard sampler configuration (SPTs run without brass liners, i.e. "unlined"). The correction from MC blowcounts to equivalent SPT blowcounts was made using unlined SPT data, therefore this correction is also required on converted equivalent SPT data.

$$C_S = 1 + \frac{N_{1,60}}{100} \text{ with } 1.10 \le C_S \le 1.30$$

This equation requires iteration until a C_S is found to satisfy the equation.

- C_B = Correction for Borehole diameter where for a typical 150mm (approximately 6in diameter) borehole diameter, C_B = 1.05
- C_E = Correction for hammer energy efficiency

$$C_E = \frac{ER}{60} \text{ , where}$$

ER = Efficiency Ratio of the SPT impact hammer in percent. Hammer energy calibrations were performed on each of the drill rigs used on the jobsite. The values used are listed below:

Drill Rig	Average Hammer Energy	Type of Hammer	Date Calibrated
Failing 1500	72.8%	Automatic	12/6/2007
Fraste Multidrill (Track-Mounted)	72.9%	Automatic	12/18/2007
Fraste Multidrill (Truck-Mounted)	76.2%	Automatic	12/5/2007
Mobile B-53	70.0%	Automatic	9/2/2008
Mobile 61	69.4%	Automatic	1/11/2008

The N1,60 blowcounts were further corrected for fines content to equivalent "clean sand" blowcounts using the equation:

$$N_{1,60,CS} = N_{1,60} \cdot C_{FINES} \text{ where,}$$

- $C_{FINES} = (1 + 0.004 \cdot FC) + \frac{FC}{N_{1,60}}$

6.2 Cycle Stress Ratio

The cyclic stress ratio (CSR), as defined by Seed and Idriss (1971), was then computed:

$$CSR = 0.65 \frac{\tau_{\max}}{\sigma_v'}, \text{ where}$$

$\tau_{\max} =$ Peak shear stress from site response analysis

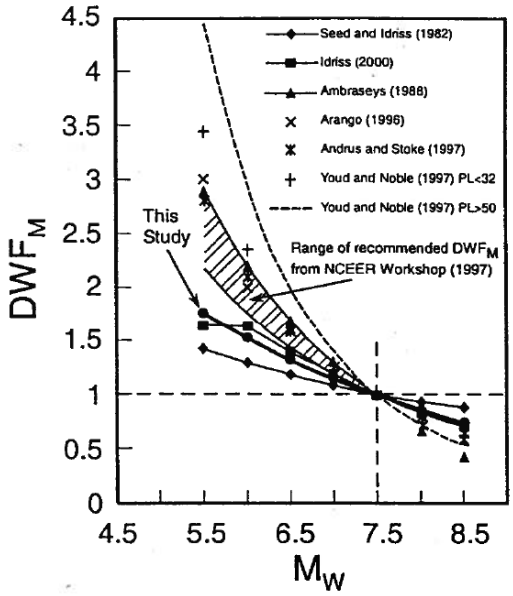
0.65 = Factor converting τ_{max} to τ_{cyclic}

$\sigma_v' =$ Effective vertical stress

A magnitude-correlated duration weighting scaling factor (DWF_M) was then applied to produce an "equivalent uniform cyclic stress ratio," CSR*, representing the equivalent CSR for a duration typical of an "average" event of moment magnitude, M_W = 7.5. This correction was applied as follows:

$$CSR^* = \frac{CSR}{DWF_M}, \text{ where}$$

DWF_M was determined from the plot below, from the curve labeled "This Study":



The three input ground motions used for the site response were the 1999 Chi-Chi (Taiwan) Earthquake (M_w=7.6), the 1990 Manjil Earthquake (M_w=7.4), and the 1999 Kocaeli Earthquake (M_w=7.8). Although the arithmetic mean of the moment-magnitude values of the three considered earthquakes is 7.6, conservatively a value of M_W = 7.5 was considered, i.e. there is no magnitude scaling factor and DWF_M = 1.0

The computed values of CSR was then normalized to an initial effective overburden stress of 1 atmosphere (atm) by multiplying by a correction factor, $K\sigma$.

$$K\sigma = (\sigma'_v)^{f-1}$$, where:

σ'_v = Effective overburden stress in atm
f = 0.7 as a median value

6.3 Probability of Liquefaction

Finally, a mean estimation of the probability of liquefaction was computed as follows:

$$P_L = \Phi\left(-\frac{\left(\begin{array}{l} N_{1,60}\cdot(1+0.004\cdot FC)-13.32\cdot\ln(CSR)- \\ 29.53\cdot\ln(M_w)-3.70\cdot\ln(\sigma'_v)+0.05\cdot FC+44.97 \end{array}\right)}{2.70}\right)$$ where,

P_L = Probability of liquefaction in percent
Φ = Standard cumulative normal distribution

6.4 Factor of Safety

For comparison purposes, the traditional Factor of Safety was also calculated. The Factor of Safety is defined as:

$$FS = \frac{CRR}{CSR_{eq,M}}$$ where,

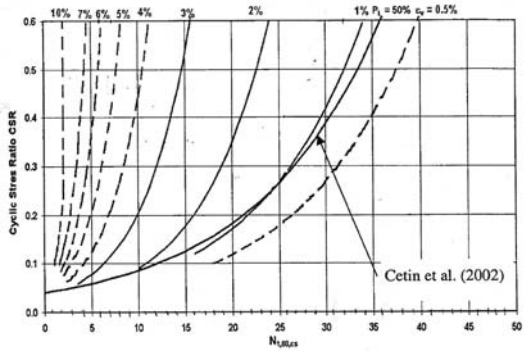
- CRR = Cyclic Resistance Ratio, defined as:

$$CRR = \exp\left(-\frac{\left(\begin{array}{l} N_{1,60}\cdot(1+0.004\cdot FC)-29.53\cdot\ln(M_W)- \\ 3.70\cdot\ln(\sigma'_v)+0.05\cdot FC+44.97+2.70\Phi^{-1}(P_L) \end{array}\right)}{13.32}\right)$$

- $CSR_{eq,M} = \frac{CSR^*}{K_\sigma}$

6.5 Estimation of Post Liquefaction Settlements

Post liquefaction settlements were determined from the procedure set forth in Seed (2003). The procedure estimates the post liquefaction volumetric strain from the plot below:



Estimated volumetric strains were then applied to the adjacent soil layer to determine the estimated settlements or d_{max}. The d_{max} value was then multiplied by the probability if liquefaction triggering (P_L) to obtain the expected settlement.

7 Results

This section presents the results of the calculations performed for the liquefaction analysis for the southbound Battery Tunnel. GRAPHER files depicting the results are located in the folder Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses.

Results of the preliminary liquefaction assessment are summarized on Table 1. In order to populate the dataset and evaluate the potential for liquefaction triggering across a larger area, test results below the northbound Battery Tunnel are also listed on Table 1 and considered in the analyses. The analyses indicate that the Fill and Colma Sand layers below the tunnel invert have a very low probability of liquefaction triggering. These results are aided by the often low groundwater level (below which liquefaction cannot occur) and the deep depths of excavation that will serve to remove any of the loose overburden soils. Figure 3 shows the probability of liquefaction triggering in the Fill. Figure 4 shows the probability of liquefaction triggering in the Colma Sand.

As there is a low probability of liquefaction triggering, post liquefaction settlements are expected to be negligible.

List of References

[1] AMEC Geomatrix (May 2009) Seismic Hazard Assessment and Site Response Analysis Doyle Drive Replacement Project Parts 1 and 2.

[2] Kramer, Steven, L. (1996) Geotechnical Earthquake Engineering. Prentice Hall, New Jersey

[3] Seed, R.B., K.O. Cetin, R.E.S. Moss, A. Kammerer, J. Wu, J.M. Pestana, M.F. Riemer, R.B. Sancio, J.D. Bray, R.E. Kayen and A. Faris, "Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework," Keynote Address, *Proceedings, 26th Annual Geotechnical Spring Seminar, Los Angeles Section of the GeoInstitute,* American Society of Civil Engineers, H.M.S. Queen Mary, Long Beach, California, April 30, 2003.

[4] Seed, H.B. and Idriss, I.M. (1982) "Ground Motions and Soil Liquefaction During Earthquakes." Monograph, Earthquake Engineering Research Institute, Berkeley, California.

[5] Seed, H.B. and Idriss, I.M. (1971) "Simplified Procedure for Evaluating Soil Liquefaction Potential." J. Soil Mech. & Foundations Div., ASCE.

TABLES

TABLE 1
SUMMARY OF LIQUEFACTION ANALYSIS FROM STANDARD PENETRATION TESTS

Borehole ID	Soil Unit	Soil Classification	Sampler Type	Depth (ft)	Elevation (ft)	Below Water Table? (Y/N)	$N_{1,60,CS}$ (bpf)	Probability of Liquefaction, P_L	Factor of Safety	Remarks	Expected Settlement $P_L \times d_{max}$ (in)
BTNB-R1	RESIDUAL SOIL	ML	MC	3.5	87.9	N	144	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R1	RESIDUAL SOIL	ML	SPT	5.0	86.4	N	168	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R1	RESIDUAL SOIL	GM	MC	8.5	82.9	N	107	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R1	RESIDUAL SOIL	GM	SPT	9.7	81.6	N	194	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R1	SANDSTONE BRECCIA	ssb	SPT	13.4	3.1	Y	175	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	SM	MC	3.5	85.9	N	38	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	ML	SPT	5.0	84.4	N	57	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	GC	MC	8.5	80.9	N	20	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	SC	SPT	10.0	79.4	N	19	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	CL	MC	13.5	75.9	N	15	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	FILL	CL	SPT	15.0	74.4	N	12	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	BURIED SOIL HORIZON/COLMA FORMATION	SM/CH	SPT	17.5	71.9	Y	10	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R2	SERPENTINITE	srp	SPT	24.5	64.9	Y	102	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	FILL	ML	MC	2.5	83.8	N	71	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	FILL	ML	SPT	4.0	82.3	N	43	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	FILL	SP	MC	7.5	78.8	N	26	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	FILL	ML	SPT	9.0	77.3	N	34	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA FORMATION	ML	MC	11.0	75.3	N	46	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA FORMATION	ML	SPT	12.5	73.8	N	27	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SC	MC	16.0	70.3	N	33	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SC	SPT	17.5	68.8	N	39	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	MC	21.0	65.3	N	64	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	SPT	22.5	63.8	Y	63	0%	>5.0	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	MC	26.0	60.3	Y	63	0%	>5.0	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	SPT	27.5	58.8	Y	52	0%	2.7	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	MC	31.0	55.3	Y	43	0%	1.2	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP-SC	SPT	32.5	53.8	Y	49	0%	1.8	Sample is Above Tunnel Invert	
BTNB-R3	COLMA SAND	SP	MC	36.0	50.3	Y	86	0%	>5.0		0.0
BTNB-R3	COLMA SAND	SP	SPT	37.5	48.8	Y	55	0%	2.9		0.0
BTNB-R3	COLMA SAND	SP	MC	41.0	45.3	Y	65	0%	>5.0		0.0
BTNB-R3	COLMA SAND	SP-SC	SPT	42.5	43.8	Y	28	100%	0.3	Sample is Liquefiable	0.7
BTNB-R3	COLMA SAND	SP-SC	MC	46.0	40.3	Y	39	43%	0.7	Sample is Liquefiable	0.1
BTNB-R3	SERPENTINITE	srp	SPT	47.5	38.8	Y	121	N/A	N/A	Sample is in Rock	
BTNB-R4-PZ	FILL	GC/OL	MC	3.5	66.9	N	33	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA FORMATION	OL/ML	SPT	5.0	65.4	N	57	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA FORMATION	ML	MC	8.5	61.9	N	83	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA FORMATION	ML	SPT	10.0	60.4	N	82	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA FORMATION	ML	MC	13.5	56.9	N	70	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA FORMATION	ML	SPT	15.0	55.4	N	63	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP	MC	18.5	51.9	N	92	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP	SPT	20.0	50.4	N	64	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	23.5	46.9	N	109	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	25.0	45.4	N	66	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	28.5	41.9	N	75	N/A	N/A	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	30.0	40.4	N	67	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	33.5	36.9	Y	54	0%	2.9		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	35.0	35.4	Y	68	0%	>5.0		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	38.5	31.9	Y	57	0%	3.2		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	40.0	30.4	Y	62	0%	4.6		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	43.5	26.9	Y	85	0%	>5.0		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	45.0	25.5	Y	40	11%	0.8		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	MC	48.5	21.9	Y	48	0%	1.4		0.0
BTNB-R4-PZ	COLMA SAND	SP-SC	SPT	50.0	20.4	Y	35	80%	0.5	Sample is Liquefiable	0.3
BTNB-R4-PZ	RESIDUAL SOIL	CL	MC	53.5	16.9	Y	18	N/A	N/A	Sample is Fine Grained	
BTNB-R4-PZ	SERPENTINITE	srp	SPT	54.8	15.7	Y	109	N/A	N/A	Sample is in Rock	
BTNB-R5-PZ-D	SANDSTONE	ss	SPT	3.1	76.5	N	297	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	FILL	SP-SM	MC	3.5	80.1	N	40	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	FILL	SP-SM	SPT	5.0	78.6	N	11	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	FILL	SP-SM	MC	8.5	75.1	N	18	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	FILL	SP-SM	SPT	10.0	73.6	N	26	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA FORMATION	ML	MC	13.5	70.1	N	38	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA FORMATION	ML	SPT	15.0	68.6	N	68	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA FORMATION	ML	MC	18.5	65.1	N	51	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA FORMATION	ML	SPT	20.0	63.6	N	40	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA SAND	SP-SM	MC	23.5	60.1	N	76	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA SAND	SP-SM	SPT	25.0	58.6	N	82	N/A	N/A	Sample is Above Water Table	
BTNB-R6-PZ-D	COLMA SAND	SP-SC	MC	28.2	55.4	N	120	Above Water Table	>5.0		
BTNB-R6-PZ-D	COLMA SAND	SP-SC	SPT	29.4	54.2	N	94	Above Water Table	>5.0		
BTNB-R6A-PZ-S	FILL	SP-SM	MC	3.5	80.0	N	31	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	FILL	SP-SM	SPT	5.0	78.5	N	13	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	FILL	SP-SM	MC	8.5	75.0	N	25	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	FILL	SP-SM	SPT	10.0	73.5	N	35	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA FORMATION	ML	MC	13.5	70.0	N	42	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA FORMATION	ML	SPT	15.0	68.5	N	32	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA FORMATION	ML	MC	18.5	65.0	N	52	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA FORMATION	ML	SPT	20.0	63.5	N	40	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA SAND	SP-SM	MC	23.5	60.0	N	47	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA SAND	SP-SM	SPT	25.0	58.5	N	54	N/A	N/A	Sample is Above Water Table	
BTNB-R6A-PZ-S	COLMA SAND/SERPENTINITE	SP-SC/srp	MC	28.5	55.0	N	75	Above Water Table	>5.0		
BTNB-R6A-PZ-S	SERPENTINITE	srp	SPT	29.7	53.8	N	131	N/A	N/A	Sample is in Rock	
BTNB-R7-PZ-D	FILL	SP	SPT	3.5	75.9	N	18	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	BURIED SOIL HORIZON	ML	SPT	8.5	70.9	N	7	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	COLMA FORMATION	ML	MC	13.5	65.9	N	46	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	COLMA SAND	SM	MC	18.5	60.9	N	20	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	COLMA SAND	SP-SM	SPT	23.5	55.9	N	47	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	COLMA SAND	SP-SM	SPT	28.5	50.9	N	33	N/A	N/A	Sample is Above Water Table	
BTNB-R7-PZ-D	COLMA SAND	SP-SM	SPT	33.5	45.9	Y	44	0%	1.4		0.0

TABLE 1
SUMMARY OF LIQUEFACTION ANALYSIS FROM STANDARD PENETRATION TESTS

Borehole ID	Soil Unit	Soil Classification	Sampler Type	Depth (ft)	Elevation (ft)	Below Water Table? (Y/N)	$N_{1,60,CS}$ (bpf)	Probability of Liquefaction, P_L	Factor of Safety	Remarks	Expected Settlement $P_L \times d_{max}$ (in)
BTNB-R7-PZ-D	COLMA SAND	SP-SM	SPT	38.5	40.9	Y	63	0%	>5.0		0.0
BTNB-R7A-PZ-S	FILL	SP	MC	3.5	75.5	N	54	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	FILL	SP	SPT	5.0	74.0	N	15	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	BURIED SOIL HORIZON	ML	MC	8.5	70.5	N	7	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	BURIED SOIL HORIZON	CL	SPT	10.0	69.0	N	23	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA FORMATION	ML	MC	13.5	65.5	N	45	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA FORMATION	ML	SPT	15.0	64.0	N	22	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA FORMATION	SM	MC	18.5	60.5	N	19	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA FORMATION	CL	SPT	20.0	59.0	N	11	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA SAND	SP	MC	23.5	55.5	N	49	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA SAND	SP	SPT	25.0	54.0	N	51	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA SAND	SP-SM	MC	28.5	50.5	N	41	N/A	N/A	Sample is Above Water Table	
BTNB-R7A-PZ-S	COLMA SAND	SP-SM	SPT	30.0	49.0	N	29	Above Water Table		Sample is Liquefiable	
BTNB-R7A-PZ-S	COLMA SAND	SP	MC	33.5	45.5	Y	58	0%	4.1		0.0
BTNB-R7A-PZ-S	COLMA SAND	SP	SPT	35.0	44.0	Y	62	0%	>5.0		0.0
BTNB-R7A-PZ-S	COLMA SAND	SP	MC	38.5	40.5	Y	75	0%	>5.0		0.0
BTNB-R7A-PZ-S	COLMA SAND	SP-SC	SPT	40.0	39.0	Y	40	5%	0.9		0.0
BTNB-R7A-PZ-S	SERPENTINITE	srp	SPT	44.5	34.5	Y	74	N/A	N/A	Sample is in Rock	
BTSB-R1-PZ	FILL	SP	MC	3.0	98.0	N	30	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	SPT	4.5	96.5	N	15	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	MC	8.5	92.5	N	35	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	SPT	10.0	91.0	N	37	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	MC	13.5	87.5	N	51	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	SPT	15.0	86.0	N	40	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	MC	18.5	82.5	Y	39	0%	1.4	Sample is Above Tunnel Invert	
BTSB-R1-PZ	FILL	SP	SPT	20.0	81.0	Y	34	29%	0.9	Sample is Above Tunnel Invert	
BTSB-R1-PZ	BURIED SOIL HORIZON	CL	MC	23.5	77.5	Y	11	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R1-PZ	BURIED SOIL HORIZON	CL	SPT	25.0	76.0	Y	6	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R1-PZ	SANDSTONE	ss	MC	33.1	68.0	Y	147	0	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	FILL	CH/SP	MC	3.5	88.6	N	17	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	FILL	SP	SPT	5.0	87.1	N	26	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	FILL/BURIED SOIL HORIZON	SP/CL	MC	8.5	83.6	N	20	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	BURIED SOIL HORIZON	CL	SPT	10.0	82.1	N	15	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	COLMA FORMATION	ML	MC	13.5	78.6	N	33	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	COLMA FORMATION	ML	SPT	15.0	77.1	N	13	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SM/SP-SM	MC	18.5	73.6	N	28	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	SPT	20.0	72.1	N	21	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	MC	23.5	68.6	N	75	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	SPT	25.0	67.1	N	83	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	MC	28.5	63.6	N	95	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	SPT	30.0	62.1	N	57	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	MC	33.5	58.6	N	67	Above Water Table	>5.0	Sample is Above Tunnel Invert	
BTSB-R2	COLMA SAND	SP-SM	SPT	35.0	57.1	N	45	Above Water Table		Sample is Above Tunnel Invert	
BTSB-R2	COLMA FORMATION	CL	MC	38.5	53.6	N	20	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	COLMA FORMATION	CL	SPT	40.0	52.1	N	36	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R2	COLMA FORMATION	CL	MC	43.5	48.6	Y	55	N/A	N/A	Sample is Fine Grained	
BTSB-R2	COLMA FORMATION/SANDSTONE	CL/ss	SPT	45.0	47.1	Y	83	N/A	N/A	Sample is Fine Grained	
BTSB-R2	SILTSTONE	st	MC	48.2	43.9	Y	93	N/A	N/A	Sample is in Rock	
BTSB-R3-PZ-D	FILL	SP	SPT	3.5	94.4	N	10	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R3-PZ-D	FILL	SP	SPT	8.5	89.4	N	52	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R3-PZ-D	BURIED SOIL HORIZON	CL	SPT	13.5	84.4	N	15	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R3-PZ-D	SANDSTONE	ss	SPT	18.5	79.4	Y	159	N/A	N/A	Sample is Above Tunnel Invert	
BTSB-R3-PZ-D	SANDSTONE	ss	SPT	20.2	77.7	Y	157	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	FILL/SILT WITHIN COLMA FORMATION	SC/ML	MC	3.5	105.0	N	22	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA FORMATION	ML	SPT	5.0	103.5	N	34	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA FORMATION	ML	MC	8.0	100.5	N	77	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA SAND	SM	SPT	9.5	99.0	N	86	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA SAND	SM	MC	13.0	95.5	N	68	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA SAND	SM	SPT	14.5	94.0	N	80	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	COLMA SAND/SANDSTONE	SM/ss	MC	18.0	90.5	N	72	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R1-PZ	SANDSTONE	ss	SPT	18.8	89.7	N	163	N/A	N/A	Sample is Above Tunnel Invert	
RW6-R2-PZ-D	FILL	SP	SPT	3.5	105.2	N	21	N/A	N/A	Sample is Above Water Table	
RW6-R2-PZ-D	FILL	SP	SPT	8.5	100.2	N	34	N/A	N/A	Sample is Above Water Table	
RW6-R2-PZ-D	COLMA SAND	SM	SPT	13.5	95.2	N	113	N/A	N/A	Sample is Above Water Table	
RW6-R2-PZ-D	COLMA SAND	SM	SPT	18.5	90.2	N	68	N/A	N/A	Sample is Above Water Table	
RW6-R2-PZ-D	COLMA SAND	SM	SPT	23.5	85.2	N	71	N/A	N/A	Sample is Above Water Table	
RW6-R2-PZ-D	SANDSTONE	ss	SPT	28.3	80.4	N	133	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	FILL	SP	MC	3.5	104.8	N	11	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	FILL	SP	SPT	5.0	103.3	N	6	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	FILL	SP	MC	8.5	99.8	N	43	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	FILL/SILT WITHIN COLMA FORMATION	SP/ML	SPT	10.0	98.3	N	34	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA SAND	SM	MC	13.5	94.8	N	127	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA SAND	SM	SPT	15.0	93.3	N	95	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA SAND	SM	MC	18.5	89.8	N	113	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA SAND	SM	SPT	20.0	88.3	N	124	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	OLMA SAND/CLAY WITHIN COLMA FORMATIO	SM/CL	MC	23.5	84.8	N	32	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA FORMATION	CL	SPT	25.0	83.3	N	93	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	COLMA FORMATION	CL/ss,sh	MC	26.3	82.1	N	93	N/A	N/A	Sample is Above Water Table	
RW6-R2A-PZ-S	SANDSTONE	ss, sh	SPT	26.6	81.7	N	136	N/A	N/A	Sample is Above Water Table	
RW8-R1-PZ	FILL	SP	MC	8.5	82.1	N	5	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	FILL	SP	SPT	10.0	80.6	N	8	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	BURIED SOIL HORIZON	CL-ML	MC	13.5	77.1	N	2	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA FORMATION	CL	SPT	15.0	75.6	N	11	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA FORMATION	CL	MC	18.5	72.1	N	24	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA FORMATION	CL	SPT	20.0	70.6	N	28	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA SAND	SP-SC	MC	28.5	62.1	N	36	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA SAND	SP-SC	SPT	30.0	60.6	N	41	N/A	N/A	Sample is Above Tunnel Invert	

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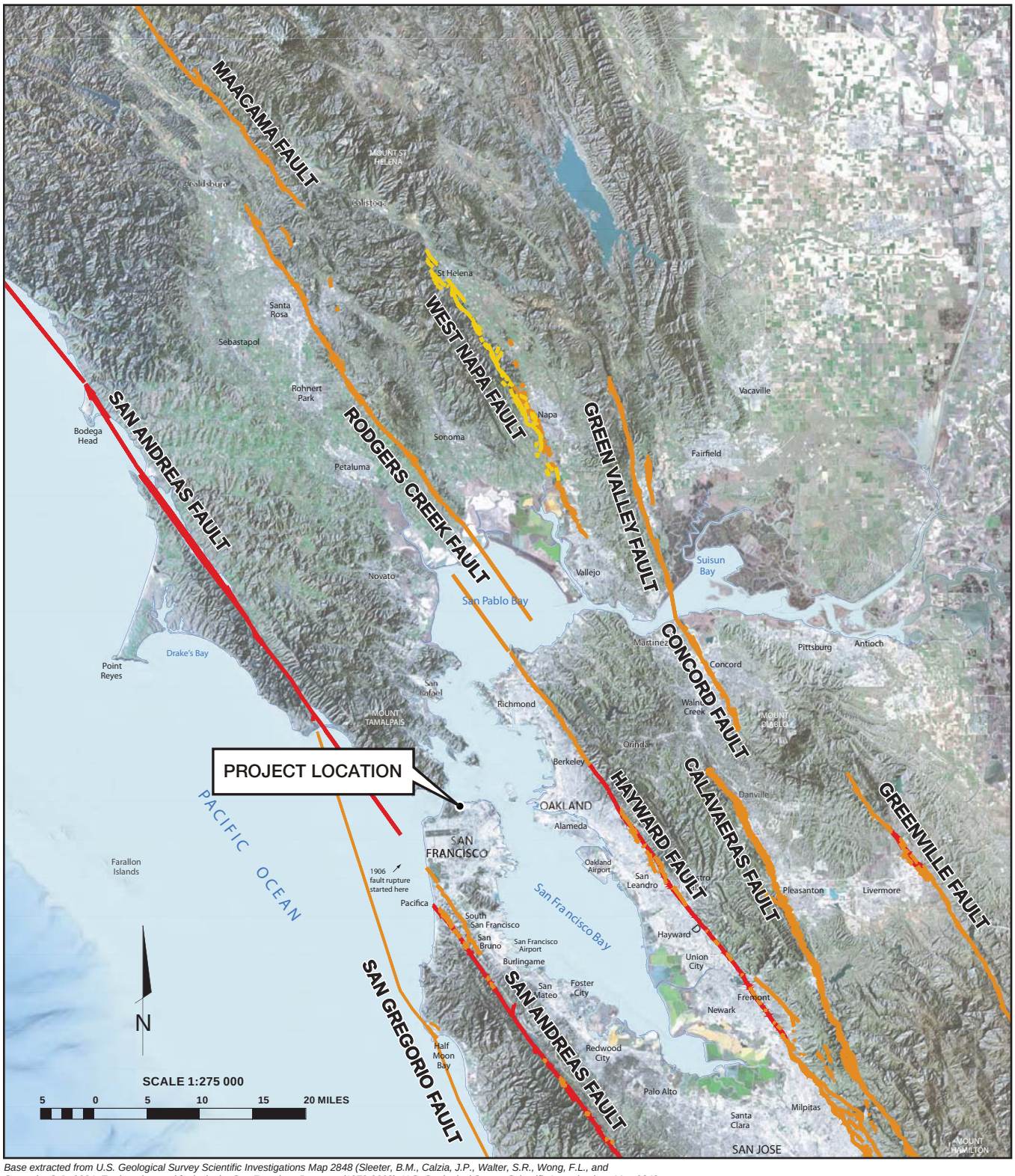
TABLE 1
SUMMARY OF LIQUEFACTION ANALYSIS FROM STANDARD PENETRATION TESTS

Borehole ID	Soil Unit	Soil Classification	Sampler Type	Depth (ft)	Elevation (ft)	Below Water Table? (Y/N)	$N_{1,60,CS}$ (bpf)	Probability of Liquefaction, P_L	Factor of Safety	Remarks	Expected Settlement $P_L \times d_{max}$ (in)
RW8-R1-PZ	COLMA SAND	SP-SC	MC	33.5	57.1	N	43	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA SAND	SP-SC	SPT	35.0	55.6	N	45	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA SAND	SP-SC	MC	38.5	52.1	N	60	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA SAND	SP-SC	SPT	40.0	50.6	Y	47	0%	1.6	Sample is Above Tunnel Invert	
RW8-R1-PZ	COLMA FORMATION	CL	MC	43.5	47.1	Y	12	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	RESIDUAL SOIL	CL	SPT	45.0	45.6	Y	18	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1-PZ	SANDSTONE	ss	MC	47.7	42.9	Y	104	N/A	N/A	Sample is in Rock	
RW8-R1-PZ	SANDSTONE	ss	SPT	48.0	42.6	Y	104	N/A	N/A	Sample is in Rock	
RW8-R1A-PZ	FILL	SP	MC	6.0	84.6	N	14	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	FILL	SP	SPT	7.5	83.1	N	7	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	FILL	SP	MC	11.0	79.6	N	12	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	BURIED SOIL HORIZON	ML/CL	SPT	12.5	78.1	N	3	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA FORMATION	CL	MC	16.0	74.6	N	14	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA FORMATION	CL	SPT	17.5	73.1	N	27	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA FORMATION	CL	MC	21.0	69.6	N	21	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA FORMATION	CL	SPT	22.5	68.1	N	16	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA SAND	SC	SPT	26.0	64.6	N	15	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA SAND	SP-SC	SPT	31.0	59.6	N	38	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA SAND	SP-SC	SPT	36.0	54.6	N	61	N/A	N/A	Sample is Above Tunnel Invert	
RW8-R1A-PZ	COLMA SAND	SP-SC	SPT	41.0	49.6	Y	26	100%	0.3	Sample is Above Tunnel Invert	
RW8-R1A-PZ	RESIDUAL SOIL	CH	SPT	46.0	44.6	Y	13	N/A	N/A	Sample is Fine Grained	
GB-5	FILL	SM	SPT	4.9	86.3	N	58	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	BURIED SOIL HORIZON	SM	MC	9.8	81.3	N	130	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	BURIED SOIL HORIZON	SM	SPT	11.8	79.4	N	92	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	COLMA FORMATION	CL	SPT	15.1	76.1	N	48	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	COLMA FORMATION	CL	SPT	20.7	70.5	N	54	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	COLMA FORMATION	CL	SPT	25.3	65.9	N	54	N/A	N/A	Sample is Above Tunnel Invert	
GB-5	COLMA SAND	SC	SPT	30.2	61.0	Y	132	0%	>5.0	Sample is Above Tunnel Invert	
GB-5	COLMA SAND	SC	MC	34.4	56.7	Y	128	0%	>5.0	Sample is Above Tunnel Invert	
GB-5	COLMA SAND	SC	SPT	35.8	55.4	Y	127	0%	>5.0	Sample is Above Tunnel Invert	
GB-5	COLMA SAND	SC	SPT	40.7	50.5	Y	122	0%	>5.0	Sample is Above Tunnel Invert	
GB-5	COLMA SAND	SC	SPT	45.6	45.6	Y	118	0%	>5.0		0.0
GB-5	COLMA SAND	SC	SPT	46.2	44.9	Y	117	0%	>5.0		0.0
GB-5	COLMA FORMATION	CL	SPT	51.2	40.0	Y	45	N/A	N/A	Sample is Fine Grained	
GB-5	COLMA FORMATION	CL	SPT	60.4	30.8	Y	113	N/A	N/A	Sample is Fine Grained	
GB-6	FILL	CL	MC	4.6	101.1	N	87	N/A	N/A	Sample is Above Tunnel Invert	
GB-6	RESIDUAL SOIL	CL	SPT	5.9	99.8	N	244	N/A	N/A	Sample is Above Tunnel Invert	
GB-6	RESIDUAL SOIL	CL	SPT	9.8	95.9	N	184	N/A	N/A	Sample is Above Tunnel Invert	

FIGURES



Base extracted from U.S. Geological Survey Scientific Investigations Map 2848 (Sleeter, B.M., Calzia, J.P., Walter, S.R., Wong, F.L., and Saucedo, G.J., 2004, Earthquakes and faults in the San Francisco Bay area (1970-2003): U.S. Geological Survey Scientific Investigations Map 2848

LEGEND

Fault that had ground rupture in an earthquake in historic time (since 1776).

Holocene-active fault

Quaternary-active fault

MAJOR ACTIVE FAULTS IN THE SAN FRANCISCO BAY REGION

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco Transporation Authority
June 2009 San Francisco, California

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Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Calculation Packages\SPT Liquefaction\Battery Tunnels\Figure 1_Major active faults.ai

FIGURE 1

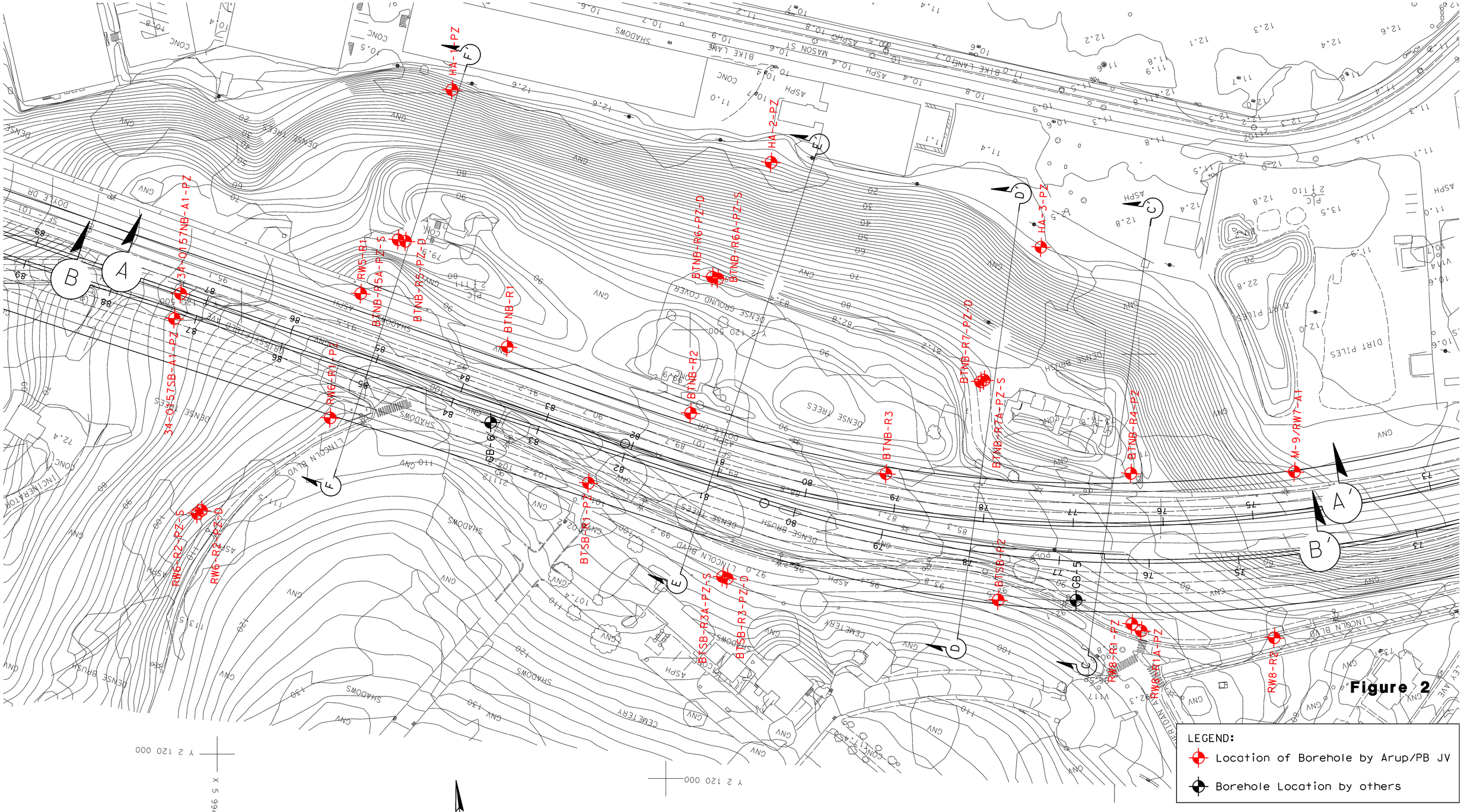

Figure 2

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

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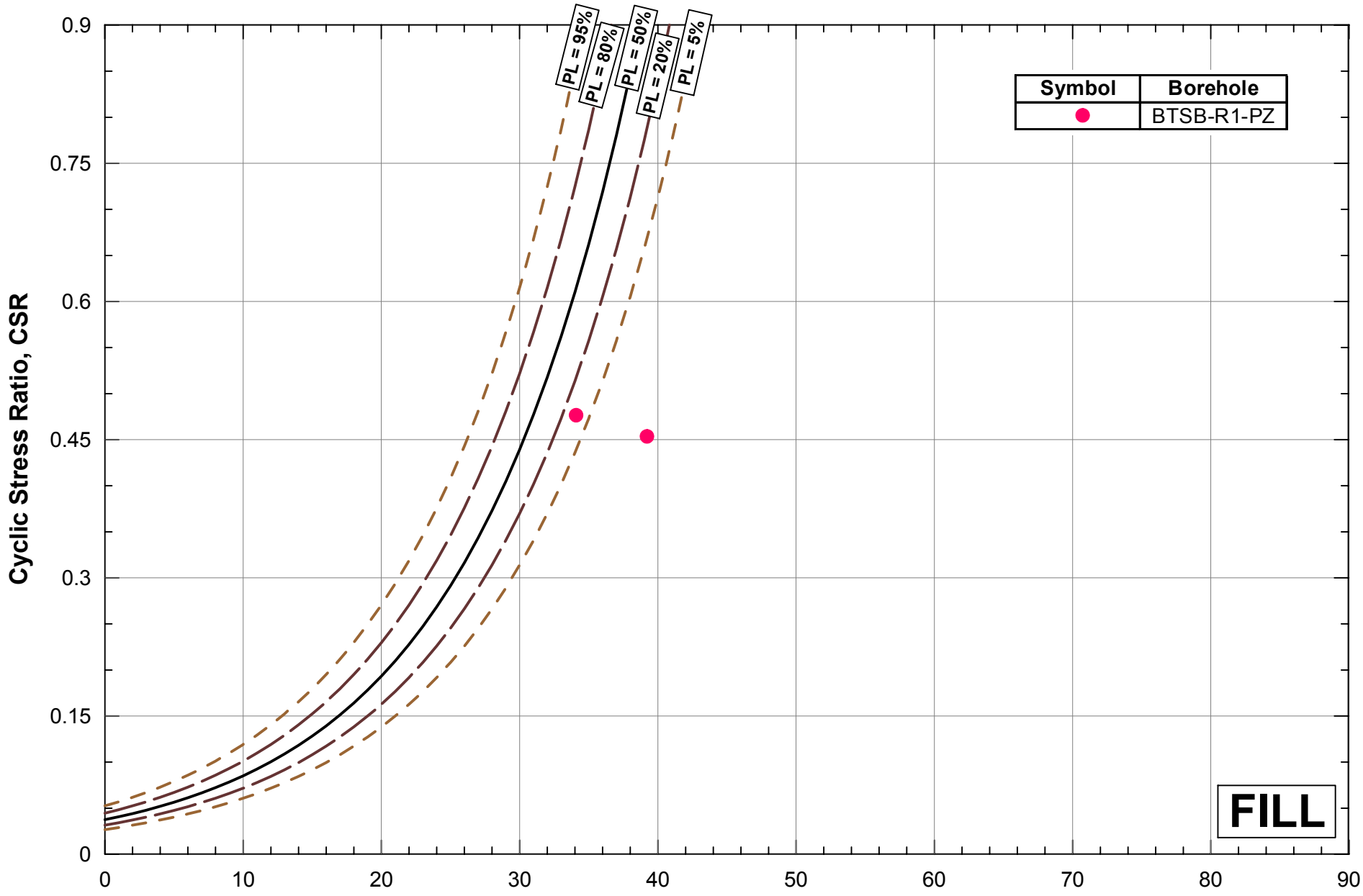

Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: FILL

Doyle Drive Replacement Project
Southbound Battery Tunnel Draft Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

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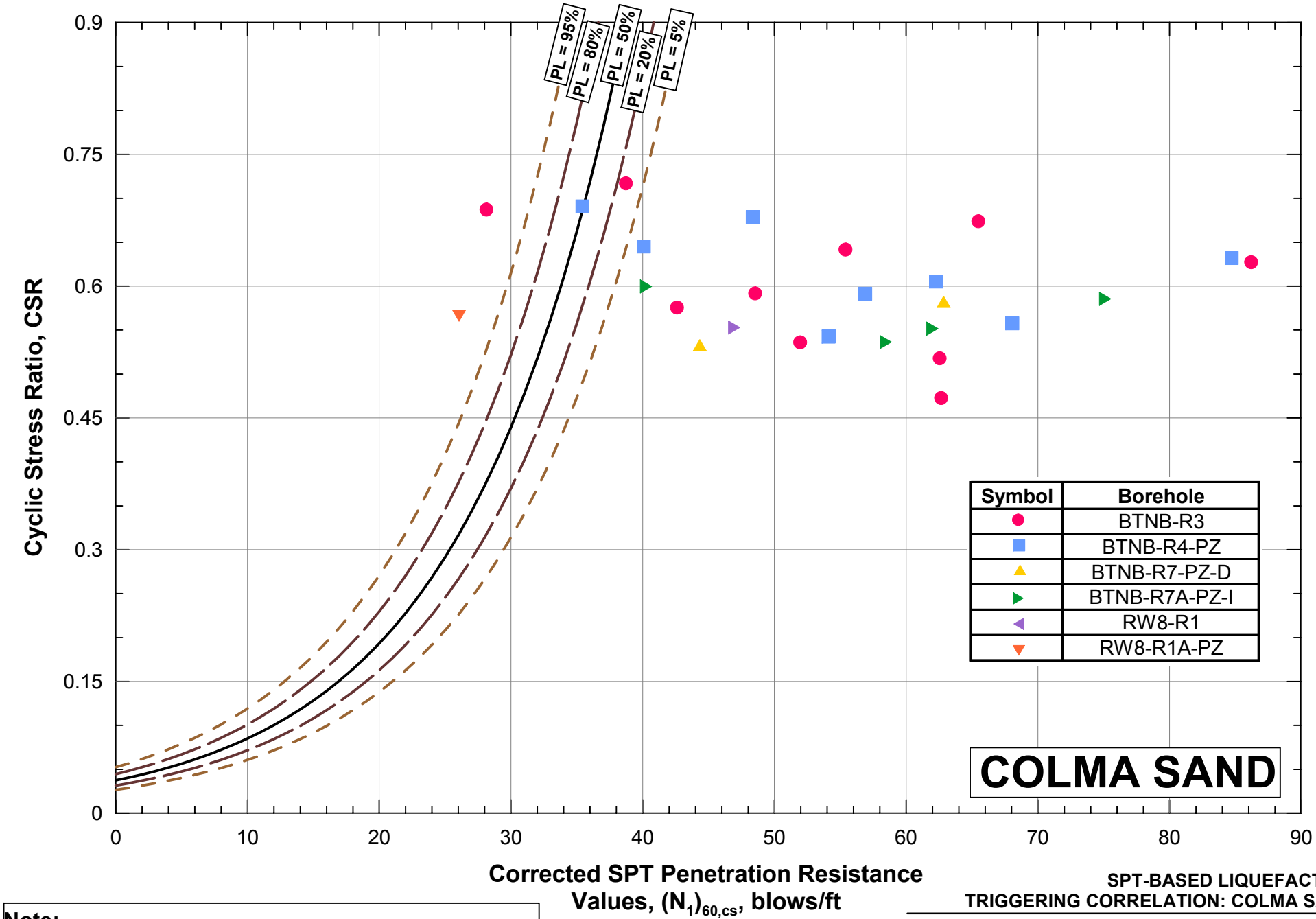
FIGURE 3

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationFILL Battery.grf



Note:

Probabilistic liquefaction (P_L) curves are for an earthquake moment magnitude, M_w= 7.5 and an effective overburden stress, σ'_v =1 .0 atm

SPT-BASED LIQUEFACTION TRIGGERING CORRELATION: COLMA SAND

Doyle Drive Replacement Project
Southbound Battery Tunnel Draft Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

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FIGURE 4

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Liquefaction Analyses\SPT-Based Liquefaction Triggering CorrelationCOLMA Battery.grf

Appendix A

Calculations

TABLE A-1
LIQUEFACTION ANALYSIS OF BOREHOLE BTSB-R1

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTSB-R1-PZ	Failing 1500	FILL	SP	MC	13	3.0	98.0	360	360	N	10	2.42	1.21	1.29	1.05	0.75	30	3	1.000	30	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	SPT	7	4.5	96.5	540	540	N	7	1.98	1.21	1.15	1.05	0.75	15	3	1.000	15	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	MC	24	8.5	92.5	1020	1020	N	18	1.44	1.21	1.30	1.05	0.81	35	3	1.000	35	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	SPT	20	10.0	91.0	1200	1200	N	20	1.33	1.21	1.30	1.05	0.84	37	3	1.000	37	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	MC	40	13.5	87.5	1620	1620	N	30	1.14	1.21	1.30	1.05	0.88	51	3.3	1.000	51	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	SPT	25	15.0	86.0	1800	1800	N	25	1.08	1.21	1.30	1.05	0.90	40	2	1.000	40	1.000	0.42	Above Water Table
BTSB-R1-PZ	Failing 1500	FILL	SP	MC	33	18.5	82.5	2220	2064	Y	25	1.01	1.21	1.30	1.05	0.93	39	2	1.000	39	1.000	0.46	0.35%
BTSB-R1-PZ	Failing 1500	FILL	SP	SPT	22	20.0	81.0	2400	2150	Y	22	0.99	1.21	1.30	1.05	0.94	34	2.1	1.000	34	1.000	0.47	29.10%
BTSB-R1-PZ	Failing 1500	BURIED SOIL HORIZON	CL	MC	12	23.5	77.5	2820	2352	Y	6	0.95	1.21	1.10	1.05	0.96	8	70	1.359	11	1.000	0.51	CLAY/SILT
BTSB-R1-PZ	Failing 1500	BURIED SOIL HORIZON	CL	SPT	3	25.0	76.0	3000	2438	Y	3	0.93	1.21	1.10	1.05	0.97	4	70	1.602	6	1.000	0.52	CLAY/SILT
BTSB-R1-PZ	Failing 1500	SANDY CLAY	ss	MC	300	33.1	68.0	4015	2954	Y	100	0.85	1.21	1.30	1.05	0.99	138	15	1.065	147	1.001	0.58	0.00%

* Depth is measured at midpoint of test (2nd 6")

TABLE A-2
LIQUEFACTION ANALYSIS OF BOREHOLE BTSB-R2

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTSB-R2	Fraste Multi-drill (Truck)	FILL	CH/SP	MC	9	3.5	88.6	420	420	N	6	2.24	1.27	1.15	1.05	0.75	15	15	1.110	17	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	FILL	SP	SPT	11	5.0	87.1	600	600	N	11	1.88	1.27	1.26	1.05	0.75	26	3	1.000	26	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	FILL/BURIED SOIL HORIZON	SP/CL	MC	14	8.5	83.6	1020	1020	N	11	1.44	1.27	1.21	1.05	0.81	20	3	1.000	20	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	BURIED SOIL HORIZON	CL	SPT	7	10.0	82.1	1200	1200	N	7	1.33	1.27	1.13	1.05	0.84	12	70	1.290	15	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	SANDY CLAY	ML	MC	22	13.5	78.6	1630	1630	N	16	1.14	1.27	1.30	1.05	0.88	27	70	1.204	33	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	SANDY CLAY	ML	SPT	7	15.0	77.1	1825	1825	N	7	1.08	1.27	1.11	1.05	0.90	10	70	1.314	13	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SM/SP-SM	MC	20	18.5	73.6	2280	2280	N	15	0.96	1.27	1.26	1.05	0.93	23	48.3	1.216	28	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	SPT	14	20.0	72.1	2475	2475	N	14	0.92	1.27	1.24	1.05	0.94	20	10	1.065	21	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	MC	70	23.5	68.6	2930	2930	N	53	0.85	1.27	1.30	1.05	0.96	75	3	1.000	75	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	SPT	60	25.0	67.1	3125	3125	N	60	0.82	1.27	1.30	1.05	0.97	83	3	1.000	83	1.000	0.42	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	MC	91	28.5	63.6	3580	3580	N	69	0.77	1.27	1.30	1.05	0.98	90	11.4	1.052	95	1.001	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	SPT	45	30.0	62.1	3775	3775	N	45	0.75	1.27	1.30	1.05	0.98	57	3	1.000	57	1.001	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	MC	69	33.5	58.6	4230	4230	N	52	0.71	1.27	1.30	1.05	0.99	63	13	1.062	67	1.001	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	COLMA SAND	SP-SM	SPT	37	35.0	57.1	4425	4425	N	37	0.69	1.27	1.30	1.05	0.99	44	5	1.026	45	1.001	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	SANDY CLAY	CL	MC	30	38.5	53.6	4880	4880	N	16	0.66	1.27	1.21	1.05	0.99	16	70	1.246	20	1.002	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	SANDY CLAY	CL	SPT	27	40.0	52.1	5075	5075	N	27	0.65	1.27	1.30	1.05	0.99	30	70	1.198	36	1.002	0.43	Above Water Table
BTSB-R2	Fraste Multi-drill (Truck)	SANDY CLAY	CL	MC	82	43.5	48.6	5530	5312	Y	43	0.63	1.27	1.30	1.05	0.99	46	70	1.178	55	1.003	0.44	CLAY/SILT
BTSB-R2	Fraste Multi-drill (Truck)	CLAY WITHIN COLMA FORMATION/ss	CL/ss	SPT	72	45.0	47.1	5730	5418	Y	72	0.62	1.27	1.30	1.05	0.99	78	15	1.070	83	1.004	0.45	CLAY/SILT
BTSB-R2	Fraste Multi-drill (Truck)	st	st	MC	109	48.2	43.9	6150	5651	Y	83	0.61	1.27	1.30	1.05	1.00	87	15	1.069	93	1.005	0.46	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-3
LIQUEFACTION ANALYSIS OF BOREHOLE BTSB-R3

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTSB-R3-PZ-D	Fraste Multi-drill (Track)	FILL	SP	SPT	4	3.5	94.4	420	420	N	4	2.24	1.22	1.10	1.05	0.75	9	5	1.046	10	1.000	0.42	Above Water Table
BTSB-R3-PZ-D	Fraste Multi-drill (Track)	FILL	SP	SPT	26	8.5	89.4	1020	1020	N	26	1.44	1.22	1.30	1.05	0.81	50	5	1.025	52	1.000	0.42	Above Water Table
BTSB-R3-PZ-D	Fraste Multi-drill (Track)	BURIED SOIL HORIZON	CL	SPT	8	13.5	84.4	1620	1620	N	8	1.14	1.22	1.12	1.05	0.88	12	70	1.292	15	1.000	0.42	Above Water Table
BTSB-R3-PZ-D	Fraste Multi-drill (Track)	ss	ss	SPT	171	18.5	79.4	2285	2260	Y	100	0.97	1.22	1.30	1.05	0.93	150	15	1.065	159	1.000	0.43	ROCK
BTSB-R3-PZ-D	Fraste Multi-drill (Track)	ss	ss	SPT	120	20.2	77.7	2495	2376	Y	100	0.94	1.22	1.30	1.05	0.94	148	15	1.065	157	1.000	0.45	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-4
LIQUEFACTION ANALYSIS OF BOREHOLE BTSB-R3A

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	MC	7	3.5	94.5	420	420	N	5	2.24	1.22	1.13	1.05	0.75	13	1.8	1.000	13	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	SPT	9	5.0	93.0	600	600	N	9	1.88	1.22	1.19	1.05	0.75	19	5	1.033	20	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	MC	29	8.5	89.5	1020	1020	N	22	1.44	1.22	1.30	1.05	0.81	43	5	1.026	44	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	SPT	11	10.0	88.0	1200	1200	N	11	1.33	1.22	1.19	1.05	0.84	19	1.4	1.000	19	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	BURIED SOIL HORIZON	CL	MC	14	13.5	84.5	1620	1620	N	7	1.14	1.22	1.10	1.05	0.88	10	70	1.310	14	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	SANDY CLAY	CL	SPT	9	15.0	83.0	1810	1810	N	9	1.08	1.22	1.12	1.05	0.90	13	70	1.280	16	1.000	0.42	Above Water Table
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	ss	ss	MC	150	18.2	79.9	2215	2072	Y	100	1.01	1.22	1.30	1.05	0.93	156	33.1	1.143	178	1.000	0.45	ROCK
BTSB-R3A-PZ-S	Fraste Multi-drill (Track)	ss	ss	SPT	100	19.1	79.0	2355	2149	Y	100	0.99	1.22	1.30	1.05	0.94	154	15	1.065	164	1.000	0.47	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-5
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R1

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)*	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTNB-R1	Fraste Multi-Drill (Track)	RESIDUAL SOIL	ML	MC	64	3.5	87.9	435	435	N	45	2.21	1.22	1.30	1.05	0.75	125	70	1.154	144	1.000	0.42	Above Water Table
BTNB-R1	Fraste Multi-Drill (Track)	RESIDUAL SOIL	ML	SPT	64	5.0	86.4	630	630	N	64	1.83	1.22	1.30	1.05	0.75	146	70	1.152	168	1.000	0.42	Above Water Table
BTNB-R1	Fraste Multi-Drill (Track)	RESIDUAL SOIL	GM	MC	82	8.5	82.9	1085	1085	N	53	1.40	1.22	1.30	1.05	0.81	100	15	1.067	107	1.000	0.42	Above Water Table
BTNB-R1	Fraste Multi-Drill (Track)	RESIDUAL SOIL	GM	SPT	109	9.7	81.6	1215	1215	N	100	1.32	1.22	1.30	1.05	0.83	182	15	1.064	194	1.000	0.42	Above Water Table
BTNB-R1	Fraste Multi-Drill (Track)	ssb	ssb	SPT	121	13.4	3.1	1680	1680	Y	100	1.12	1.22	1.30	1.05	0.88	164	15	1.065	175	1.000	0.42	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-6
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R2

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTNB-R2	Multi-Drill (Truck)		FILL	SM	MC	16	3.5	85.9	420	420	N	12	2.24	1.27	1.30	1.05	0.75	35	15	1.081	38	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		FILL	ML	SPT	20	5.0	84.4	600	600	N	20	1.88	1.27	1.30	1.05	0.75	49	70	1.176	57	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		FILL	GC	MC	15	8.5	80.9	1020	1020	N	10	1.44	1.27	1.18	1.05	0.81	18	15	1.102	20	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		FILL	SC	SPT	10	10.0	79.4	1200	1200	N	10	1.33	1.27	1.17	1.05	0.84	17	15	1.103	19	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		FILL	CL	MC	15	13.5	75.9	1620	1620	N	8	1.14	1.27	1.12	1.05	0.88	12	70	1.289	15	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		FILL	CL	SPT	6	15.0	74.4	1800	1800	N	6	1.08	1.27	1.10	1.05	0.90	9	70	1.344	12	1.000	0.42	Above Water Table
BTNB-R2	Multi-Drill (Truck)		TIDAL HORIZON/CLAY WITHIN C(	SM/CH	SPT	6	17.5	71.9	2105	1949	Y	6	1.04	1.27	1.10	1.05	0.92	8	15	1.148	10	1.000	0.46	100.00%
BTNB-R2	Multi-Drill (	Rock	srp	srp	SPT	61	24.5	64.9	3025	2432	Y	61	0.93	1.27	1.30	1.05	0.97	95	15	1.068	102	1.000	0.53	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-7
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R3

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTNB-R3	Fraste Multi-Drill (Track)	FILL	ML	MC	26	2.5	83.8	300	300	N	18	2.66	1.22	1.30	1.05	0.75	61	70	1.169	71	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	FILL	ML	SPT	14	4.0	82.3	480	480	N	14	2.10	1.22	1.30	1.05	0.75	37	70	1.188	43	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	FILL	SP	MC	18	7.5	78.8	900	900	N	14	1.53	1.22	1.25	1.05	0.75	25	5	1.030	26	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	FILL	ML	SPT	15	9.0	77.3	1080	1080	N	15	1.40	1.22	1.28	1.05	0.82	28	70	1.202	34	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	SANDY CLAY	ML	MC	31	11.0	75.3	1340	1340	N	22	1.26	1.22	1.30	1.05	0.85	39	70	1.185	46	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	SANDY CLAY	ML	SPT	14	12.5	73.8	1535	1535	N	14	1.17	1.22	1.22	1.05	0.87	22	70	1.219	27	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SC	MC	26	16.0	70.3	1990	1990	N	20	1.03	1.22	1.30	1.05	0.91	31	15	1.084	33	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SC	SPT	24	17.5	68.8	2185	2185	N	24	0.98	1.22	1.30	1.05	0.92	36	15	1.081	39	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	MC	57	21.0	65.3	2640	2640	N	43	0.90	1.22	1.30	1.05	0.95	61	10	1.048	64	1.000	0.42	Above Water Table
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	SPT	43	22.5	63.8	2835	2760	Y	43	0.88	1.22	1.30	1.05	0.96	60	10	1.048	63	1.000	0.44	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	MC	58	26.0	60.3	3290	2997	Y	44	0.84	1.22	1.30	1.05	0.97	60	10	1.048	63	1.000	0.47	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	SPT	37	27.5	58.8	3485	3098	Y	37	0.83	1.22	1.30	1.05	0.98	49	10	1.050	52	1.001	0.48	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	MC	41	31.0	55.3	3940	3335	Y	31	0.80	1.22	1.30	1.05	0.98	40	10	1.052	43	1.001	0.50	0.37%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	SPT	36	32.5	53.8	4135	3436	Y	36	0.78	1.22	1.30	1.05	0.99	46	10	1.051	49	1.001	0.51	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP	MC	91	36.0	50.3	4590	3673	Y	69	0.76	1.22	1.30	1.05	0.99	86	3	1.000	86	1.001	0.53	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP	SPT	45	37.5	48.8	4785	3774	Y	45	0.75	1.22	1.30	1.05	0.99	55	3	1.000	55	1.002	0.54	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP	MC	72	41.0	45.3	5240	4011	Y	55	0.73	1.22	1.30	1.05	0.99	65	3	1.000	65	1.002	0.56	0.00%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	SPT	23	42.5	43.8	5435	4112	Y	23	0.72	1.22	1.27	1.05	0.99	27	10	1.059	28	1.003	0.56	99.98%
BTNB-R3	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	MC	42	46.0	40.3	5890	4349	Y	32	0.70	1.22	1.30	1.05	1.00	37	10	1.054	39	1.004	0.58	42.70%
BTNB-R3	Fraste Multi-Drill (Track)	srp	srp	SPT	109	47.5	38.8	6095	4460	Y	100	0.69	1.22	1.30	1.05	1.00	114	15	1.067	121	1.005	0.58	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-8
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R4

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTNB-R4-PZ	Multi-Drill (Track)		FILL	GC/OL	MC	17	3.5	66.9	420	420	N	11	2.24	1.22	1.30	1.05	0.75	31	15	1.084	33	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		SANDY CLAY	OL/ML	SPT	21	5.0	65.4	605	605	N	21	1.87	1.22	1.30	1.05	0.75	49	70	1.176	57	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		SANDY CLAY	ML	MC	53	8.5	61.9	1060	1060	N	38	1.41	1.22	1.30	1.05	0.81	72	81.1	1.164	83	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		SANDY CLAY	ML	SPT	39	10.0	60.4	1255	1255	N	39	1.30	1.22	1.30	1.05	0.84	70	70	1.165	82	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		SANDY CLAY	ML	MC	52	13.5	56.9	1710	1710	N	37	1.11	1.22	1.30	1.05	0.88	60	54.4	1.169	70	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		SANDY CLAY	ML	SPT	34	15.0	55.4	1905	1905	N	34	1.05	1.22	1.30	1.05	0.90	54	70	1.173	63	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP	MC	81	18.5	51.9	2360	2360	N	62	0.95	1.22	1.30	1.05	0.93	90	5	1.023	92	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP	SPT	44	20.0	50.4	2555	2555	N	44	0.91	1.22	1.30	1.05	0.94	63	5	1.024	64	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	101	23.5	46.9	3010	3010	N	77	0.84	1.22	1.30	1.05	0.96	103	14.3	1.064	109	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	48	25.0	45.4	3205	3205	N	48	0.81	1.22	1.30	1.05	0.97	63	10	1.048	66	1.000	0.42	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	76	28.5	41.9	3660	3660	N	58	0.76	1.22	1.30	1.05	0.98	71	10	1.047	75	1.001	0.43	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	53	30.0	40.4	3855	3855	N	53	0.74	1.22	1.30	1.05	0.98	64	10	1.048	67	1.001	0.43	Above Water Table
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	58	33.5	36.9	4310	4127	Y	44	0.72	1.22	1.30	1.05	0.99	52	9.5	1.047	54	1.001	0.44	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	56	35.0	35.4	4505	4229	Y	56	0.71	1.22	1.30	1.05	0.99	65	10	1.048	68	1.001	0.45	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	63	38.5	31.9	4960	4465	Y	48	0.69	1.22	1.30	1.05	0.99	54	10	1.049	57	1.002	0.47	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	53	40.0	30.4	5155	4567	Y	53	0.68	1.22	1.30	1.05	0.99	59	10	1.048	62	1.002	0.48	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	97	43.5	26.9	5545	4770	Y	74	0.67	1.22	1.30	1.05	0.99	81	10	1.046	85	1.003	0.50	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	35	45.0	25.5	5740	4871	Y	35	0.66	1.22	1.30	1.05	0.99	38	10	1.053	40	1.004	0.50	11.06%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	56	48.5	21.9	6260	5141	Y	43	0.64	1.22	1.30	1.05	1.00	45	14.2	1.073	48	1.005	0.52	0.00%
BTNB-R4-PZ	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	32	50.0	20.4	6455	5243	Y	32	0.64	1.22	1.30	1.05	1.00	34	10	1.055	35	1.006	0.53	79.74%
BTNB-R4-PZ	Multi-Drill (Track)		RESIDUAL SOIL	CL	MC	30	53.5	16.9	6910	5479	Y	16	0.62	1.22	1.14	1.05	1.00	14	70	1.265	18	1.009	0.54	CLAY/SILT
BTNB-R4-PZ	Multi-Drill (	Rock	srp	srp	SPT	100	54.8	15.7	7045	5552	Y	100	0.62	1.22	1.30	1.05	1.00	102	15	1.067	109	1.010	0.54	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-9
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R5

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
TNB-R5-PZ-	Multi-Drill (	Rock	ss	ss	SPT	200	3.1	76.5	420	420	N	100	2.24	1.22	1.30	1.05	0.75	279	15	1.063	297	1.000	0.42	Above Water Table

* Depth is measured at midpoint of test (2nd 6")

TABLE A-10
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R6

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
TNB-R6-PZ-	Multi-Drill (Track)		FILL	SP-SM	MC	18	3.5	80.1	420	420	N	14	2.24	1.22	1.30	1.05	0.75	38	10	1.053	40	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		FILL	SP-SM	SPT	5	5.0	78.6	600	600	N	5	1.88	1.22	1.10	1.05	0.75	10	10	1.091	11	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		FILL	SP-SM	MC	13	8.5	75.1	1020	1020	N	10	1.44	1.22	1.17	1.05	0.81	17	9.5	1.066	18	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		FILL	SP-SM	SPT	14	10.0	73.6	1200	1200	N	14	1.33	1.22	1.25	1.05	0.84	25	10	1.060	26	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		SANDY CLAY	ML	MC	27	13.5	70.1	1630	1630	N	19	1.14	1.22	1.30	1.05	0.88	32	60	1.195	38	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		SANDY CLAY	ML	SPT	36	15.0	68.6	1825	1825	N	36	1.08	1.22	1.30	1.05	0.90	58	60	1.170	68	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		SANDY CLAY	ML	MC	41	18.5	65.1	2280	2280	N	29	0.96	1.22	1.30	1.05	0.93	43	59.1	1.180	51	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		SANDY CLAY	ML	SPT	23	20.0	63.6	2475	2475	N	23	0.92	1.22	1.30	1.05	0.94	33	60	1.193	40	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	MC	68	23.5	60.1	2930	2930	N	52	0.85	1.22	1.30	1.05	0.96	70	17.9	1.084	76	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	59	25.0	58.6	3125	3125	N	59	0.82	1.22	1.30	1.05	0.97	78	10.9	1.051	82	1.000	0.42	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SC	MC	120	28.2	55.4	3515	3515	N	91	0.78	1.22	1.30	1.05	0.98	115	10.9	1.048	120	1.001	0.43	Above Water Table
TNB-R6-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SC	SPT	66	29.4	54.2	3645	3645	N	66	0.76	1.22	1.30	1.05	0.98	82	31.8	1.147	94	1.001	0.43	Above Water Table

TABLE A-11
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R6A

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
TNB-R6A-PZ	Multi-Drill (Track)		FILL	SP-SM	MC	14	3.5	80.0	420	420	N	11	2.24	1.22	1.29	1.05	0.75	29	10	1.057	31	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		FILL	SP-SM	SPT	6	5.0	78.5	600	600	N	6	1.88	1.22	1.12	1.05	0.75	12	10	1.081	13	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		FILL	SP-SM	MC	17	8.5	75.0	1020	1020	N	13	1.44	1.22	1.23	1.05	0.81	24	10	1.061	25	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		FILL	SP-SM	SPT	18	10.0	73.5	1200	1200	N	18	1.33	1.22	1.30	1.05	0.84	33	10	1.055	35	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		SANDY SILT	ML	MC	30	13.5	70.0	1630	1630	N	21	1.14	1.22	1.30	1.05	0.88	36	60	1.189	42	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		SANDY SILT	ML	SPT	17	15.0	68.5	1825	1825	N	17	1.08	1.22	1.27	1.05	0.90	27	60	1.206	32	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		SANDY SILT	ML	MC	42	18.5	65.0	2280	2280	N	30	0.96	1.22	1.30	1.05	0.93	44	60	1.179	52	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		SANDY SILT	ML	SPT	23	20.0	63.5	2475	2475	N	23	0.92	1.22	1.30	1.05	0.94	33	60	1.193	40	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		COLMA SAND	SP-SM	MC	42	23.5	60.0	2930	2930	N	32	0.85	1.22	1.30	1.05	0.96	43	15	1.077	47	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	38	25.0	58.5	3125	3125	N	38	0.82	1.22	1.30	1.05	0.97	50	15	1.075	54	1.000	0.42	Above Water Table
TNB-R6A-PZ	Multi-Drill (Track)		COLMA SAND/srp	SP-SC/srp	MC	69	28.5	55.0	3585	3585	N	52	0.77	1.22	1.30	1.05	0.98	65	31.8	1.152	75	1.001	0.43	Above Water Table
TNB-R6A-PZ	Multi-Drill (	Rock	srp	srp	SPT	109	29.7	53.8	3725	3725	N	100	0.75	1.22	1.30	1.05	0.98	123	15	1.066	131	1.001	0.43	Above Water Table

* Depth is measured at midpoint of test (2nd 6")

TABLE A-12
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R7

Borehole ID	Drill Rig	Rock?	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
TNB-R7-PZ-	Multi-Drill (Track)		FILL	SP	SPT	7	3.5	75.9	420	420	N	7	2.24	1.22	1.18	1.05	0.75	18	5	1.034	18	1.000	0.42	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		BURIED SOIL HORIZO	ML	SPT	3	8.5	70.9	1020	1020	N	3	1.44	1.22	1.10	1.05	0.81	5	70	1.496	7	1.000	0.42	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		SANDY CLAY	ML	MC	33	13.5	65.9	1640	1640	N	23	1.14	1.22	1.30	1.05	0.88	39	70	1.185	46	1.000	0.42	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		COLMA SAND	SM	MC	18	18.5	60.9	2290	2290	N	14	0.96	1.22	1.18	1.05	0.93	18	15	1.101	20	1.000	0.42	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	33	23.5	55.9	2940	2940	N	33	0.85	1.22	1.30	1.05	0.96	45	10	1.051	47	1.000	0.42	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	25	28.5	50.9	3590	3590	N	25	0.77	1.22	1.30	1.05	0.98	31	10	1.056	33	1.001	0.43	Above Water Table
TNB-R7-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	36	33.5	45.9	4240	4138	Y	36	0.72	1.22	1.30	1.05	0.99	42	10	1.052	44	1.001	0.44	0.01%
TNB-R7-PZ-	Multi-Drill (Track)		COLMA SAND	SP-SM	SPT	53	38.5	40.9	4890	4476	Y	53	0.69	1.22	1.30	1.05	0.99	60	10	1.048	63	1.002	0.46	0.00%

* Depth is measured at midpoint of test (2nd 6")

TABLE A-13
LIQUEFACTION ANALYSIS OF BOREHOLE BTNB-R6A

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical effective stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	FILL	SP	MC	25	3.5	75.5	420	420	N	19	2.24	1.22	1.30	1.05	0.75	53	5	1.025	54	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	FILL	SP	SPT	7	5.0	74.0	600	600	N	7	1.88	1.22	1.14	1.05	0.75	14	5	1.037	15	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	BURIED SOIL HORIZON	ML	MC	4	8.5	70.5	1020	1020	N	3	1.44	1.22	1.10	1.05	0.81	5	70	1.516	7	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	BURIED SOIL HORIZON	CL	SPT	11	10.0	69.0	1200	1200	N	11	1.33	1.22	1.19	1.05	0.84	19	70	1.234	23	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	SANDY SILT	ML	MC	32	13.5	65.5	1640	1640	N	23	1.14	1.22	1.30	1.05	0.88	38	70	1.186	45	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	SANDY SILT	ML	SPT	12	15.0	64.0	1835	1835	N	12	1.07	1.22	1.17	1.05	0.90	17	70	1.241	22	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	SANDY CLAY	SM	MC	15	18.5	60.5	2290	2290	N	11	0.96	1.22	1.15	1.05	0.93	15	52.5	1.257	19	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	SANDY CLAY	CL	SPT	7	20.0	59.0	2485	2485	N	7	0.92	1.22	1.10	1.05	0.94	9	70	1.345	11	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP	MC	44	23.5	55.5	2940	2940	N	33	0.85	1.22	1.30	1.05	0.96	45	17.6	1.090	49	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP	SPT	38	25.0	54.0	3135	3135	N	38	0.82	1.22	1.30	1.05	0.97	50	5	1.025	51	1.000	0.42	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP-SM	MC	41	28.5	50.5	3590	3590	N	31	0.77	1.22	1.30	1.05	0.98	39	10	1.053	41	1.001	0.43	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP-SM	SPT	23	30.0	49.0	3785	3785	N	23	0.75	1.22	1.28	1.05	0.98	28	10	1.058	29	1.001	0.43	Above Water Table
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP	MC	60	33.5	45.5	4240	4099	Y	46	0.72	1.22	1.30	1.05	0.99	54	18.2	1.090	58	1.001	0.44	0.00%
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP	SPT	52	35.0	44.0	4435	4201	Y	52	0.71	1.22	1.30	1.05	0.99	61	5	1.024	62	1.001	0.45	0.00%
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP	MC	85	38.5	40.5	4890	4437	Y	65	0.69	1.22	1.30	1.05	0.99	73	5	1.023	75	1.002	0.47	0.00%
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	COLMA SAND	SP-SC	SPT	34	40.0	39.0	5085	4539	Y	34	0.68	1.22	1.30	1.05	0.99	38	10	1.053	40	1.002	0.48	5.05%
BTNB-R7A-PZ-S	Fraste Multi-Drill (Track)	srp	srp	SPT	64	44.5	34.5	5700	4873	Y	64	0.66	1.22	1.30	1.05	0.99	70	15	1.071	74	1.003	0.50	ROCK

TABLE A-14
LIQUEFACTION ANALYSIS OF BOREHOLE RW6-R1

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N	Depth	Elevation	Total Vertical Stress	Vertical Effective Stress	Below Water Table?	Equivalent SPT N Values	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$	FC	C_{FINES}	$N_{1,60,CS}$	r_d	CSR_{eq}	P_L
					bpf	(ft)	(ft)	(psf)	(psf)	(Y/N)	(bpf)						(bpf)	(%)		(bpf)			
RW6-R1-PZ	CME 550	FILL/SILT WITHIN COLMA FORMATION	SC/ML	MC	10	3.5	105.0	420	420	N	7	2.24	1.27	1.20	1.05	0.75	18	49.5	1.240	22	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	SANDY CLAY	ML	SPT	12	5.0	103.5	615	615	N	12	1.85	1.27	1.28	1.05	0.75	28	70	1.201	34	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	SANDY CLAY	ML	MC	49	8.0	100.5	1005	1005	N	35	1.45	1.27	1.30	1.05	0.75	66	75.6	1.167	77	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	COLMA SAND	SM	SPT	42	9.5	99.0	1200	1200	N	42	1.33	1.27	1.30	1.05	0.83	80	15	1.069	86	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	COLMA SAND	SM	MC	47	13.0	95.5	1655	1655	N	36	1.13	1.27	1.30	1.05	0.88	61	21.5	1.103	68	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	COLMA SAND	SM	SPT	45	14.5	94.0	1850	1850	N	45	1.07	1.27	1.30	1.05	0.90	75	15	1.070	80	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	COLMA SAND/ss	SM/ss	MC	54	18.0	90.5	2310	2310	N	41	0.96	1.27	1.30	1.05	0.93	63	27.4	1.131	72	1.000	0.42	Above Water Table
RW6-R1-PZ	CME 550	ss	ss	SPT	600	18.8	89.7	2380	2380	N	100	0.94	1.27	1.30	1.05	0.93	153	15	1.065	163	1.000	0.42	Above Water Table

* Depth is measured at midpoint of test (2nd 6")

TABLE A-15
LIQUEFACTION ANALYSIS OF BOREHOLE RW6-R2

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
RW6-R2-PZ-D	Fraste Multi-drill (Track)	FILL	SP	SPT	8	3.5	105.2	420	420	N	8	2.24	1.22	1.21	1.05	0.75	21	5	1.032	21	1.000	0.42	Above Water Table
RW6-R2-PZ-D	Fraste Multi-drill (Track)	FILL	SP	SPT	17	8.5	100.2	1020	1020	N	17	1.44	1.22	1.30	1.05	0.81	33	5	1.028	34	1.000	0.42	Above Water Table
RW6-R2-PZ-D	Fraste Multi-drill (Track)	COLMA SAND	SM	SPT	64	13.5	95.2	1665	1665	N	64	1.13	1.22	1.30	1.05	0.88	106	15	1.067	113	1.000	0.42	Above Water Table
RW6-R2-PZ-D	Fraste Multi-drill (Track)	COLMA SAND	SM	SPT	43	18.5	90.2	2315	2315	N	43	0.96	1.22	1.30	1.05	0.93	64	15	1.072	68	1.000	0.42	Above Water Table
RW6-R2-PZ-D	Fraste Multi-drill (Track)	COLMA SAND	SM	SPT	49	23.5	85.2	2965	2965	N	49	0.84	1.22	1.30	1.05	0.96	66	15	1.071	71	1.000	0.42	Above Water Table
RW6-R2-PZ-D	Fraste Multi-drill (Track)	ss	ss	SPT	100	28.3	80.4	3570	3570	N	100	0.77	1.22	1.30	1.05	0.98	125	15	1.066	133	1.001	0.43	Above Water Table

* Depth is measured at midpoint of test (2nd 6")

TABLE A-16
LIQUEFACTION ANALYSIS OF BOREHOLE RW6-R2A

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	MC	6	3.5	104.8	420	420	N	5	2.24	1.22	1.11	1.05	0.75	11	4.5	1.000	11	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	SPT	3	5.0	103.3	600	600	N	3	1.88	1.22	1.10	1.05	0.75	6	5	1.062	6	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	FILL	SP	MC	29	8.5	99.8	1020	1020	N	22	1.44	1.22	1.30	1.05	0.81	43	2.7	1.000	43	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	FILL/SILT WITHIN COLMA FORMATION	SP/ML	SPT	17	10.0	98.3	1210	1210	N	17	1.32	1.22	1.30	1.05	0.84	31	15	1.084	34	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	COLMA SAND	SM	MC	95	13.5	94.8	1665	1665	N	72	1.13	1.22	1.30	1.05	0.88	119	15	1.066	127	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	COLMA SAND	SM	SPT	56	15.0	93.3	1860	1860	N	56	1.07	1.22	1.30	1.05	0.90	89	15	1.068	95	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	COLMA SAND	SM	MC	94	18.5	89.8	2315	2315	N	71	0.96	1.22	1.30	1.05	0.93	106	16.4	1.073	113	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	COLMA SAND	SM	SPT	81	20.0	88.3	2510	2510	N	81	0.92	1.22	1.30	1.05	0.94	116	15	1.066	124	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	COLMA SAND/CLAY WITHIN COLMA FORMATION	SM/CL	MC	29	23.5	84.8	2965	2965	N	22	0.84	1.22	1.29	1.05	0.96	29	15	1.085	32	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	SANDY CLAY	CL	SPT	66	25.0	83.3	3160	3160	N	66	0.82	1.22	1.30	1.05	0.97	87	15	1.069	93	1.000	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	CLAY WITHIN COLMA FORMATION/ss	CL/ss,sh	MC	104	26.3	82.1	3290	3290	N	68	0.80	1.22	1.30	1.05	0.97	87	15	1.069	93	1.001	0.42	Above Water Table
RW6-R2A-PZ-S	Fraste Multi-drill (Track)	ss	ss, sh	SPT	300	26.6	81.7	3360	3360	N	100	0.79	1.22	1.30	1.05	0.97	128	15	1.066	136	1.001	0.42	Above Water Table

* Depth is measured at midpoint of test (2nd 6")

TABLE A-17
LIQUEFACTION ANALYSIS OF BOREHOLE RW8-R1

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
RW8-R1-PZ	Failing 1500	FILL	SP	MC	4	8.5	82.1	1020	1020	N	3	1.44	1.21	1.10	1.05	0.81	5	5	1.070	5	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	FILL	SP	SPT	5	10.0	80.6	1200	1200	N	5	1.33	1.21	1.10	1.05	0.84	8	5	1.052	8	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	BURIED SOIL HORIZON	CL-ML	MC	0	13.5	77.1	1620	1620	N	0	1.14	1.21	1.10	1.05	0.88	0	70	175001.140	2	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	SANDY CLAY	CL	SPT	6	15.0	75.6	1810	1810	N	6	1.08	1.21	1.10	1.05	0.90	8	70	1.354	11	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	SANDY CLAY	CL	MC	28	18.5	72.1	2265	2265	N	15	0.97	1.21	1.19	1.05	0.93	20	70	1.228	24	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	SANDY CLAY	CL	SPT	17	20.0	70.6	2460	2460	N	17	0.93	1.21	1.23	1.05	0.94	23	70	1.215	28	1.000	0.42	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	MC	36	28.5	62.1	3565	3565	N	27	0.77	1.21	1.30	1.05	0.98	34	10	1.055	36	1.001	0.43	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	SPT	32	30.0	60.6	3760	3760	N	32	0.75	1.21	1.30	1.05	0.98	39	10	1.053	41	1.001	0.43	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	MC	46	33.5	57.1	4215	4215	N	35	0.71	1.21	1.30	1.05	0.99	40	10	1.052	43	1.001	0.43	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	SPT	38	35.0	55.6	4410	4410	N	38	0.69	1.21	1.30	1.05	0.99	43	10	1.052	45	1.001	0.43	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	MC	69	38.5	52.1	4865	4865	N	52	0.66	1.21	1.30	1.05	0.99	57	10	1.049	60	1.002	0.43	Above Water Table
RW8-R1-PZ	Failing 1500	COLMA SAND	SP-SC	SPT	42	40.0	50.6	5060	5060	Y	42	0.65	1.21	1.30	1.05	0.99	45	10	1.051	47	1.002	0.43	0.00%
RW8-R1-PZ	Failing 1500	SANDY CLAY	CL	MC	20	43.5	47.1	5515	5515	Y	10	0.62	1.21	1.10	1.05	0.99	9	70	1.335	12	1.003	0.43	CLAY/SILT
RW8-R1-PZ	Failing 1500	RESIDUAL SOIL	CL	SPT	16	45.0	45.6	5710	5710	Y	16	0.61	1.21	1.14	1.05	0.99	14	70	1.264	18	1.004	0.43	CLAY/SILT
RW8-R1-PZ	Failing 1500	ss	ss	MC	150	47.7	42.9	6040	6040	Y	100	0.59	1.21	1.30	1.05	1.00	98	15	1.068	104	1.005	0.43	ROCK
RW8-R1-PZ	Failing 1500	ss	ss	SPT	120	48.0	42.6	6110	6110	Y	100	0.59	1.21	1.30	1.05	1.00	97	15	1.068	104	1.005	0.43	ROCK

* Depth is measured at midpoint of test (2nd 6")

TABLE A-18
LIQUEFACTION ANALYSIS OF BOREHOLE RW8-R1A

Borehole ID	Drill Rig	Soil Unit	Soil Classification	Sampler Type	N bpf	Depth (ft)	Elevation (ft)	Total Vertical Stress (psf)	Vertical Effective Stress (psf)	Below Water Table? (Y/N)	Equivalent SPT N Values (bpf)	C_N	C_E	C_S	C_B	C_R	$N_{1,60}$ (bpf)	FC (%)	C_{FINES}	$N_{1,60,CS}$ (bpf)	r_d	CSR_{eq}	P_L
RW8-R1A-PZ	Mobile B-53	FILL	SP	MC	10	6.0	84.6	720	720	N	8	1.71	1.17	1.14	1.05	0.75	14	5	1.038	14	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	FILL	SP	SPT	4	7.5	83.1	900	900	N	4	1.53	1.17	1.10	1.05	0.75	6	5	1.060	7	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	FILL	SP	MC	10	11.0	79.6	1320	1320	N	8	1.27	1.17	1.11	1.05	0.85	11	5	1.042	12	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	BURIED SOIL HORIZON	ML/CL	SPT	1	12.5	78.1	1500	1500	N	1	1.19	1.17	1.10	1.05	0.87	1	70	2.395	3	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	SANDY CLAY	CL	MC	16	16.0	74.6	1935	1935	N	8	1.05	1.17	1.11	1.05	0.91	11	70	1.302	14	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	SANDY CLAY	CL	SPT	16	17.5	73.1	2130	2130	N	16	1.00	1.17	1.22	1.05	0.92	22	70	1.219	27	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	SANDY CLAY	CL	MC	26	21.0	69.6	2585	2585	N	14	0.90	1.17	1.17	1.05	0.95	17	70	1.245	21	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	SANDY CLAY	CL	SPT	11	22.5	68.1	2780	2780	N	11	0.87	1.17	1.13	1.05	0.96	13	70	1.278	16	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	COLMA SAND	SC	SPT	12	26.0	64.6	3235	3235	N	12	0.81	1.17	1.13	1.05	0.97	13	15	1.117	15	1.000	0.42	Above Water Table
RW8-R1A-PZ	Mobile B-53	COLMA SAND	SP-SC	SPT	31	31.0	59.6	3885	3885	N	31	0.74	1.17	1.30	1.05	0.98	36	10	1.054	38	1.001	0.43	Above Water Table
RW8-R1A-PZ	Mobile B-53	COLMA SAND	SP-SC	SPT	54	36.0	54.6	4535	4535	N	54	0.68	1.17	1.30	1.05	0.99	58	10	1.049	61	1.001	0.43	Above Water Table
RW8-R1A-PZ	Mobile B-53	COLMA SAND	SP-SC	SPT	25	41.0	49.6	5185	5064	Y	25	0.65	1.17	1.25	1.05	0.99	25	10	1.060	26	1.002	0.44	99.96%
RW8-R1A-PZ	Mobile B-53	RESIDUAL SOIL	CH	SPT	12	46.0	44.6	5835	5402	Y	12	0.63	1.17	1.10	1.05	1.00	10	70	1.314	13	1.004	0.46	CLAY/SILT

* Depth is measured at midpoint of test (2nd 6")

Appendix B

Copy of Amec-Geomatrix Site Response Analyses for the Southbound Battery Tunnel

Table 4: Horizontal site response analysis result for East Battery Tunnels (deep) profile, SEE scenario

Layer No.	Soil Type	Thickness ft	Top Depth ft	Unit Weight pcf	small strain Vs ft/sec	strain-compatible Vs ft/sec	strain-compatible Damping %	Peak shear strain %	Peak shear stress psf
1	FILL	3.0	0.0	119.5	560	473	5.00	0.0274	228
2	FILL	2.0	3.0	119.5	560	473	5.00	0.0274	228
3	FILL	2.5	5.0	119.5	679	515	7.50	0.0539	531
4	COLMA SILT	2.5	7.5	131.0	679	535	6.00	0.0611	717
5	COLMA SILT	1.5	10.0	131.0	951	814	4.25	0.0362	982
6	COLMA SILT	3.5	11.5	131.0	951	814	4.25	0.0362	982
7	COLMA SILT	2.5	15.0	131.0	1234	1106	3.50	0.0245	1220
8	COLMA SAND	2.5	17.5	131.0	1234	1092	3.75	0.0280	1361
9	COLMA SAND	5.0	20.0	131.0	1547	1421	3.00	0.0190	1563
10	COLMA SAND	5.0	25.0	131.0	1448	1288	3.50	0.0272	1827
11	COLMA SAND	5.0	30.0	131.0	1497	1321	3.75	0.0295	2081
12	COLMA SAND	0.5	35.0	131.0	1418	1210	4.50	0.0390	2307
13	COLMA SAND	4.5	35.5	131.0	1418	1210	4.50	0.0390	2307
14	COLMA CLAY	5.0	40.0	131.0	1534	1457	2.50	0.0292	2518
15	COLMA CLAY	5.0	45.0	131.0	1739	1665	2.50	0.0241	2715
16	ROCK	5.0	50.0	140.0	2573	2461	2.00	0.0110	2900
17	ROCK	5.0	55.0	140.0	2790	2675	2.00	0.0099	3086
18	ROCK	5.0	60.0	140.0	2916	2797	2.00	0.0096	3278
19	ROCK	5.0	65.0	140.0	3177	3056	2.00	0.0085	3464
20	ROCK	BASE	70.0	140.0	3500	3500	2.00		

Table 5: Horizontal site response analysis result for West Battery Tunnels (shallow) profile, SEE scenario

Layer No.	Soil Type	Thickness ft	Top Depth ft	Unit Weight pcf	small strain Vs ft/sec	strain-compatible Vs ft/sec	strain-compatible Damping %	Peak shear strain %	Peak shear stress psf
1	FILL	3.0	0.0	119.5	560	499	4.00	0.0178	164
2	FILL	2.0	3.0	119.5	560	499	4.00	0.0178	164
3	FILL	5.0	5.0	119.5	833	719	4.50	0.0233	447
4	FILL	1.5	10.0	119.5	1000	852	5.00	0.0255	689
5	FILL	3.5	11.5	119.5	1000	852	5.00	0.0255	689
6	FILL	5.0	15.0	119.5	1150	979	5.00	0.0257	917
7	COLMA SILT	5.0	20.0	131.0	1500	1409	2.50	0.0143	1153
8	COLMA SILT	5.0	25.0	131.0	2000	1923	2.00	0.0092	1380
9	ROCK	5.0	30.0	140.0	3897	3843	2.00	0.0025	1610
10	ROCK	0.5	35.0	140.0	4490	4441	2.00	0.0022	1847
11	ROCK	4.5	35.5	140.0	4490	4441	2.00	0.0022	1847
12	ROCK	5.0	40.0	140.0	4011	3941	2.00	0.0031	2081
13	ROCK	BASE	45.0	140.0	5000	5000	2.00		

Table 6: Horizontal site response analysis result for BTSB-R3 profile, SEE scenario

Soil Type	Thickness ft	Top Depth ft	Unit Weight pcf	small strain Vs ft/sec	strain-compatible Vs ft/sec	strain-compatible Damping %	Peak shear strain %	Peak shear stress psf
FILL	3.0	0.0	119.5	560	470	5.25	0.0291	238
FILL	2.0	3.0	119.5	560	470	5.25	0.0291	238
FILL	5.0	5.0	119.5	772	609	6.75	0.0432	596
COLMA SILT	1.5	10.0	131.0	1018	913	3.50	0.0246	833
COLMA SILT	3.5	11.5	131.0	1018	913	3.50	0.0246	833
ROCK	5.0	15.0	140.0	3492	3458	2.00	0.0020	1035
ROCK	5.0	20.0	140.0	4065	4032	2.00	0.0018	1283
ROCK	5.0	25.0	140.0	4746	4720	2.00	0.0016	1537
ROCK	5.0	30.0	140.0	4496	4448	2.00	0.0021	1799
ROCK	0.5	35.0	140.0	4482	4422	2.00	0.0024	2064
ROCK	4.5	35.5	140.0	4482	4422	2.00	0.0024	2064
ROCK	5.0	40.0	140.0	4430	4358	2.00	0.0028	2327
ROCK	5.0	45.0	140.0	4491	4412	2.00	0.0031	2590
ROCK	BASE	50.0	140.0	3500	5000	2.00		

Appendix C

Development of Correction Factors for Modified California Sampler

Introduction

This Appendix presents the methods and results for determining factors for correcting Modified California (MC) blowcounts to equivalent Standard Penetration Test (SPT) blowcounts.

Throughout the field investigation, double sampling was performed typically within the upper 50 feet of the borehole. Double sampling includes driving a MC followed directly by a SPT. At the conclusion of the fieldwork, the blowcounts were compared to determine an average value that could be used to adjust all MC N-values to equivalent SPT N-values.

Methodology

The methodology used to determine the correction factors was to plot each of uncorrected (direct blowcounts from the field) MC N-value versus uncorrected SPT N-value that immediately followed it. From this plot, a best fit line was determined, the slope of which was taken to be the correction factor.

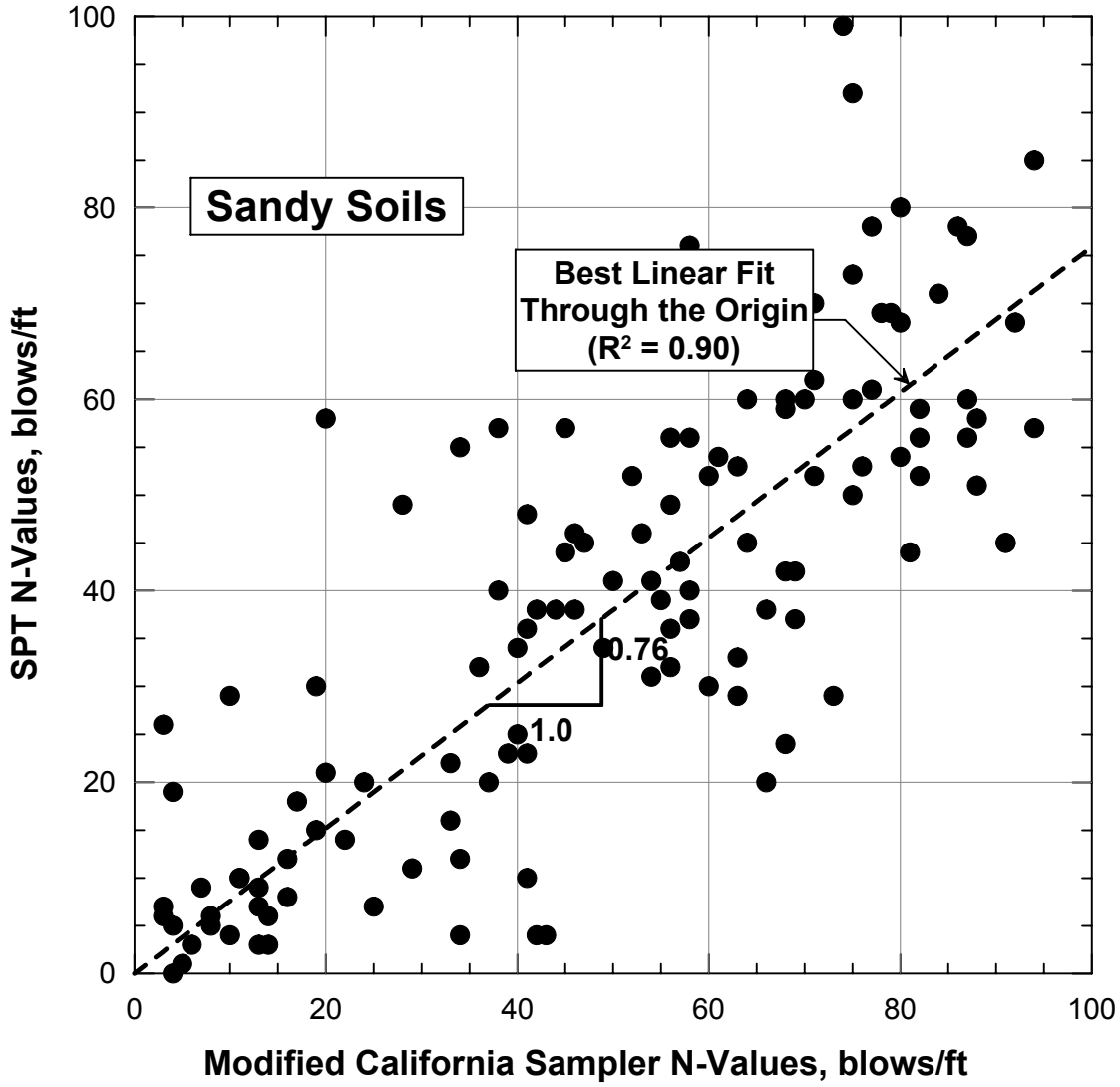
Only consecutive samples taken within the same soil type were accepted. If there was a change in soil type or formation, the pair of blowcounts was removed from the database.

Results

After comparing all of the data by soil type, it was determined that all sandy soils (FC<50%) should be grouped together into one correlation. Silty soils were separated from clayey soils. The following table summarizes the results.

Soil Type	Number of Consecutive Tests	Correction Factor Applied to Modified California N-values
Sand	124	0.76
Silt	11	0.71
Clay	13	0.52

Figure C-1 presents the results from Sandy Soils, Figure C-2 presents the results from Silt (Soil Type ML), and Figure C-3 presents the results from Clay (Soil Type CL).



COMPARISON OF SPT AND MODIFIED CALIFORNIA PENETRATION RESISTANCE TEST RESULTS: SANDY SOILS

Doyle Drive Replacement Project
Southbound Battery Tunnel Draft Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

ARUP PB joint venture

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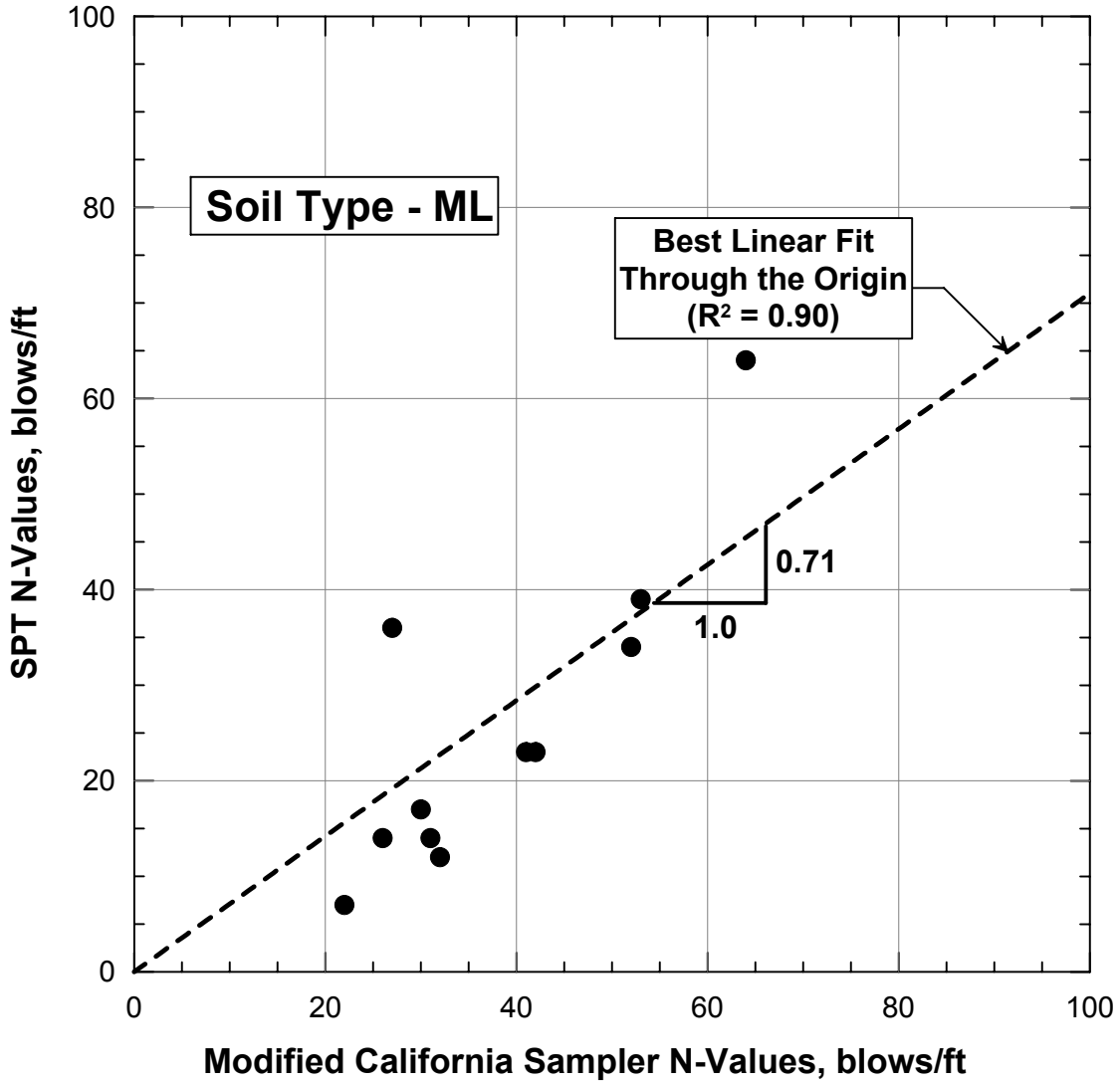
FIGURE C-1



COMPARISON OF SPT AND MODIFIED CALIFORNIA PENETRATION RESISTANCE TEST RESULTS: SOIL TYPE "ML"

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Southbound Battery Tunnel Draft Foundation Report
San Francisco County Transportation Authority
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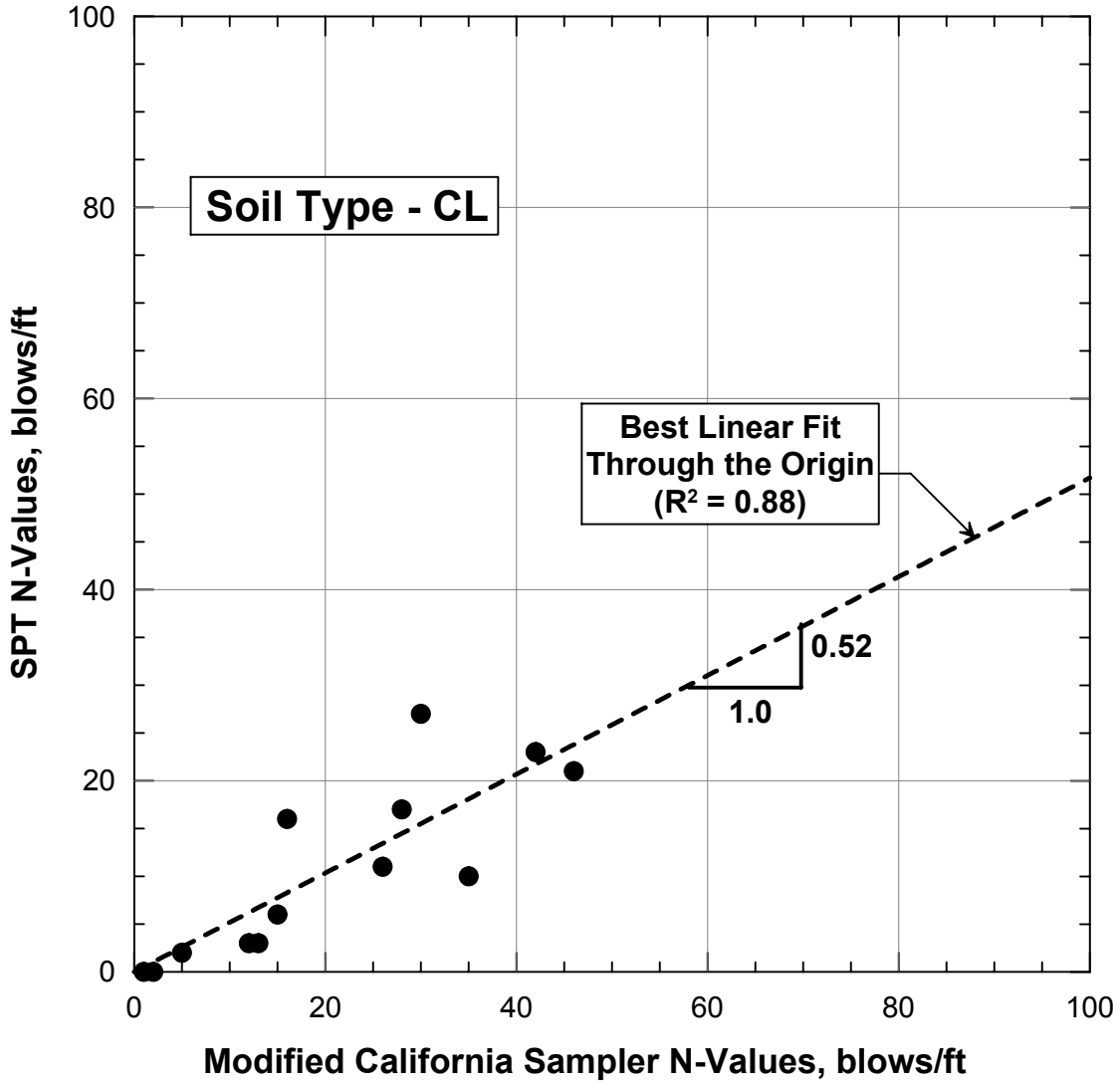
FIGURE C-2



COMPARISON OF SPT AND MODIFIED CALIFORNIA PENETRATION RESISTANCE TEST RESULTS: SOIL TYPE "CL"

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Southbound Battery Tunnel Draft Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

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FIGURE C-3

APPENDIX F.2

Lateral Earth Pressures for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Lateral Earth Pressures for the Southbound Battery Tunnel

July 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Lateral Earth Pressures for the Southbound Battery Tunnel

July 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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1 Introduction

This package presents the results of our calculations of Lateral Earth Pressures for the Southbound Battery Tunnel portion of the Doyle Drive Replacement Project. The Battery Tunnels are cut and cover tunnels that will be constructed as part of the Doyle Drive Replacement Project in San Francisco, California. Temporary retaining walls will be constructed with soldier piles and lagging and internal bracing. A portion of the walls east of the east portal will be retained using tiebacks. These calculations should be used for design of the temporary retaining walls to be built for construction as well as the final design of the exterior walls of the Southbound Battery Tunnel.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Develop apparent pressure diagrams at three locations along the Battery Tunnels. The locations analyzed were approximately the east end (Station 78+00), the midpoint (Station 81+00), and the west end (Station 85+00). These three locations were chosen to represent the three main excavation conditions and represent the range of earth pressures that should be anticipated. The three main excavation conditions are:
    - Soil over the full depth of the excavation (Station 78+00)
    - Intermediate depth of soil over bedrock (Station 81+00)
    - Shallow soil over sandstone bedrock (Station 85+00)
- Estimate seismic earth pressures for the construction earthquake event. The construction earthquake event was considered equal to the Functional Evaluation Earthquake (FEE), defined as a 108-year return period, and was determined from the site response analyses performed by Amec-Geomatrix. The earth pressures developed for the construction seismic event are in addition to the calculated apparent pressures.
- Develop at-rest earth pressure diagrams at the same three locations mentioned above. The at-rest earth pressures should be used in the long-term design of the Southbound Battery Tunnel.
- Estimate seismic earth pressures for the Safety Evaluation Earthquake (SEE) condition. The SEE is defined as the larger of either the median ground motion from the maximum credible earthquake or the ground motion with a 1,000 year return period and was the determined from the site response analyses performed by Amec-Geomatrix. The seismic earth pressures are in addition to active pressures that will act on the permanent walls during an earthquake.

3 Inputs

The following input data was required for the analyses.

3.1 Stratigraphy

The stratigraphy used for this analysis was determined from the field investigation. Figure 1 shows the location of boreholes that were drilled in relation to the Battery Tunnel structures. Figures 2 through 4 show idealized cross sections at Station 78+00, Station 81+00, and Station 85+00. The major soil types are as follows:

- The surficial unit is Sandy Fill which is as thin as 4 ft thick at Station 85+00 and as thick as 17 ft at Station 81+00. The Sandy Fill is primarily comprised of loose to medium dense sand with some silt and clay.

- On the eastern portion of the site, the Sandy Fill is underlain by a Buried Soil Horizon. When present, this unit ranges from 1 to 5 ft thick and is characterized by soft, dark brown silts with some sand and a strong organic odor.
- Sandy Silts and Sandy Clays underlay the Buried Soil Horizon to the east and the Sandy Fill to the south west. When present, this unit ranges from 3 to 7 ft thick and is typically medium stiff.
- Below the Sandy Silts and Sandy Clays lies the Colma Sand. This unit is 5 to 24 ft thick. It is generally dense to very dense. In the south east portion of the site, there is a layer of Sandy Silts and Sandy Clays approximately 8 ft thick below the Colma Sand.
- Franciscan Formation bedrock is found between 19 to 47 ft below the site. To the south west, the bedrock consists mostly of sandstone with some interbedding of mélange matrix. To the northeast, the bedrock is mostly serpentinite.

3.2 Material Properties

The material properties required for this analysis included unit weight (γ), friction angle (ϕ), cohesion (c). The materials are summarized in Table 1. The values of these properties were based on laboratory testing conducted for the project.

For the purposes of the calculations, Plasticity Index of the serpentinite and Mélange Matrix was assumed to be equal to 5. All other soils were taken to be Non-Plastic. The Overconsolidation Ratio of all soils was taken to be 1.0.

A wall friction value (δ) of ½ of ϕ was assumed.

3.3 Site Response Analyses

The site response analyses were performed by Amec-Geomtrix and presented in their report dated May 2009.

4 Assumptions

The following assumptions were made in these calculations:

- The ground surface at the top of the retaining wall was assumed to be level. The slope of the ground behind the retaining wall is typically very shallow. This assumption was validated on the location with the steepest sloping ground.
- The Buried Soil Horizon was assumed to have similar properties to the Sandy Fill and the two layers were combined for this analysis.
- The Sandy Silts and Sandy Clays layer was assumed to act as a cohesionless soil.
- The area behind each retaining wall was assumed to extend indefinitely.
- Hydrostatic pressures will not act on the retaining walls or tunnel structure because dewatering will be performed behind the solider pile and lagging walls during construction and in the long-term condition drainage panels will be installed to divert the water.
- The sandstone bedrock was modeled as very dense gravel ($\varphi = 55°$ per Bowles 1996).
- The serpentinite bedrock was modeled as very stiff clay.

5 Calculations

This section summarizes the calculations performed for the lateral earth pressure analysis for the southbound Battery Tunnels. The EXCEL file containing these calculations is located at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\BT LEP Calcs.xls. Printouts of the excel files are attached in Appendices A through C.

5.1 Active Earth Pressure

The first step of the analysis was to calculate profiles of the total vertical stress, σ_z, and effective vertical stress, σ'_z. Points of calculation included the top and bottom of each soil layer as well as the midpoint. However, for the layer in which the water table was located, the stresses were calculated at this point instead of the midpoint. Also, the depth of the excavation at each location was assumed to be three feet below the bottom of the tunnel structure and was calculated from the file Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections.xls on December 8, 2008.

Next, the coefficient of active earth pressure, K_a, was calculated from the equation:

$$K_a = \left(45^\circ - \left(\frac{\sin\phi}{2}\right)\right)^2$$, (from Coduto 2001) where

ϕ = friction angle

Then, the active earth pressure, σ_x, in psf, was calculated with depth using the equation:

$$\sigma_x = K_a(\sigma'_z) - 2(c)\left(\sqrt{K_a}\right)$$, (from Coduto 2001) where

c = cohesion, in psf

The second term of this equation represents the effects of cohesion and disappears if c =0. When purely cohesive soils were encountered (no friction component, i.e. serpentinite bedrock) a total stress analysis was performed.

Finally, the hydrostatic pressure was calculated below the water table by multiplying the unit weight of water (equal to 62.4 pcf) by the depth. It was then added to the calculated earth pressures.

Another way of reporting earth pressures is by equivalent fluid pressures. The equivalent fluid pressure, γ_{eq}, is the unit weight of a fictitious fluid that would exert the same horizontal pressures on the wall as the soil. (Coduto 2001) For each wall of the tunnels, it was determined by creating a triangle on the active earth pressure diagrams that encompassed all pressures, excluding hydrostatic and surcharge pressures.

Active pressures were combined with the SEE seismic pressures to represent the long-term seismic design pressures.

5.2 Apparent Pressure

Apparent pressure diagrams were calculated using Terzaghi and Peck (1969) method. The Terzaghi and Peck values were used. The formulas and methodologies were taken from Fang (1991). The Terzaghi and Peck apparent pressure diagrams were developed for braced excavations, however Fang indicates that they can be used for tie-back walls as well. They were developed from field case histories and as such contain construction surcharge loads.

The Terzaghi and Peck apparent pressures are based on the following conditions:

- They apply to excavations greater than 20 feet deep.
- An artificial loading diagram, designated “apparent” pressure, is used for determining strut loads.
- Water table is below bottom of excavation. Shear strength of clay is taken in the undrained state. Pore pressures are not considered.

The Terzaghi and Peck apparent pressure diagram for sandy soils consists of a rectangular pressure diagram with a constant pressure with depth equal to:

$$Apparent\ \mathrm{Pr}essure = 0.65K_a\gamma H \text{ , where}$$

K_a = active earth pressure coefficient
γ = the highest total unit weight of all the soil layers
H = the total height of the excavation

For simplicity and to be conservative, when soil overlay sandstone bedrock, the apparent pressure was calculated as if the soil covered the entire depth of the excavation. When soil overlay serpentinite bedrock a mixed soil conditions approach was used. The apparent pressure diagram for the mixed soil condition of sand over clay consists of a rectangular pressure diagram with constant pressure with depth equal to:

$$Apparent\ \mathrm{Pr}essure = K'_a\,\gamma'_{mixed}\,H \text{ , where}$$

K'_a = equivalent active earth pressure for the clay and sand,
γ'_{mixed} = average unit weight of the clay and sand weighted by the thickness of the layer, and
H = total height of the excavation

$$K'_a = 1 - m\left[\frac{2q'_u}{\gamma'_{mixed}\,H}\right], \text{ where}$$

m = a reduction factor depending on N values, for stiff clays m = 1
q'_u = Equivalent Unconfined Compressive Strength of the clay and sand

$$q'_u = \frac{\gamma_{sand}H_{sand}^2K_{sand}\tan\phi + H_{clay}nq_u}{H}, \text{ where}$$

γ_{sand} = average unit weight of the sand layer
H_{sand} = thickness of the sand layer
φ = friction angle of the sand
H_{clay} = thickness of the clay layer
n = ratio of field unconfined compressive strength to that determined in the laboratory (taken to be 1.5)
q_u = unconfined compressive strength of the clay

5.3 At-Rest Earth Pressure

The first step of the analysis was to calculate profiles of the total vertical stress, σ_z , and effective vertical stress, σ'_z . Points of calculation included the top and bottom of each soil layer as well as the midpoint.

Next, the coefficient of at-rest earth pressure, K_o , was calculated from the equation:

$K_o = (1 - \sin\phi) OCR^{\sin\phi}$, (Coduto 2001) where

OCR = overconsolidation ratio

For cohesive layers, the following equation was used:

$K_o = 0.44 - 0.42\left[\frac{PI(\%)}{100}\right]$, (Das 2005) where

PI = plasticity index

The at-rest earth pressure, in psf, was calculated with depth using the equation:

$\sigma_x = K_o(\sigma'_z) - 2(c)\left(\sqrt{K_o}\right)$, (from Coduto 2001) where

c = cohesion, in psf

The second term of this equation represents the effects of cohesion and disappears if c =0. When purely cohesive soils were encountered (no friction component, i.e. serpentinite bedrock) a total stress analysis was performed.

$$P_{At-Rest} = \frac{1}{2} K_0 \gamma H^2$$, where

γ = unit weight of the backfill
H = height of the wall

The at-rest pressure calculations represent the long-term static loading case and do not include a seismic pressure.

5.4 Seismic Pressure

Seismic Pressures were calculated based upon the Mononobe-Okabe (M-O) pseudo-static analysis of seismic earth pressures on retaining structures. Similar to the static case, the total active thrust may be expressed as:

$$P_{AE} = \frac{1}{2} K_{AE} \gamma H^2 (1 - k_v)$$, where

K_{AE} = seismic (dynamic) active earth pressure coefficient
γ = unit weight of the backfill
H = height of the wall
k_v = vertical seismic coefficient

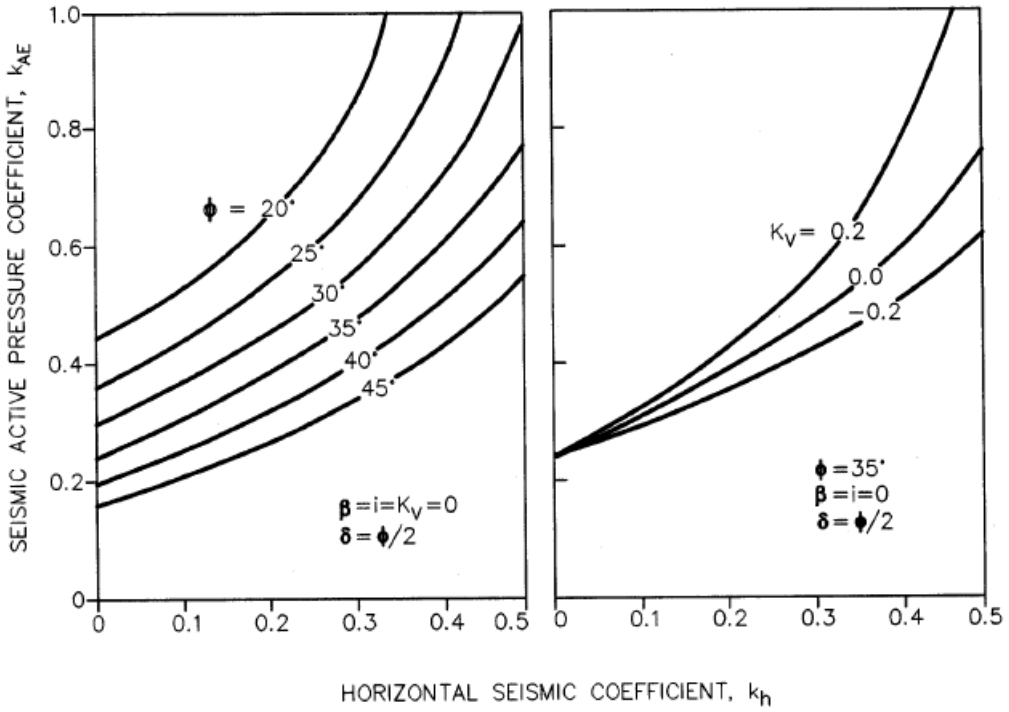
K_{AE}, is given by:

$$K_{AE} = \frac{\cos^2(\phi - \theta - \psi)}{\cos\psi \cos^2\theta \cos(\delta + \theta + \psi)\left[1 + \sqrt{\frac{\sin(\delta + \phi)\sin\phi - \beta - \psi)}{\cos(\delta + \theta + \psi)\cos(\beta - \theta)}}\right]^2}$$

where,

φ = friction angle of the backfill
β = slope of the backfill behind the wall
δ = friction angle of the wall/backfill interface
ψ = $\tan^{-1}[k_h/(1-k_v)]$, where $\varphi - \beta \geq \psi$

Lam and Martin (1986) graphical solutions were used to determine K_{AE} using the horizontal seismic coefficient, k_h. k_h was determined from the site response analyses at the base of the wall. This solution is based on level backfill and assumes that the total seismic active earth pressure is uniformly distributed over the height of the wall and therefore the earth pressure resultant acts at the midheight of the wall.



Effect of seismic coefficients and friction angle on seismic active pressure coefficient[5]

The calculated P_{AE} value includes both seismic and active pressures. For the purposes of plotting, the seismic pressures were isolated and converted to a uniform pressure per height of wall. This was done by calculating the active pressures and subtracting from P_{AE}.

The active pressures were calculated similarly to the at-rest pressures after substituting the coefficient of active earth pressure, K_a , in place of the at-rest coefficient.

$K_a = \left(45^\circ - \left(\frac{\sin\phi}{2}\right)\right)^2$, (from Coduto 2001) where

ϕ = friction angle

Then, the active earth pressure, σ_x, in psf, was calculated with depth using the equation:

$\sigma_x = K_a(\sigma'_z) - 2(c)\left(\sqrt{K_a}\right)$, (from Coduto 2001) where

c = cohesion, in psf

The second term of this equation represents the effects of cohesion and disappears if c =0. When purely cohesive soils were encountered (no friction component, i.e. serpentinite bedrock) a total stress analysis was performed.

$$P_{active} = \frac{1}{2} K_a \gamma H^2, \text{ where}$$

γ = unit weight of the backfill
H = height of the wall

Therefore:

$$P_{Earthquake} = P_{AE} - P_{active}$$

Seismic pressures ($P_{Earthquake}$) were evaluated at each of the three cross-section locations for both the FEE and SEE. The seismic pressures from the FEE were applied on top of the apparent pressures and represent the anticipated seismic pressures on the temporary shoring walls. The seismic pressures from the SEE were applied on top of active pressures and represent the anticipated long-term seismic pressures on the permanent tunnel structure.

5.5 Surcharges

Surcharges adjacent to the excavation and tunnel limits will add increased lateral earth pressures to the temporary shoring and the permanent tunnel. Different surcharge conditions exist on the south and north sides of the Southbound Battery Tunnel. On the south side, the National Cemetery limits the placements of loads and on the north side, the in service Doyle Drive will increase the lateral loads for design.

5.5.1 South Side of the Southbound Battery Tunnel

The temporary braced excavation will be designed using Apparent Pressures. The Apparent Pressure diagrams used for design of the temporary braced excavation include typical construction loads. Therefore, additional surcharge loads are not required for design of the south side of the braced excavation.

After completion of the Southbound Battery Tunnel, construction activities will begin for the construction of the adjacent Northbound Battery Tunnel and the area above and around the Southbound Tunnel will be used for construction activities. Therefore, the effect of an additional vertical surcharge pressure of 250 psf should be applied to the long-term static and long-term seismic conditions to account for these loads being applied to the permanent structure.

A uniform vertical surcharge of 250 psf produces a non-uniform distributed horizontal pressure on the walls. For simplification, the non-uniform horizontal pressure was converted to uniform pressures applied on the walls, such that the same moment is

imposed on the base of the wall from the non-uniform pressures and the equivalent uniform pressures.

On the south side of the Southbound Battery Tunnel, loads cannot be placed adjacent to the tunnel between Stations 77+50 and 78+50 and between Stations 83+00 and 84+50 because access is restricted by the fence of the National Cemetery. The fence-line is very close to the limits of the southern tunnel wall (less than 5 feet) at these locations. Therefore, the additional surcharge loads do not need to be applied to the permanent structure at these locations.

5.5.2 North Side of the Southbound Battery Tunnel

During construction of the Southbound Battery Tunnel and prior to construction of the Northbound Battery Tunnel, the existing Doyle Drive will remain in service adjacent to the north side of the excavation. The traffic loads from the Doyle Drive roadway will impose lateral pressures on the walls of the excavation and the permanent structure. A uniform vertical surcharge of 250 psf can be used to account for the active roadway loads and any typical construction loads that may be present between the edge of the excavation and the roadway.

A uniform vertical surcharge of 250 psf produces a non-uniform distributed horizontal pressure on the walls. For simplification, the non-uniform horizontal pressure was converted to uniform pressures applied on the walls, such that the same moment is imposed on the base of the wall from the non-uniform pressures and the equivalent uniform pressures.

These loads should be applied to the braced excavation in addition to the Apparent Pressures and to the permanent structure in addition to the Long-Term Static and Long-Term Seismic Pressures.

6 Results

This section presents the results of the calculations performed for the lateral earth pressure analysis for the battery tunnels. GRAPHER files depicting the results are located in the folder Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures.

6.1 Apparent Pressure

Apparent pressures for braced excavations in soil vary from approximately 762 psf at Station 81+00 to 965 psf at Station 78+00. Apparent pressures for braced excavations in rock vary from approximately 363 psf at Station 85+00 to 384 psf at Station 81+00.

The applied FEE seismic pressures range from 1xH at Station 81+00 to 2xH at Stations 78+00 and 85+00.

Apparent pressure diagrams for all three locations may be found in Figures 5 to 7. These diagrams include the FEE seismic pressure, with dewatering to bedrock.

6.2 Long-Term Seismic Pressures

The long-term seismic pressures vary from approximately 288 psf at Station 81+00 to 379 psf at Station 78+00.

The applied SEE seismic pressures range from 9H at Station 81+00 to 12H at Station 78+00.

Long-term seismic pressure diagrams for all three locations may be found in Figures 11 to 13. These diagrams include the active pressure, SEE seismic pressure, and initial and uniform surcharge pressures, with dewatering to bedrock.

6.3 At-Rest Earth Pressure

At-rest earth pressures in soil vary from approximately 696 psf at Station 85+00 to 2,089 psf at Station 78+00. In rock, at-rest earth pressures vary from approximately 847 psf at Station 85+00 to 1,190 psf at Station 81+00.

The highest pressures generally correspond to the areas with the deepest excavation and therefore, the greatest amount of soil above the tunnel wall (Station 78+00), while the lowest pressures are found at the location of the shallowest excavation (Station 85+00).

At-rest earth pressures diagrams for all three locations may be found in Figures 8 to 10. These diagrams include initial and uniform surcharge pressures, with dewatering to bedrock.

6.4 Surcharges

We recommend the following surcharge loads. The recommended loads not consider loads imposed by individual pieces of equipment, such as a crane or grout plant, and such loads should be evaluated separately.

6.4.1 South Side of the Southbound Battery Tunnel

Where appropriate, we recommend an additional 300 psf/ft of lateral load be applied to the upper 10 feet of the wall and 150 psf/ft be applied from 10 to 20 feet below the top of the wall.

6.4.2 North Side of the Southbound Battery Tunnel

Where appropriate, the surcharge load is simplified to a lateral pressure of 350 psf/ft applied to the upper 10 feet of the wall and 175 psf/ft applied from 10 to 20 feet below the top of the wall.

List of References

[1] AMEC Geomatrix (May 2009) Seismic Hazard Assessment and Site Response Analysis Doyle Drive Replacement Project Parts 1 and 2.

[2] Bowles, Joseph, E. (1996) Foundation Analysis and Design, 5th ed. The McGraw-Hill Companies, Inc., New York.

[3] Coduto, Donald. (2001) Foundation Design: Principles and Practices, 2nd ed. Prentice Hall, New Jersey.

[4] Das, Braja J. (2005) Fundamentals of Geotechnical Engineering, 2nd ed. Thomson, Canada.

[5] Fang, His-Yang (1991) Foundation Engineering Handbook, 2nd ed. Van Nostrand Reinhold, New York.

[6] U.S. Department of Transportation Federal Highway Administration (1997) Geotechnical Engineering Circular No. 3. Design Guidance: Geotechnical Earthquake Engineering for Highways, Publication No. FHWA-SA-97-076

TABLES

TABLE 1
Earth Pressure Coefficients and Equivalent Fluid Weight Values

	γ	ϕ	c'	δ	Active Pressures		At Rest Pressures		Passive Resistance	
					K_a	Equivalent Fluid Pressure (pcf)	K_0	Equivalent Fluid Pressure (pcf)	K_p	Equivalent Fluid Pressure (pcf)
Sandy Fill	120	32	0	16	0.28	33	0.47	56	5.8	693
Sandy Silts and Sandy Clays	120	32	0	16	0.28	33	0.47	56	5.8	693
Colma Sand	130	38	0	19	0.22	28	0.38	50	9.6	1253
Sandstone (ss)	165	55	0	28	0.10	16	0.18	30	12.0	1980
Serpentinite (srp)	150	0	1400	0	1.00	0	1.00	0	1.0	2950
Mélange Matrix (mg)	150	0	1400	0	1.00	0	1.00	0	1.0	2950

Notes:

1) The wall friction angle, δ, is taken to be one-half of the soil friction angle, φ. No wall friction is considered for the at-rest case.
2) No factor of safety has been applied to the passive pressures. We recommend a minimum factor of safety of 2.5.
3) The value of K_p for the sandstone was capped at 12.
4) The ground surface behind the walls is typically level.
1) Typically c' values for Mélange Matrix are higher than for the serpentinite however, we do not have site specific data to determine separate values.

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FIGURES

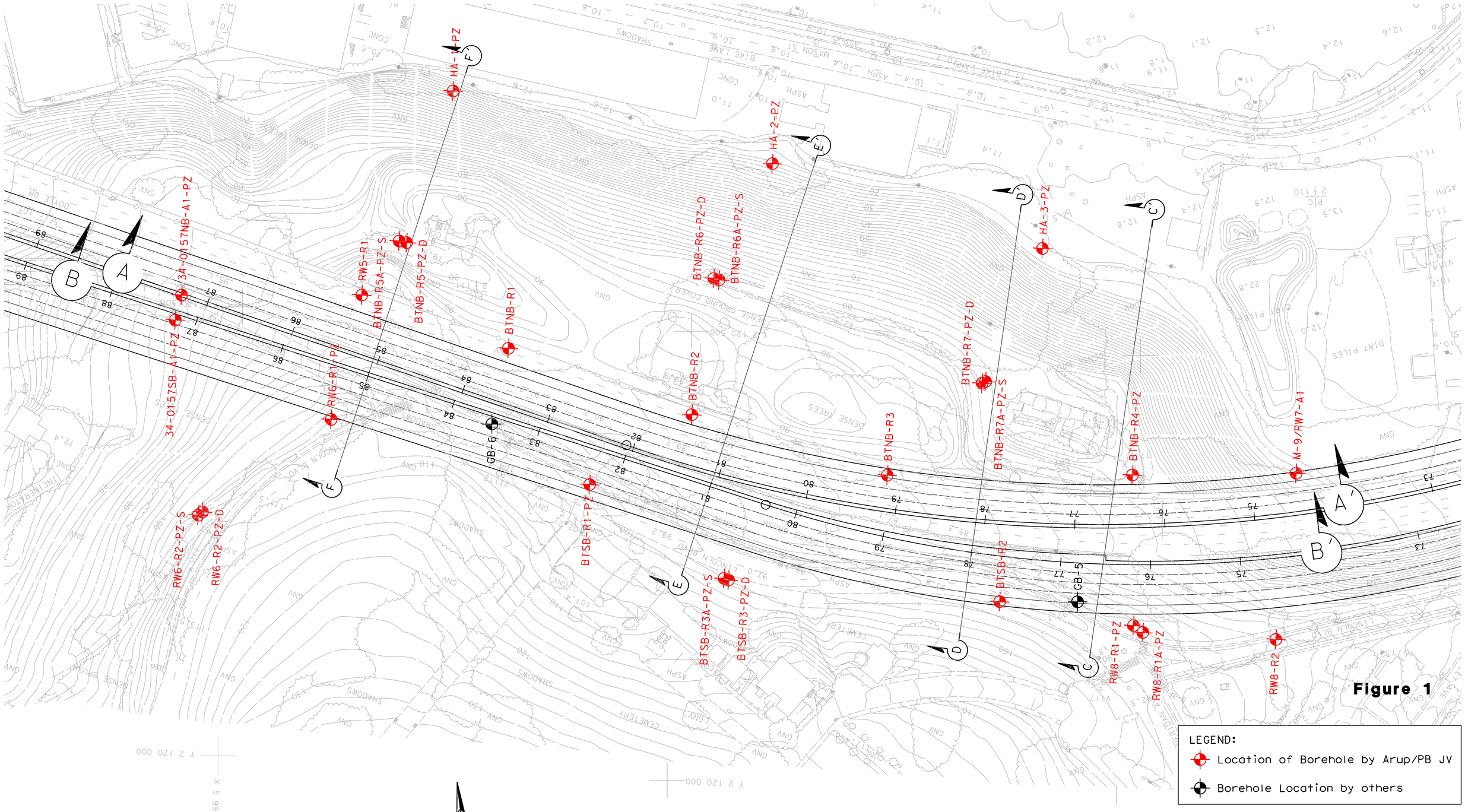

Figure 1

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

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DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

SOUTH
D

NORTH
D'

Existing Doyle Drive

SB Profile Grade Line

BTSB-R2
Proj. 40 ft. West

BTNB-R7-PZ-D
Proj. 15 ft. East

HA-3-PZ
Proj. 30 ft. West

Original Grade

FILL

BURIED SOIL HORIZON

Proposed Battery Tunnel Southbound

Future Battery Tunnel Northbound

SANDY CLAY

COLMA SAND

+47.5 ft.

Screen Interval

Straight Drilled

FRANCISCAN BEDROCK

FRANCISCAN BEDROCK

Note: Serpentinite bedrock encountered in HA-3-PZ

Elevation (NAVD88), ft

Distance Left of SB Profile Grade Line (ft)

Distance Right of SB Profile Grade Line (ft)

ss Sandstone	gs Greenstone	RQD %	Recovery %
st Siltstone	ga Gabbro		
srp Serpentinite	gr Granulite		

DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Cross Section D-D'
Transverse Cross Section at Station 78+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 2

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\78+00 BT Transverse.grf

SOUTH
E

NORTH
E'

SB Profile Grade Line

Existing Doyle Drive

BTSB-R3-PZ-D
Proj. 50 ft. West

BTNB-R2
Proj. 45 ft. East

BTNB-R6-PZ-D
Proj. 70 ft. East

HA-2-PZ
Proj. 40 ft. East

ENGINEERED FILL

BURIED SOIL HORIZON

Proposed Battery Tunnel Southbound

Future Battery Tunnel Northbound

FILL

SANDY CLAY

COLMA SAND

FILL

Original Grade

Screen Interval

Screen Interval

FRANCISCAN BEDROCK

FRANCISCAN BEDROCK

Elevation (NAVD88), ft

Elevation (NAVD88), ft

Distance Left of SB Profile Grade Line (ft)

Distance Right of SB Profile Grade Line (ft)

ss Sandstone
ss, sh Sandstone/Shale
sh Shale
gs Greenstone
srp Serpentinite
RQD %
Recovery %

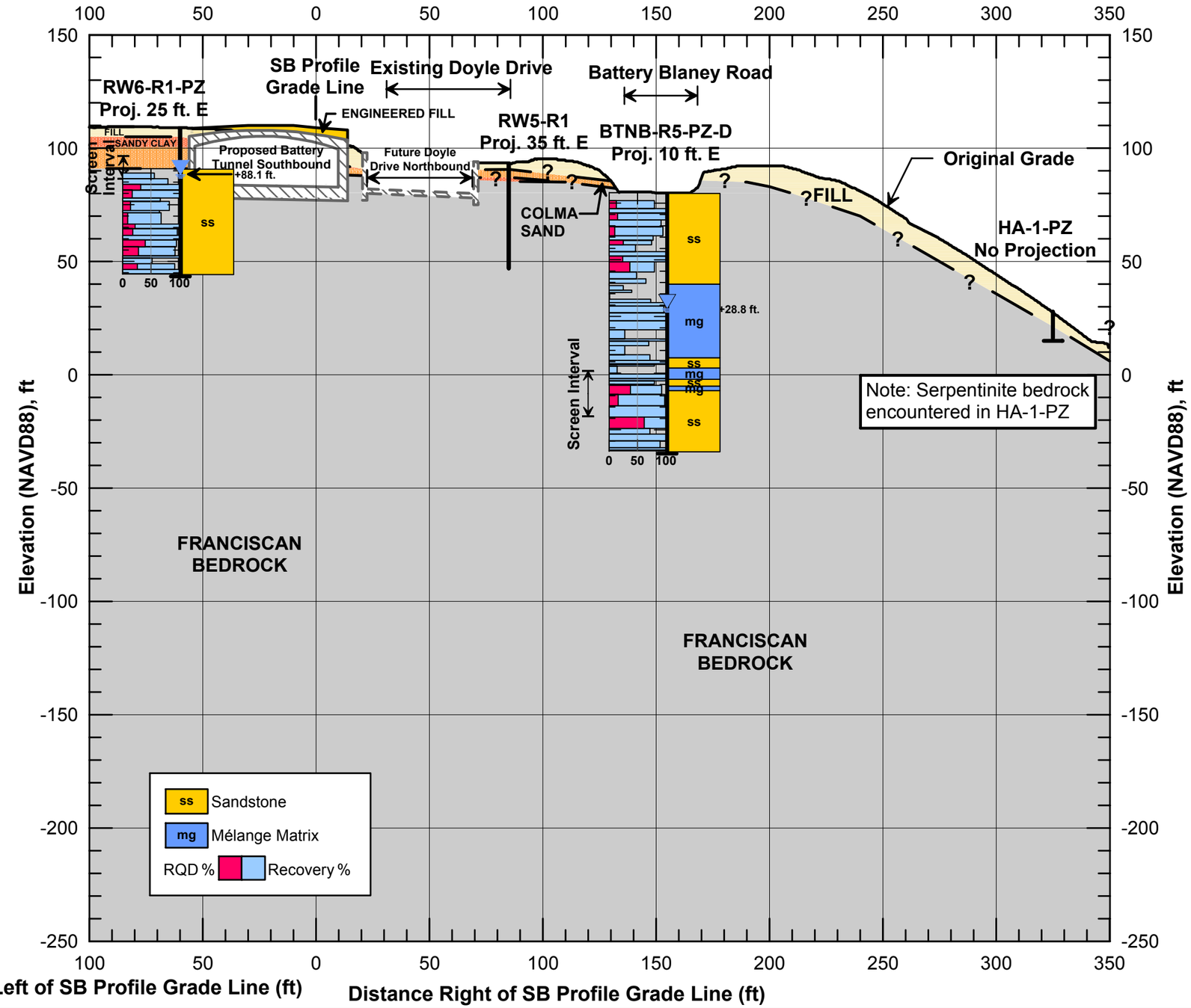
DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Section E-E'
Transverse Cross Section at Station 81+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 3

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\81+00 BT Transverse.grf

SOUTH
F

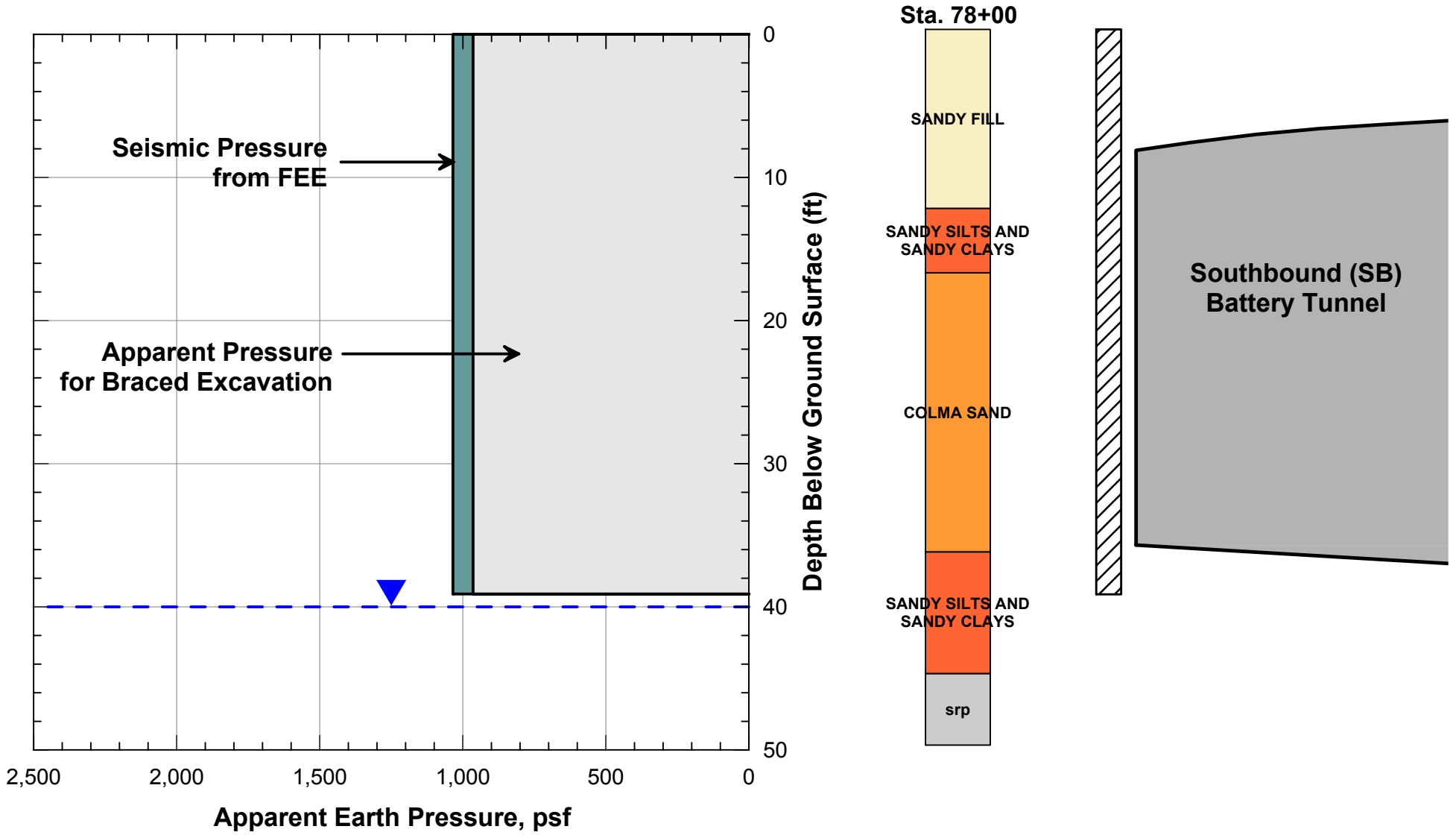
NORTH
F'



DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy, Section F-F'
Transverse Cross Section at Station 85+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 4

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\85+00 BT Transverse.grf

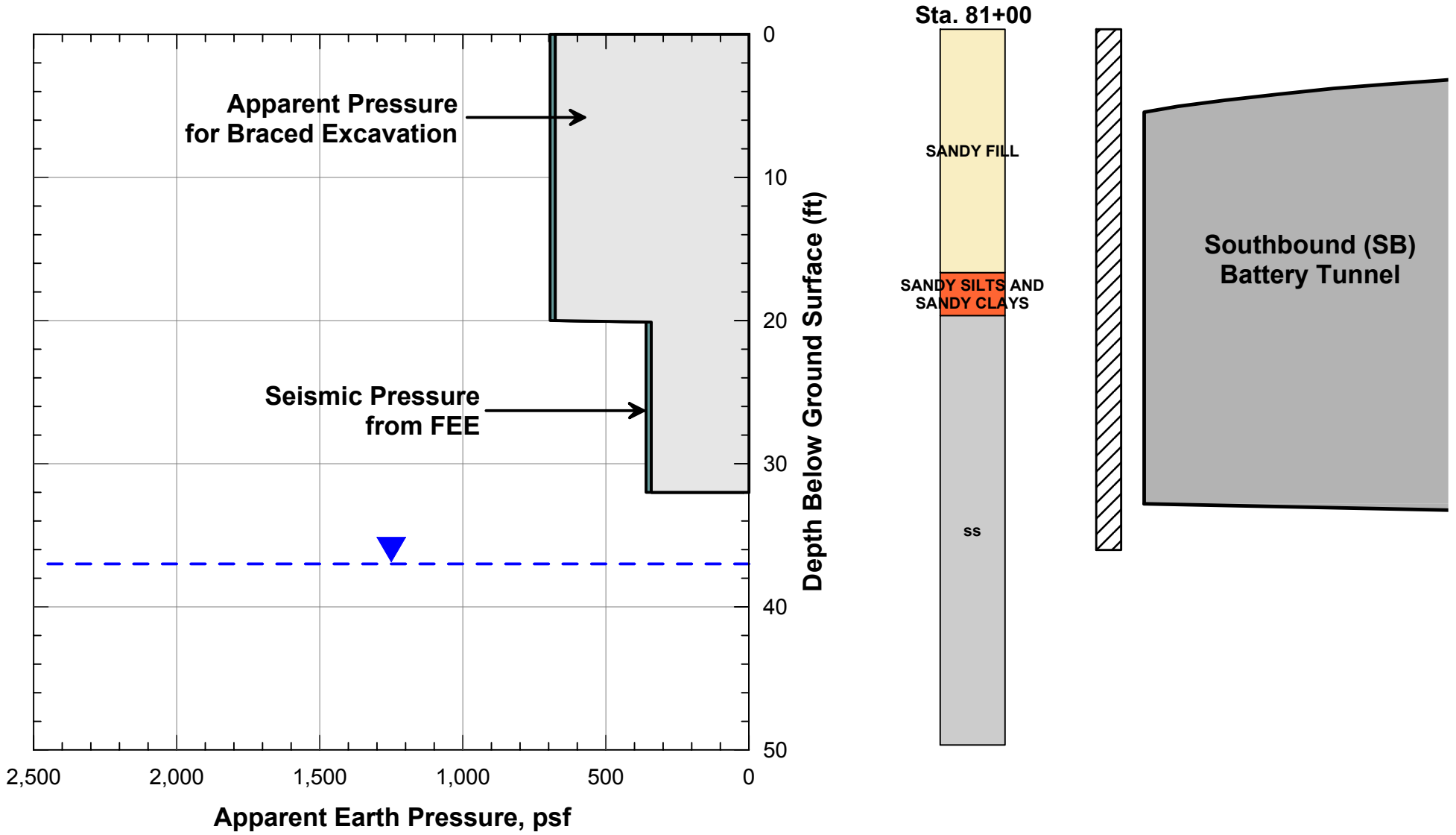


APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
July 2009 San Francisco, California

FIGURE 5

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 78SB-S.grf



APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
July 2009 San Francisco, California

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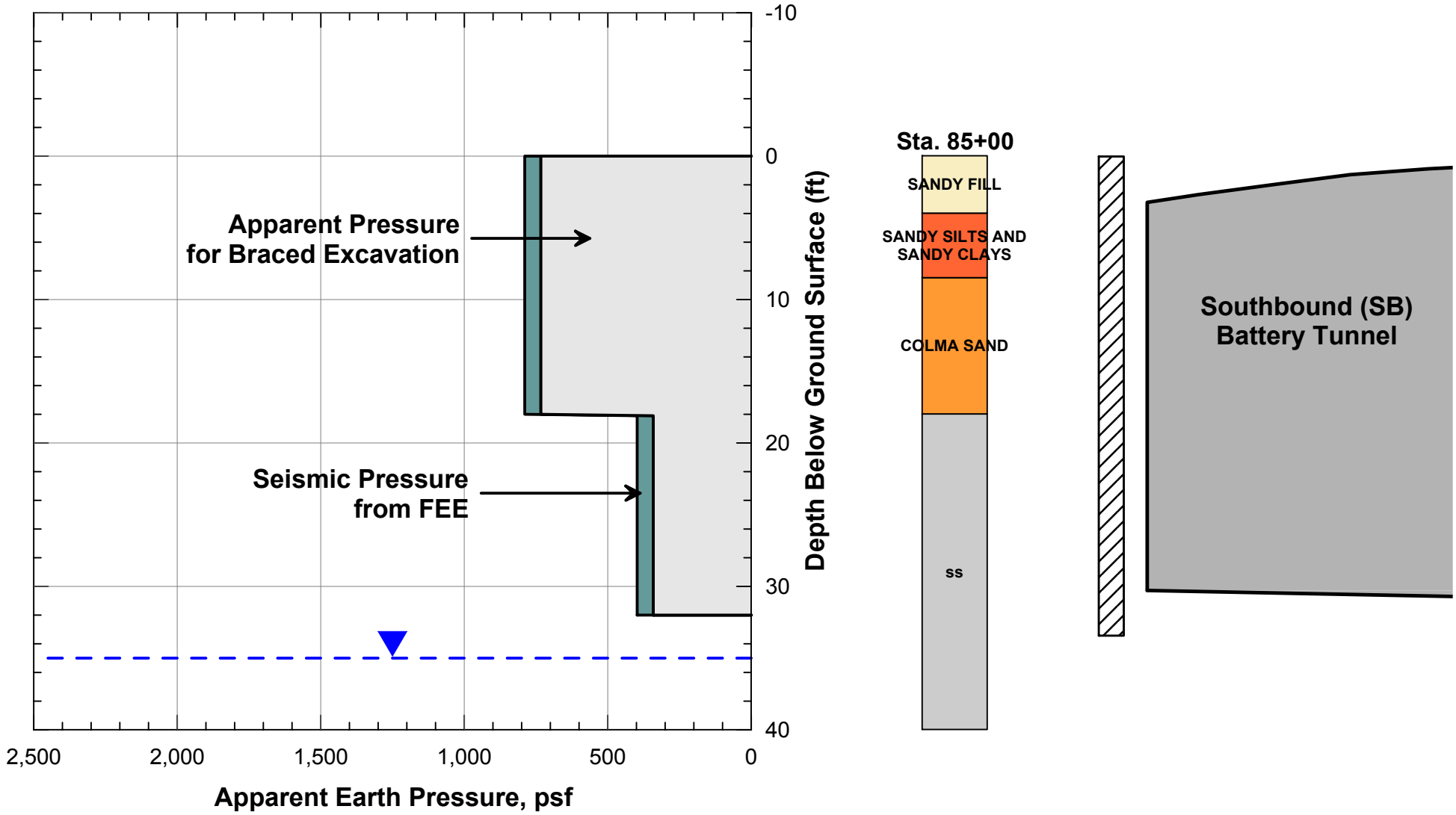
FIGURE 6

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 81SB-S.grf



APPARENT PRESSURE DIAGRAM FOR BRACED EXCAVATIONS ALONG THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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Southbound Battery Tunnel Foundation Report
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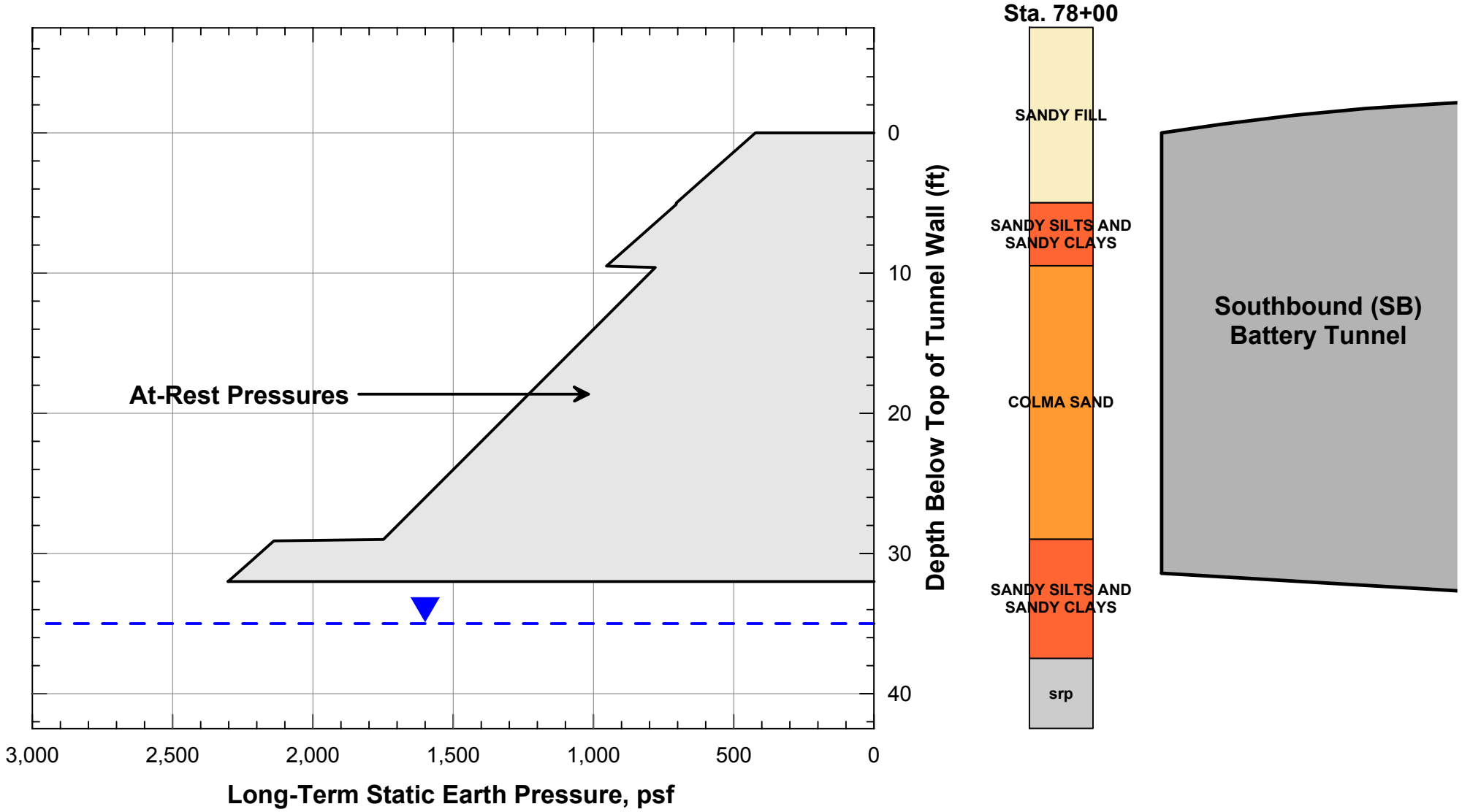
FIGURE 7

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ApparentPressures BT 85SB-S.grf



LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

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Southbound Battery Tunnel Foundation Report
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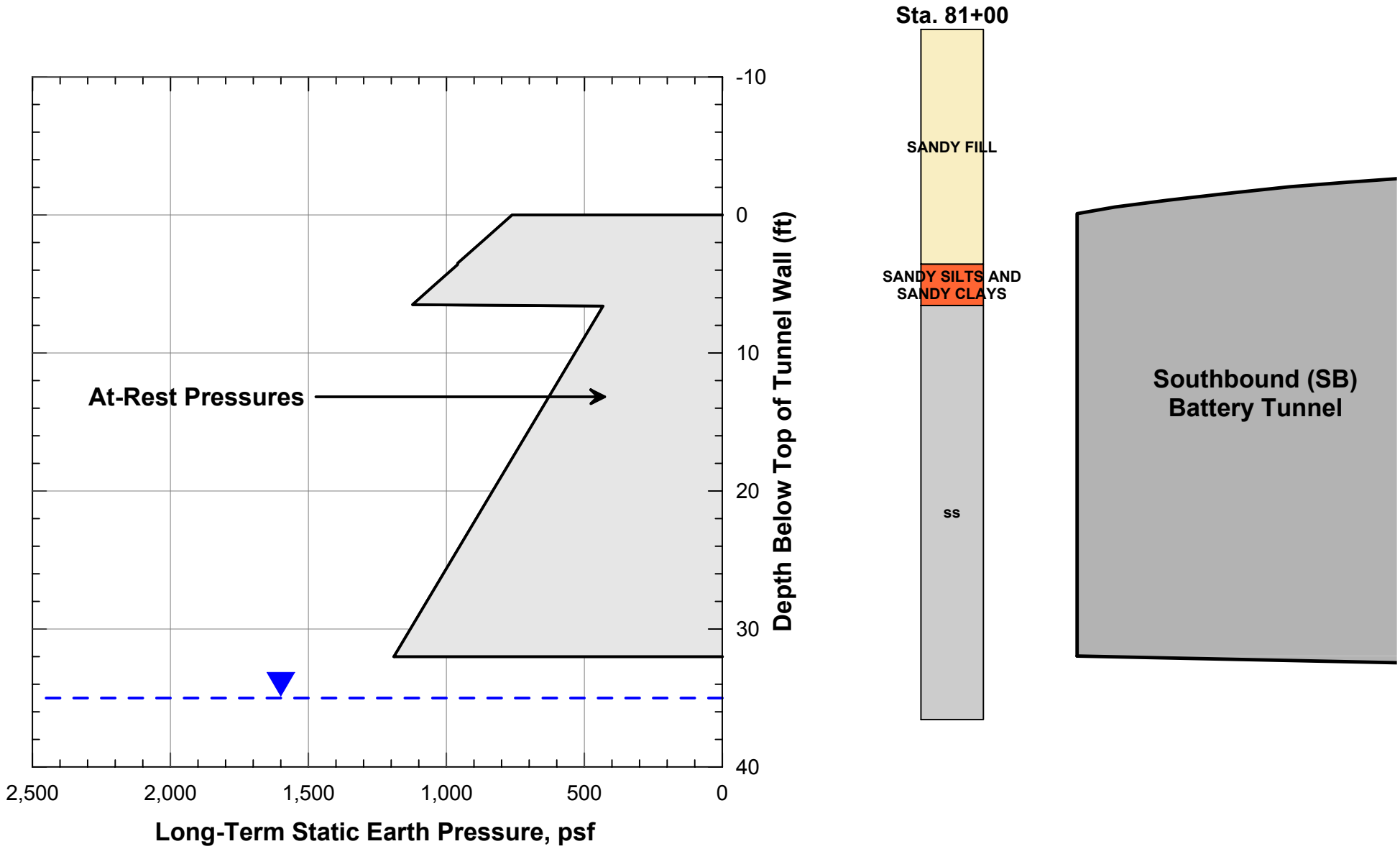
FIGURE 8

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 78SB-S.grf



LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

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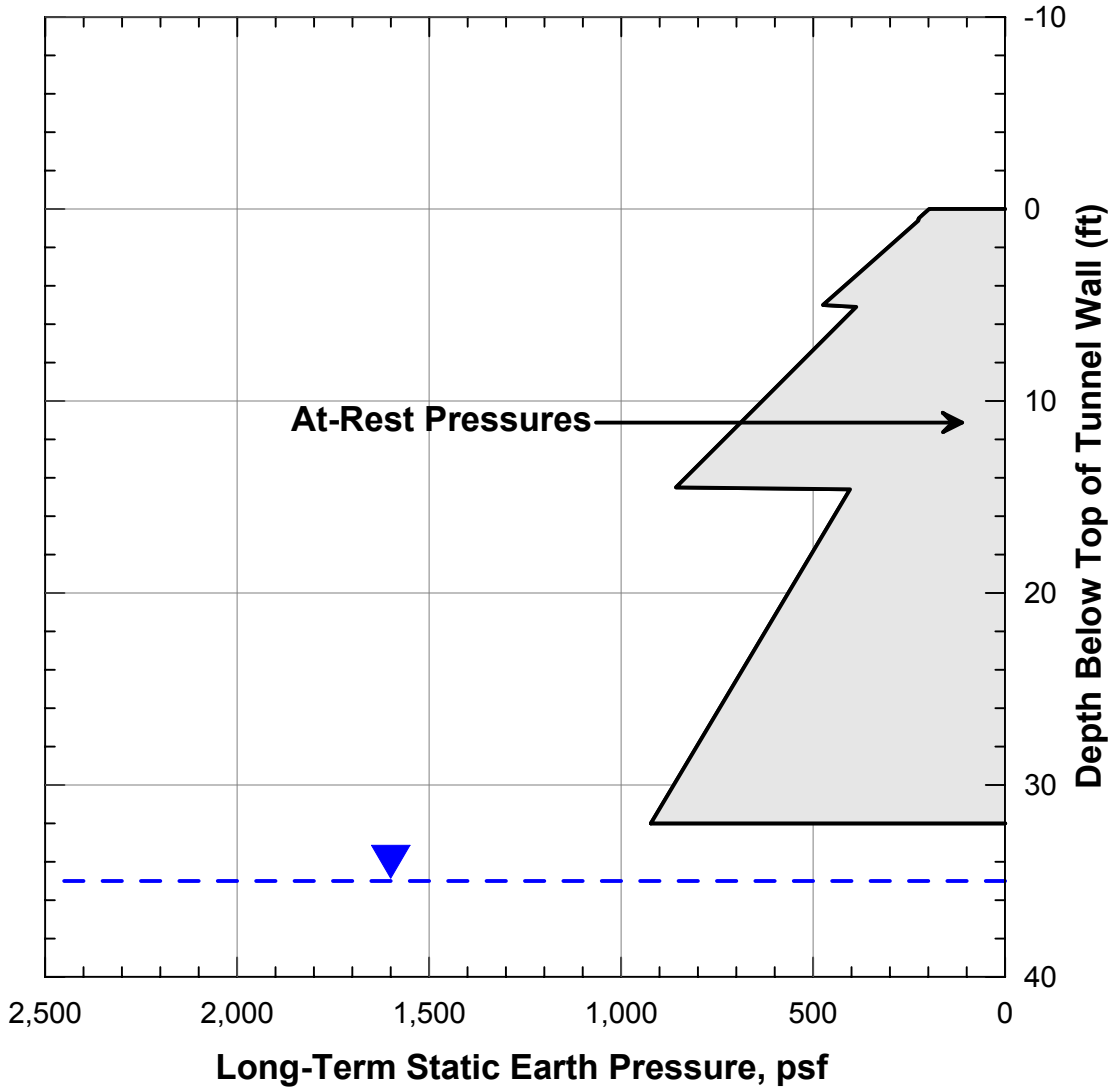
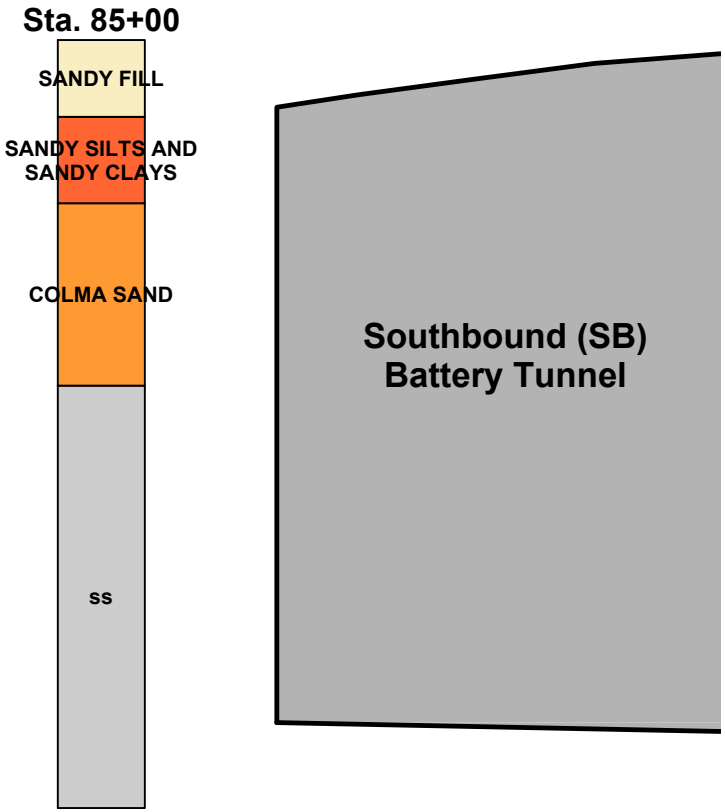
FIGURE 9

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 81SB-S.grf





LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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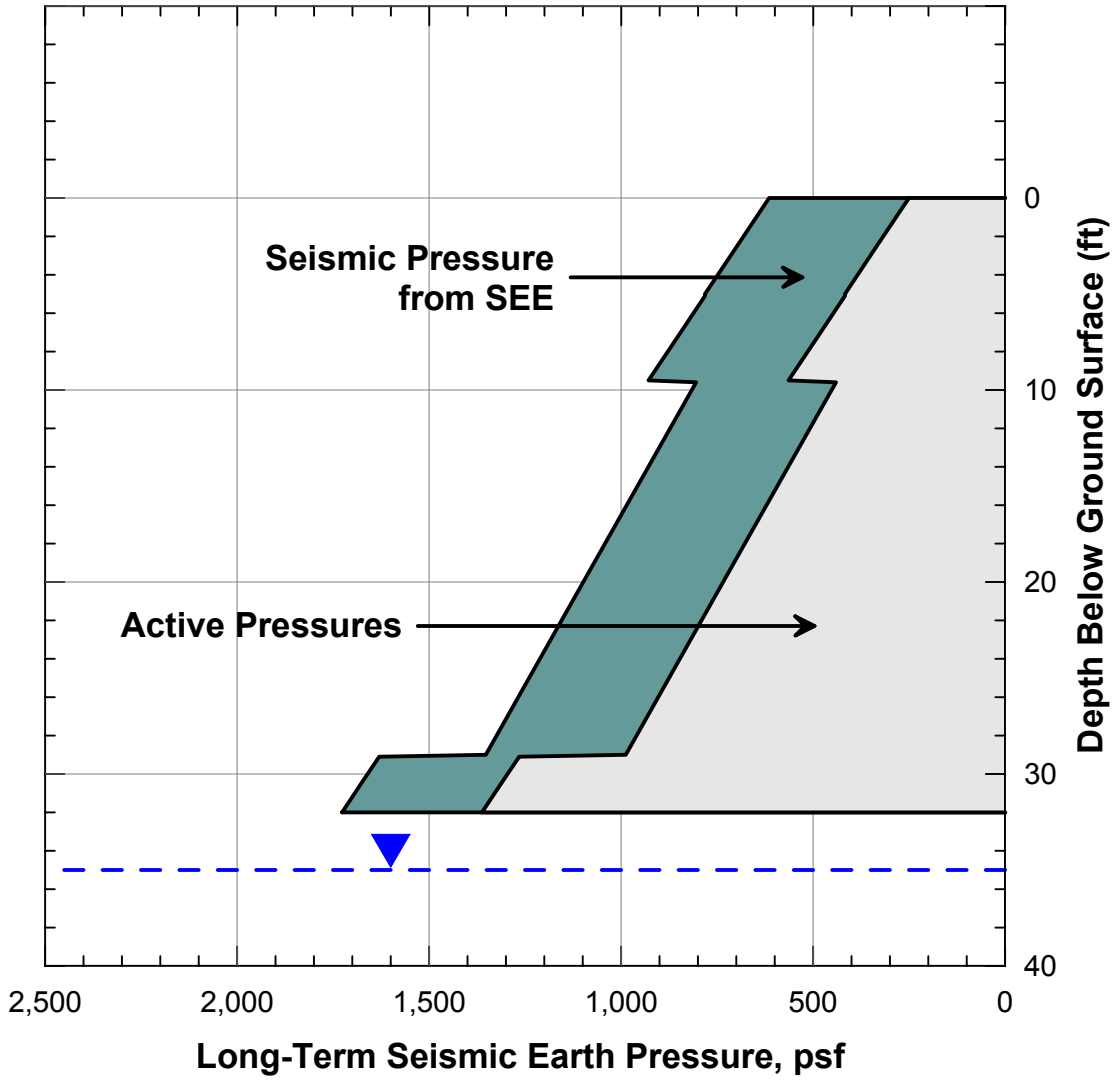
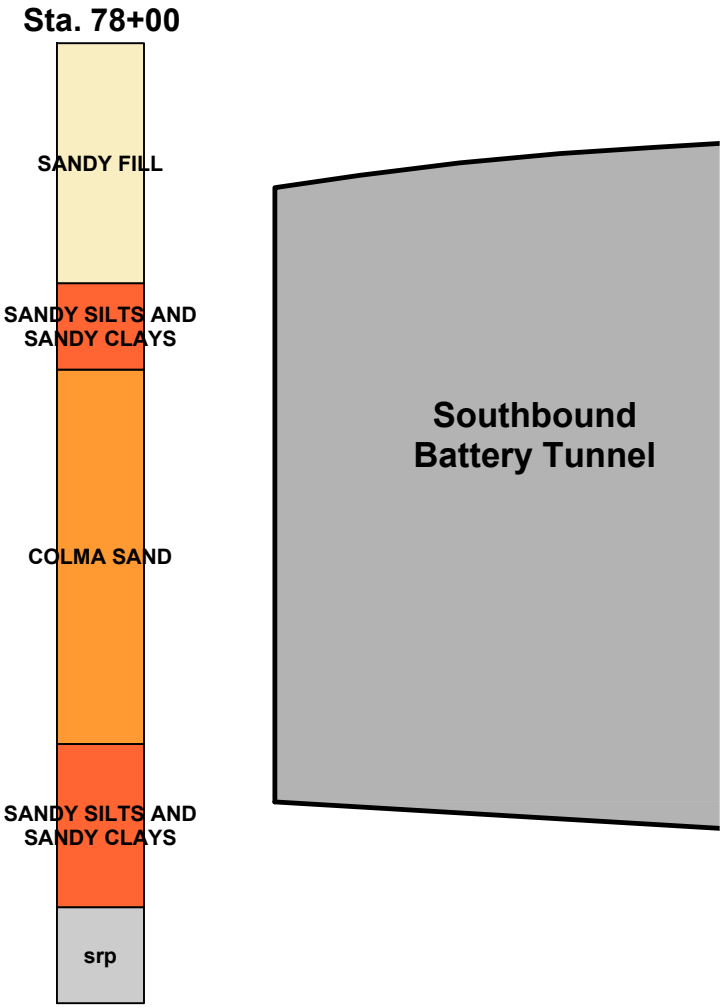
FIGURE 10

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 85SB-S.grf





LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 78+00

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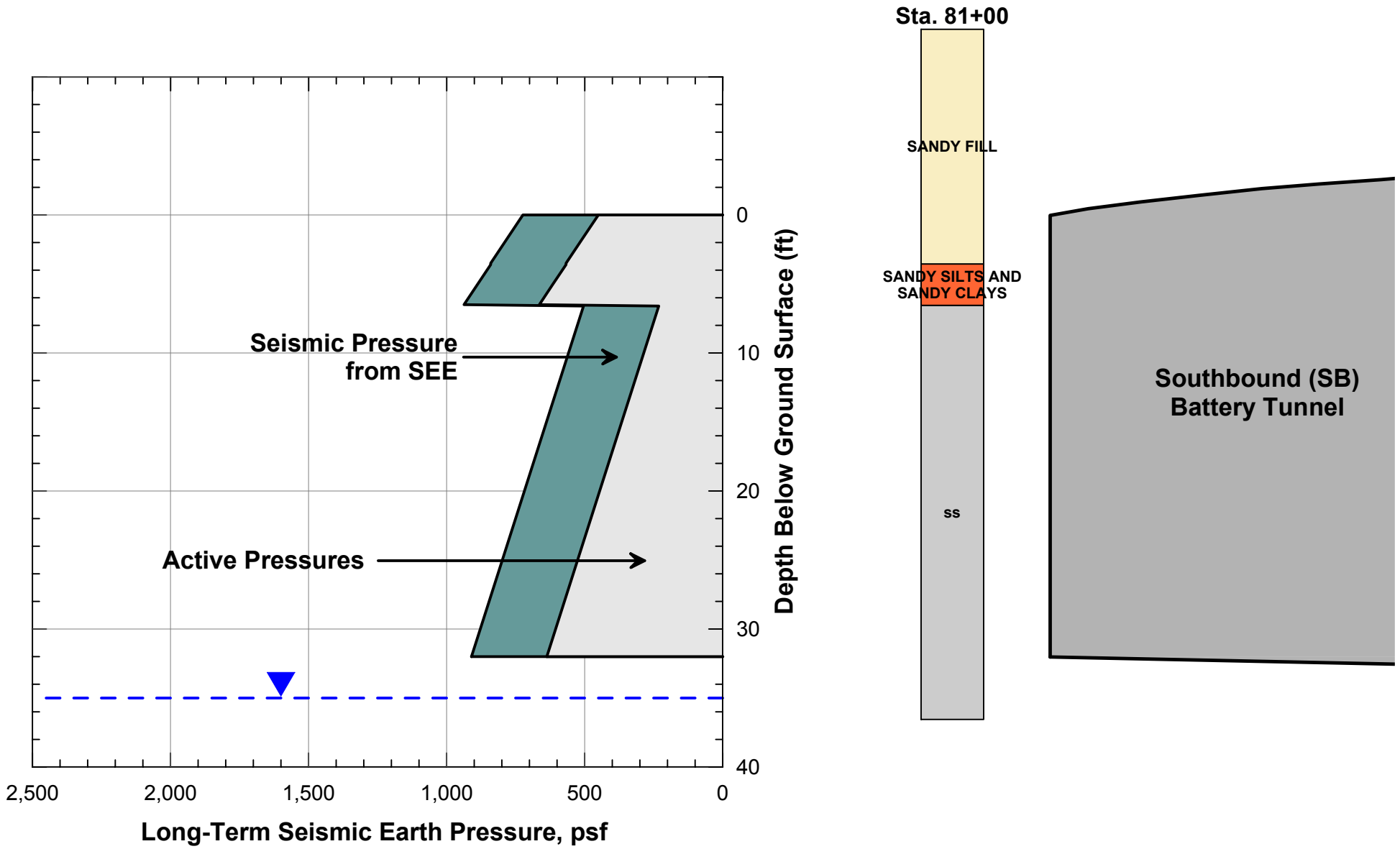
FIGURE 11

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 78SB-S.grf



LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 81+00

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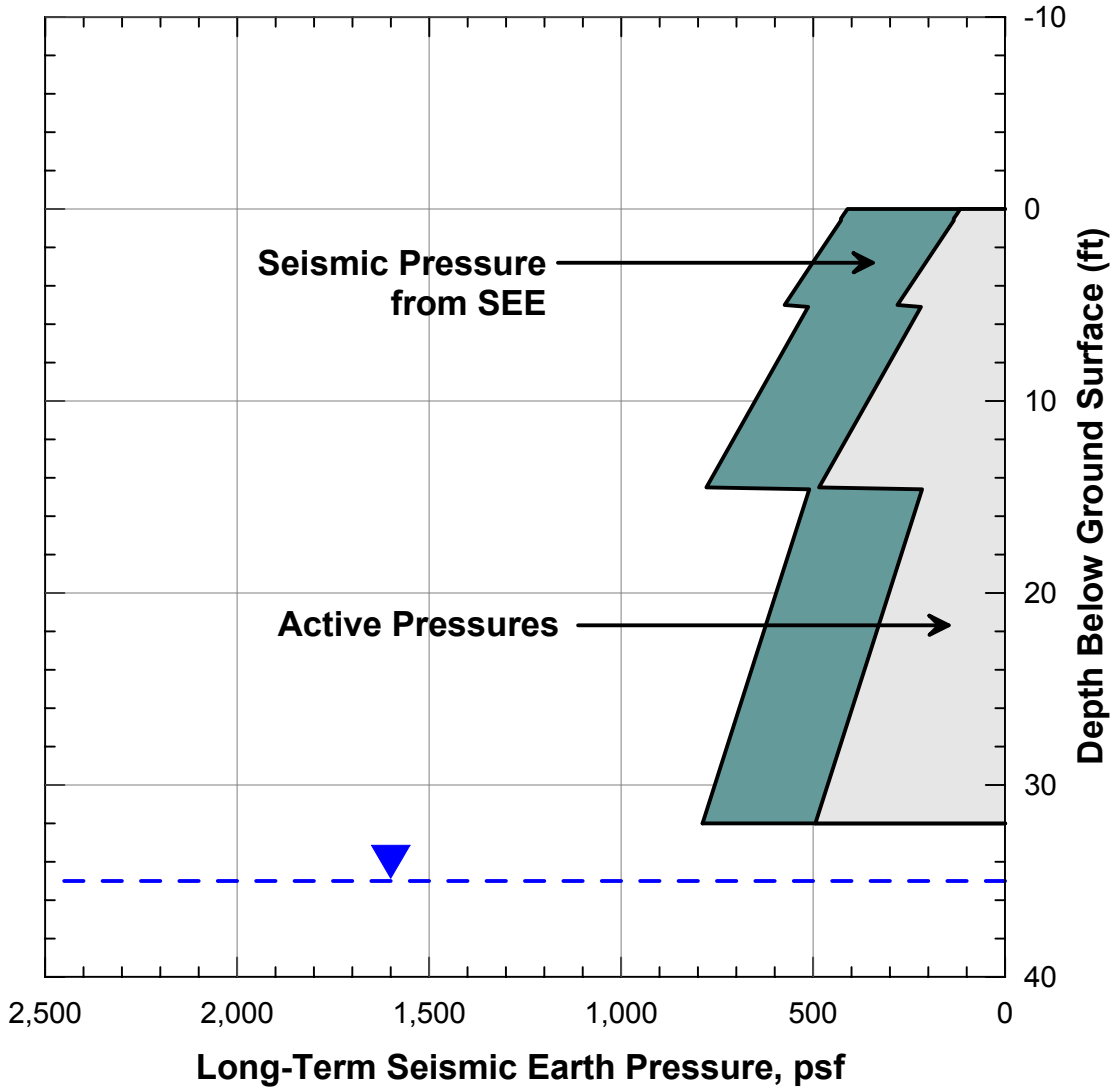
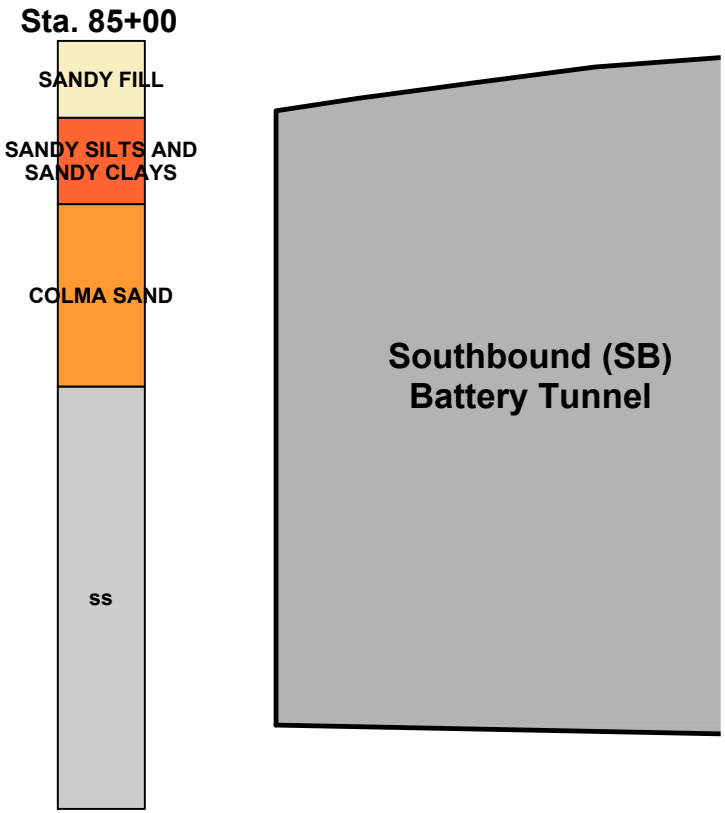
FIGURE 12

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 81SB-S.grf





LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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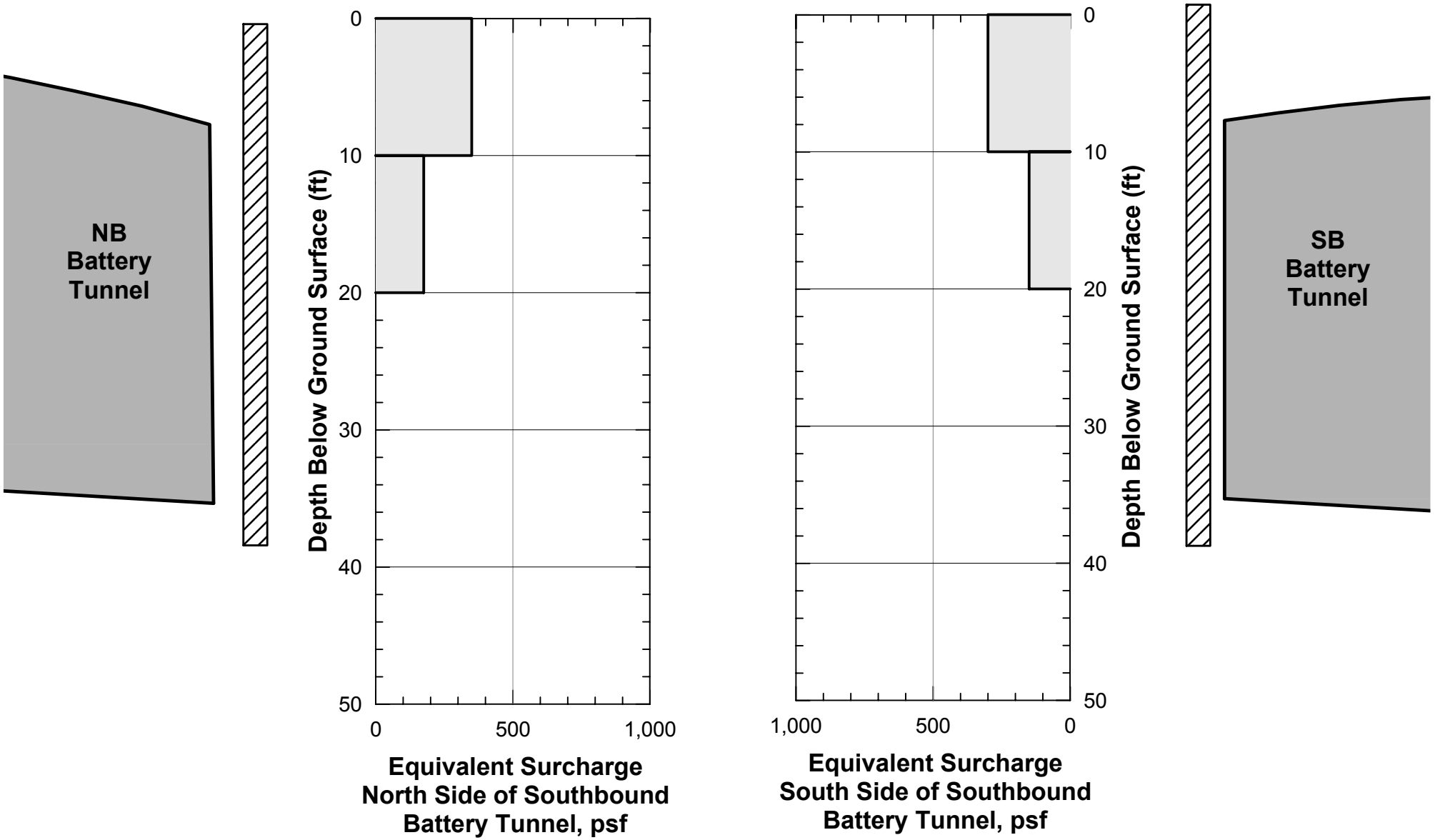
FIGURE 13

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 85SB-S.grf



EQUIVALENT SURCHARGES TO BE APPLIED TO THE TUNNEL AND RETAINING WALLS

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Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
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FIGURE 14

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Surcharge Pressures.grf

Appendix A

Apparent Earth Pressure Calculations

BRACED EXCAVATION CALCULATION

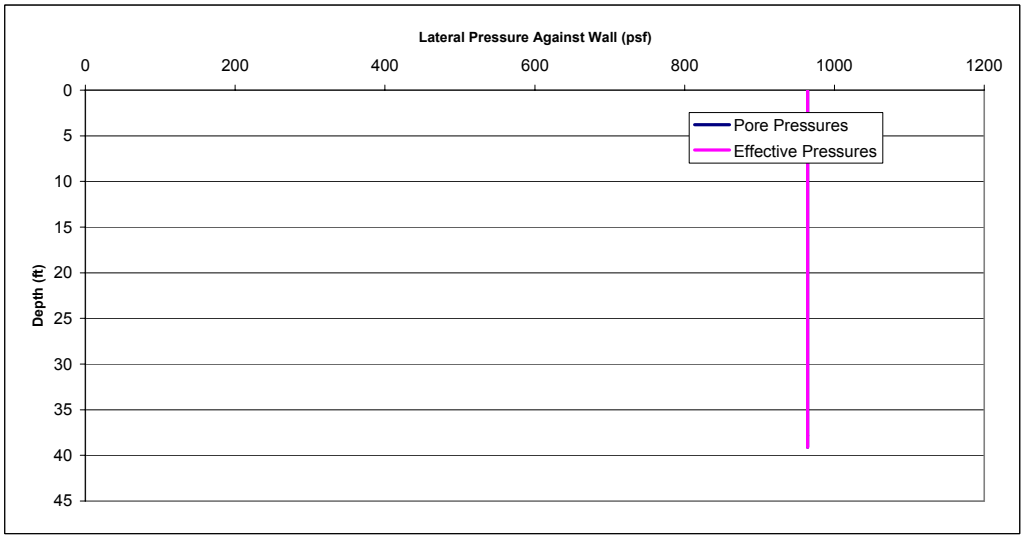
Location: Southbound Tunnel at Sta 78+00

Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	12.5	Sandy Fill
12.5	17	Sandy Silts and Sandy Clays
17	36.5	Colma Sand
36.5	45	Sandy Silts and Sandy Clays
45		srp

Height of soil above wall	0	ft
Equivalent surcharge pressure	0	psf
Groundwater Depth	40.0	ft
Bottom of Excavation	39.1	ft

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Method: Peck 1969 Apparent Pressure = $0.65*K_a*\gamma*H$ 0.65*Ka*γ*H (psf)	Peck Apparent Pressure w/ Hydrostatic (psf)
Sandy Fill	0.0	0.27	0	0	0	964	964
Sandy Fill	6.3	0.27	750	0	750	964	964
Sandy Fill	12.5	0.27	1500	0	1500	964	964
Sandy Silts and Sandy Clays	12.6	0.27	1500	0	1500	964	964
Sandy Silts and Sandy Clays	14.8	0.27	1764	0	1764	964	964
Sandy Silts and Sandy Clays	17.0	0.27	2028	0	2028	964	964
Colma Sand	17.1	0.24	2028	0	2028	964	964
Colma Sand	26.8	0.24	3289	0	3289	964	964
Colma Sand	36.5	0.24	4550	0	4550	964	964
Sandy Silts and Sandy Clays	36.6	0.27	4550	0	4550	964	964
Sandy Silts and Sandy Clays	37.9	0.27	4700	0	4700	964	964
Sandy Silts and Sandy Clays	39.1	0.27	4850	0	4850	964	964



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BRACED EXCAVATION CALCULATION

EQ Load

θ_{wall}	0	Wall is vertical
ψ	0.002	
τ_{max}	893	Construction Event (FEE)
$z_{bottom\ of\ wall}$	39.1	
φ_{ave}	36.3	
γ_{ave}	124.3	
σ_v	4861	
Maximum Horizontal Equivalent Acceleration	0.184	g
F.S.	1.2	
Kh	0.110	=1/2 MHEA*F.S.
Kv	0	Assumed
K_{AE} (Lam and Martin, 1986)	0.3	
K_{AE} (M-O)		
P_{AE} (Includes active-static)	28512	psf
$P_{active\text{-}static}$	25755	psf
$P_{earthquake\ Only}$	2757	psf
Seismic Pressure Per H of wall	71	plf of wall
	2	

Depth (ft)	τ_{max} (FEE)
35.5	842
40	906
τ_{max} (FEE)	893

ARUP PB joint venture

BRACED EXCAVATION CALCULATION

Location: Southbound Tunnel at Sta 81+00

Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	17	Sandy Fill
17	20	Sandy Silts and Sandy Clays
20		ss

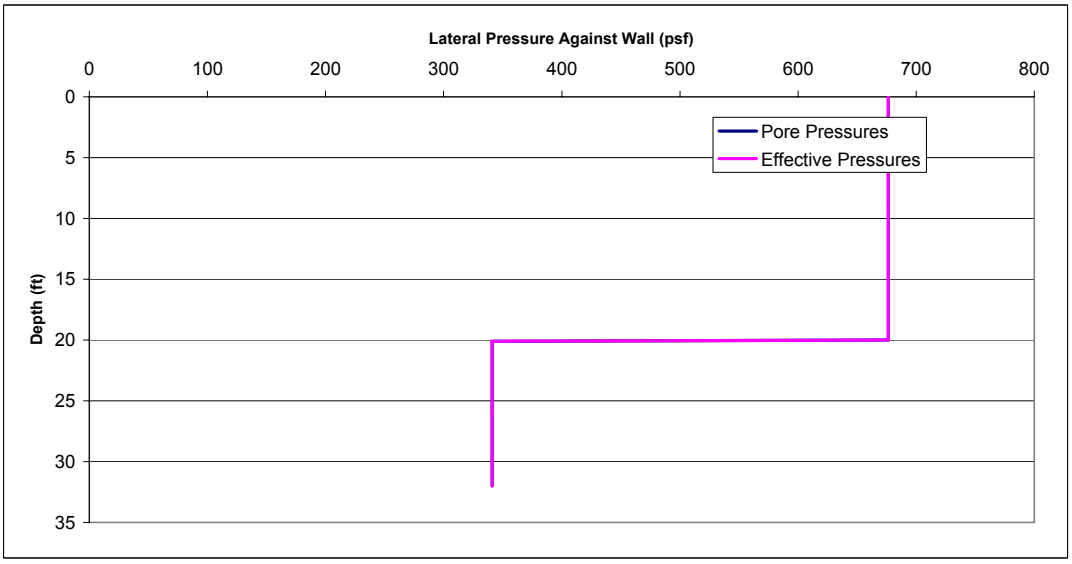
Notes:

Cannot repeat depths, the second depth (top of soil layer below) must be slightly larger

Height of soil above wall	0 ft	
Equivalent surcharge pressure	0 psf	<- Empirical values include const. surcharges (from case histories)
Groundwater Depth	37.0 ft	
Bottom of Excavation	32.0 ft	

Method: Peck 1969
Apparent Pressure = 0.65*K_a*γ*H

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	0.65*Ka*γ*H (psf)	Peck Apparent Pressure w/ Hydrostatic (psf)
Sandy Fill	0.0	0.27	0	0	0	676	676
Sandy Fill	8.5	0.27	1020	0	1020	676	676
Sandy Fill	17.0	0.27	2040	0	2040	676	676
Sandy Silts and Sandy Clays	17.1	0.27	2040	0	2040	676	676
Sandy Silts and Sandy Clays	18.6	0.27	2214	0	2214	676	676
Sandy Silts and Sandy Clays	20.0	0.27	2388	0	2388	676	676
ss	20.1	0.10	2388	0	2388	341	341
ss	26.1	0.10	3370	0	3370	341	341
ss	32.0	0.10	4352	0	4352	341	341



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BRACED EXCAVATION CALCULATION

EQ Load

θ_{wall}	0	Wall is vertical
ψ	0.002	
τ_{max}	768	Construction Event (FEE)
$z_{bottom\ of\ wall}$	32.0	
φ_{ave}	37.4	
γ_{ave}	128.0	
σ_v	4096	
Maximum Horizontal Equivalent Acceleration	0.188	
F.S.	1.2	
Kh	0.113	
Kv	0	
K_{AE} (Lam and Martin, 1986)	0.28	
K_{AE} (M-O)		
P_{AE} (Includes active-static)	18350	
$P_{active\text{-}static}$	17760	
$P_{earthquake\ Only}$	590	
Seismic Pressure Per H of wall	18	
	1	

Depth (ft)	τ_{max} (FEE)
35.5	768
40	768
τ_{max} (FEE)	768

BRACED EXCAVATION CALCULATION

Location: Southbound Tunnel at Sta 85+00

Stratigraphy

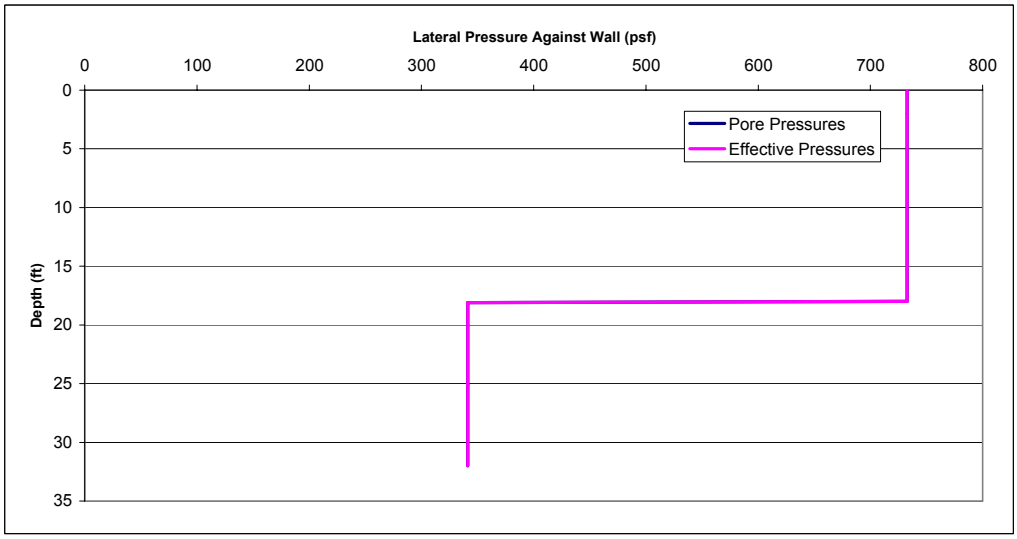
Top of Layer	Bottom of Layer	Soil Profile
0	4	Sandy Fill
4	8.5	Sandy Silts and Sandy Clays
8.5	18	Colma Sand
18	100	ss

Notes:
Cannot repeat depths, the second depth (top of soil layer below) must be slightly larger

Height of soil above wall	0 ft	
Equivalent surcharge pressure	0 psf	<- Empirical values include const. surcharges (from case histories)
Groundwater Depth	35.0 ft	
Bottom of Excavation	32.0 ft	

Method: Peck 1969
Apparent Pressure = $0.65*K_a*\gamma*H$

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	0.65*Ka*γ*H (psf)	Peck Apparent Pressure w/ Hydrostatic (psf)
Sandy Fill	0.0	0.27	0	0	0	733	733
Sandy Fill	2.0	0.27	240	0	240	733	733
Sandy Fill	4.0	0.27	480	0	480	733	733
Sandy Silts and Sandy Clays	4.1	0.27	480	0	480	733	733
Sandy Silts and Sandy Clays	6.3	0.27	744	0	744	733	733
Sandy Silts and Sandy Clays	8.5	0.27	1008	0	1008	733	733
Colma Sand	8.6	0.24	1008	0	1008	733	733
Colma Sand	13.3	0.24	1619	0	1619	733	733
Colma Sand	18.0	0.24	2230	0	2230	733	733
ss	18.1	0.10	2230	0	2230	341	341
ss	25.1	0.10	3377	0	3377	341	341
ss	32.0	0.10	4524	0	4524	341	341



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BRACED EXCAVATION CALCULATION

EQ Load

θ_{wall}	0	Wall is vertical
ψ	0.002	
τ_{max}	626	Construction Event (FEE)
$z_{bottom\ of\ wall}$	32.0	
φ_{ave}	35.3	
γ_{ave}	121.0	
σ_v	3870	
Maximum Horizontal Equivalent Acceleration	0.162	g
F.S.	1.2	
Kh	0.097	=1/2 MHEA*F.S.
Kv	0	Assumed
K_{AE} (Lam and Martin, 1986)	0.3	
K_{AE} (M-O)		
P_{AE} (Includes active-static)	18578	psf
$P_{active\text{-}static}$	16781	psf
$P_{earthquake\ Only}$	1796	psf
Seismic Pressure	56	plf of wall
Per H of wall	2	

Depth (ft)	τ_{max} (FEE)
30	594
35	675
τ_{max} (FEE)	626

Appendix B

Long-Term Seismic Earth Pressure Calculations

Location: SB Tunnel at Sta. 78+00

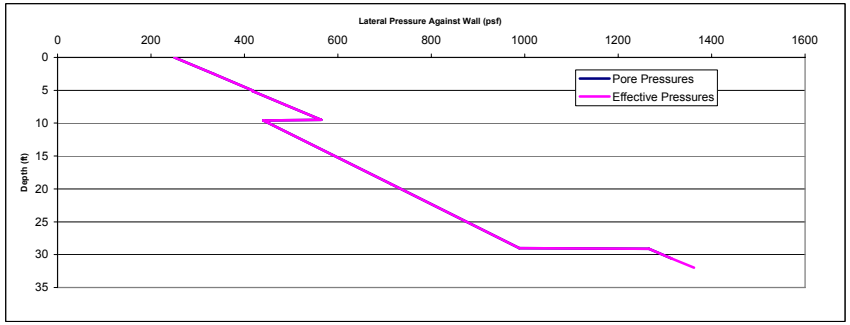
Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	5	SANDY FILL
5	9.5	SANDY SILTS AND SANDY CLAYS
9.5	29	COLMA SAND
29	37.5	SANDY SILTS AND SANDY CLAYS
37.5	40	srp

Height of soil above wall	7.5	ft	
Equivalent surcharge pressure	900	psf	
Groundwater Depth	35	ft	
Height of Wall	32.0	ft	
θ_{wall}	0		Wall is vertical
ψ	0.006		
τ_{max}	2171		From SEE Site Response
$z_{bottom\ of\ wall}$	32.0		
φ_{ave}	36.6		
γ_{ave}	125.2		
σ_v	4006		
Maximum Horizontal Equivalent Acceleration	0.542	g	
F.S.	1.2		
Kh	0.325		=1/2 MHEA*F.S.
Kv	0		Assumed
K_{AE} (Lam and Martin, 1986)	0.46		
K_{AE} (M-O)			
P_{AE} (Includes active-static)	29487	psf	
$P_{active\text{-}static}$	17830	psf	
$P_{earthquake\ Only}$	11657	psf	
Seismic Pressure	364	plf of wall	
Per H of wall	11		

Depth (ft)	τ_{max} (SEE)
30	2081
35	2307
τ_{max} (SEE)	2171

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.28	900	0	900	250	0	250	250	364
SANDY FILL	2.5	0.28	1200	0	1200	334	0	334	334	364
SANDY FILL	5.0	0.28	1500	0	1500	417	0	417	417	364
SANDY SILTS AND□SANDY CLAYS	5.1	0.28	1500	0	1500	417	0	417	417	364
SANDY SILTS AND□SANDY CLAYS	7.3	0.28	1764	0	1764	491	0	491	491	364
SANDY SILTS AND□SANDY CLAYS	9.5	0.28	2028	0	2028	564	0	564	564	364
COLMA SAND	9.6	0.22	2028	0	2028	440	0	440	440	364
COLMA SAND	19.3	0.22	3289	0	3289	714	0	714	714	364
COLMA SAND	29.0	0.22	4550	0	4550	988	0	988	988	364
SANDY SILTS AND□SANDY CLAYS	29.1	0.28	4550	0	4550	1266	0	1266	1266	364
SANDY SILTS AND□SANDY CLAYS	30.6	0.28	4724	0	4724	1314	0	1314	1314	364
SANDY SILTS AND□SANDY CLAYS	32.0	0.28	4898	0	4898	1362	0	1362	1362	364



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LONG-TERM SEISMIC

Location: SB Tunnel at Sta. 81+00

Stratigraphy

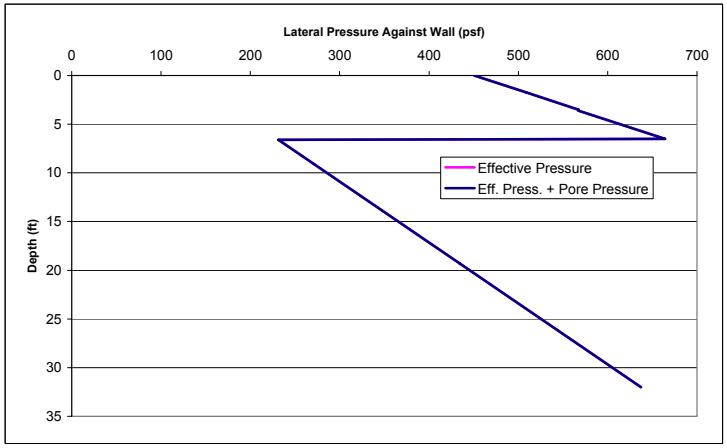
Top of Layer	Bottom of Layer	Soil Profile
0	3.5	SANDY FILL
3.5	6.5	SANDY SILTS AND SANDY CLAYS
6.5		ss

Height of soil above wall	13.5	ft
Equivalent surcharge pressure	1620	psf
Groundwater Depth	35	ft
Height of Wall	32.0	ft

θ_{wall}	0	Wall is vertical
ψ	0.005	
τ_{max}	2064	From SEE Site Response
$z_{bottom\ of\ wall}$	32.0	
φ_{ave}	37.8	
γ_{ave}	129.4	
σ_v	4139	
Maximum Horizontal Equivalent Acceleration	0.499	g
F.S.	1.2	
Kh	0.299	=1/2 MHEA*F.S.
Kv	0	Assumed
K_{AE} (Lam and Martin	0.41	
K_{AE} (M-O)		
P_{AE} (Includes active-	27153	psf
$P_{active\text{-}static}$	18421	psf
$P_{earthquake\ Only}$	8732	psf
Seismic Pressure Per H of wall	273	plf of wall
	9	

Depth (ft)	τ_{max} (SEE)
35.5	2064
40	2064
τ_{max} (SEE)	2064

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.28	1620	0	1620	451	0	451	451	273
SANDY FILL	1.8	0.28	1830	0	1830	509	0	509	509	273
SANDY FILL	3.5	0.28	2040	0	2040	567	0	567	567	273
SANDY SILTS AND□SANDY CLAYS	3.6	0.28	2040	0	2040	567	0	567	567	273
SANDY SILTS AND□SANDY CLAYS	5.1	0.28	2214	0	2214	616	0	616	616	273
SANDY SILTS AND□SANDY CLAYS	6.5	0.28	2388	0	2388	664	0	664	664	273
ss	6.6	0.10	2388	0	2388	231	0	231	231	273
ss	19.3	0.10	4484	0	4484	434	0	434	434	273
ss	32.0	0.10	6579	0	6579	637	0	637	637	273



ARUP PB joint venture

Location: SB Tunnel at Sta. 85+00

Stratigraphy

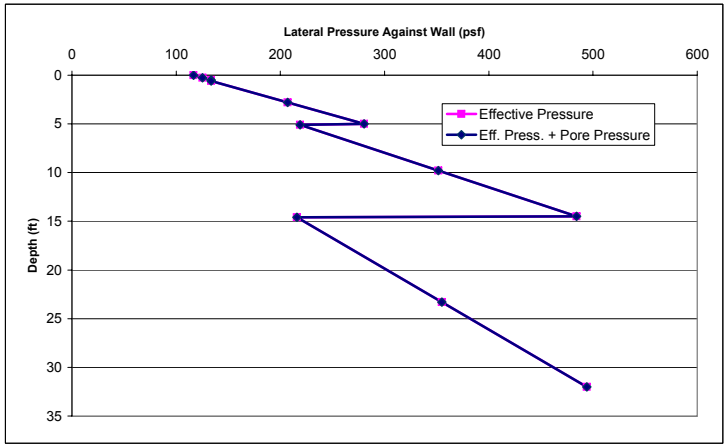
Top of Layer	Bottom of Layer	Soil Profile
0	0.5	SANDY FILL
0.5	5	SANDY SILTS AND SANDY CLAYS
5	14.5	COLMA SAND
14.5		ss

Height of soil above wall	3.5	ft
Equivalent surcharge pressure	420	psf
Groundwater Depth	35.0	ft
Height of Wall	32.0	ft

θ_{wall}	0	Wall is vertical
ψ	0.005	
τ_{max}	1705	From SEE Site Response
$z_{bottom\ of\ wall}$	32.0	
φ_{ave}	35.3	
γ_{ave}	121.0	
σ_v	3870	
Maximum Horizontal Equivalent Acceleration	0.440	g
F.S.	1.2	
Kh	0.264	=1/2 MHEA*F.S.
Kv	0	Assumed
K_{AE} (Lam and Martin	0.43	
K_{AE} (M-O)		
P_{AE} (Includes active-	26628	psf
$P_{active\text{-}static}$	17225	psf
$P_{earthquake\ Only}$	9403	psf
Seismic Pressure	294	plf of wall
Per H of wall	9	

Depth (ft)	τ_{max} (SEE)
30	1610
35	1847
τ_{max} (SEE)	1705

Soil Unit	Depth (ft)	Ka	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.28	420	0	420	117	0	117	117	294
SANDY FILL	0.3	0.28	450	0	450	125	0	125	125	294
SANDY FILL	0.5	0.28	480	0	480	134	0	134	134	294
SANDY SILTS AND□SANDY Cl	0.6	0.28	480	0	480	134	0	134	134	294
SANDY SILTS AND□SANDY Cl	2.8	0.28	744	0	744	207	0	207	207	294
SANDY SILTS AND□SANDY Cl	5.0	0.28	1008	0	1008	280	0	280	280	294
COLMA SAND	5.1	0.22	1008	0	1008	219	0	219	219	294
COLMA SAND	9.8	0.22	1619	0	1619	352	0	352	352	294
COLMA SAND	14.5	0.22	2230	0	2230	484	0	484	484	294
ss	14.6	0.10	2230	0	2230	216	0	216	216	294
ss	23.3	0.10	3666	0	3666	355	0	355	355	294
ss	32.0	0.10	5101	0	5101	494	0	494	494	294



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Appendix C

At-Rest Pressure Calculations

AT-REST EARTH PRESSURE (LONG-TERM STATIC)

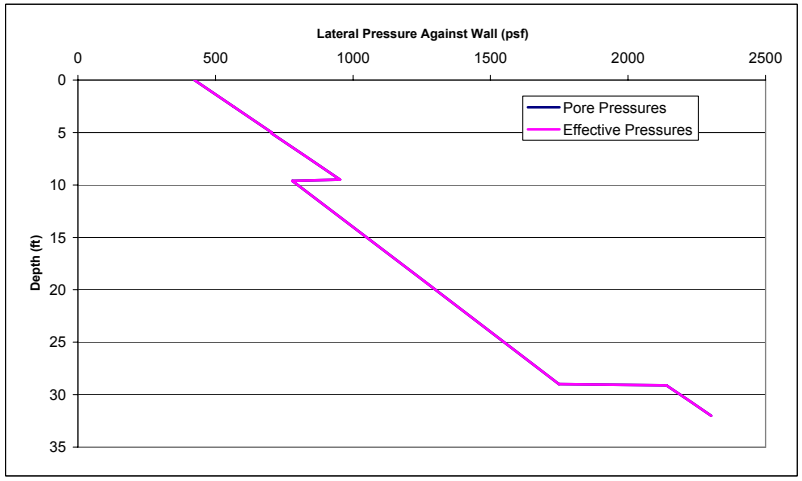
Location: SB Tunnel at Sta. 78+00

Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	5	SANDY FILL
5	9.5	SANDY SILTS AND SANDY CLAYS
9.5	29	COLMA SAND
29	37.5	SANDY SILTS AND SANDY CLAYS
37.5	40	srp

Height of soil above wall	7.5	ft
Equivalent surcharge pressure	900	psf
Groundwater Depth	35	ft
Bottom of Excavation	32	ft

Soil Unit	Depth (ft)	Ko	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.47	900	0	900	423	0	423	423	0
SANDY FILL	2.5	0.47	1200	0	1200	564	0	564	564	0
SANDY FILL	5.0	0.47	1500	0	1500	705	0	705	705	0
SANDY SILTS AND□SANDY CLAYS	5.1	0.47	1500	0	1500	705	0	705	705	0
SANDY SILTS AND□SANDY CLAYS	7.3	0.47	1764	0	1764	829	0	829	829	0
SANDY SILTS AND□SANDY CLAYS	9.5	0.47	2028	0	2028	953	0	953	953	0
COLMA SAND	9.6	0.38	2028	0	2028	779	0	779	779	0
COLMA SAND	19.3	0.38	3289	0	3289	1264	0	1264	1264	0
COLMA SAND	29.0	0.38	4550	0	4550	1749	0	1749	1749	0
SANDY SILTS AND□SANDY CLAYS	29.1	0.47	4550	0	4550	2139	0	2139	2139	0
SANDY SILTS AND□SANDY CLAYS	30.6	0.47	4724	0	4724	2221	0	2221	2221	0
SANDY SILTS AND□SANDY CLAYS	32.0	0.47	4898	0	4898	2302	0	2302	2302	0



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AT-REST EARTH PRESSURE (LONG-TERM STATIC)

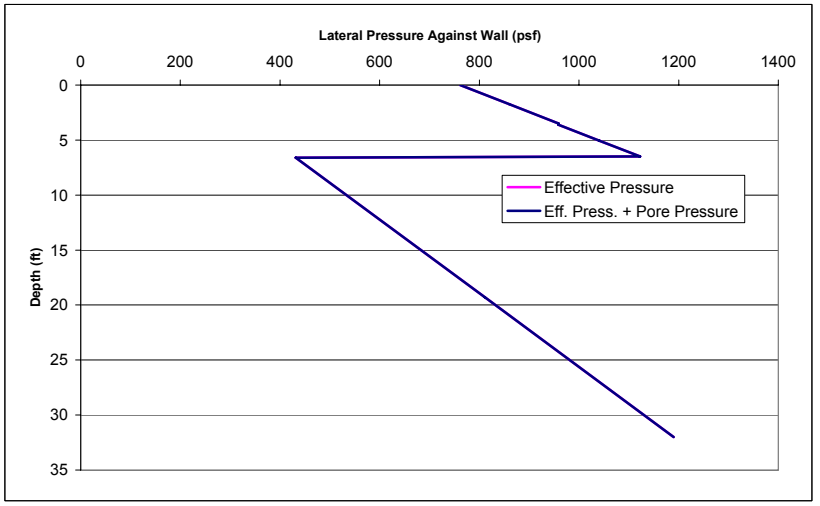
Location: SB Tunnel at Sta. 81+00

Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	3.5	SANDY FILL
		SANDY SILTS
		AND
3.5	6.5	SANDY CLAYS
6.5		ss

Height of soil above wall	13.5	ft
Equivalent surcharge pressure	1620	psf
Groundwater Depth	35	ft
Bottom of Excavation	32	ft

Soil Unit	Depth (ft)	Ko	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.47	1620	0	1620	762	0	762	762	0
SANDY FILL	1.8	0.47	1830	0	1830	860	0	860	860	0
SANDY FILL	3.5	0.47	2040	0	2040	959	0	959	959	0
SANDY SILTS AND□SANDY CLAYS	3.6	0.47	2040	0	2040	959	0	959	959	0
SANDY SILTS AND□SANDY CLAYS	5.1	0.47	2214	0	2214	1041	0	1041	1041	0
SANDY SILTS AND□SANDY CLAYS	6.5	0.47	2388	0	2388	1123	0	1123	1123	0
ss	6.6	0.18	2388	0	2388	432	0	432	432	0
ss	19.3	0.18	4484	0	4484	811	0	811	811	0
ss	32.0	0.18	6579	0	6579	1190	0	1190	1190	0



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AT-REST EARTH PRESSURE (LONG-TERM STATIC)

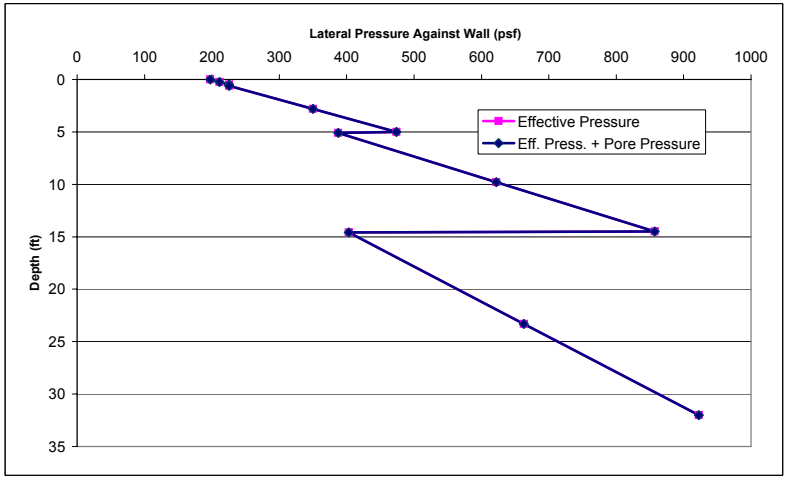
Location: SB Tunnel at Sta. 85+00

Stratigraphy

Top of Layer	Bottom of Layer	Soil Profile
0	0.5	SANDY FILL
0.5	5	SANDY SILTS AND SANDY CLAYS
5	14.5	COLMA SAND
14.5		ss

Height of soil above wall	3.5	ft
Equivalent surcharge pressure	420	psf
Groundwater Depth	35.0	ft
Height of Wall	32	ft

Soil Unit	Depth (ft)	Ko	Total Stress Behind Wall (psf)	Hydrostatic Pressure (psf)	Effective Stress Behind Wall (psf)	Ka * Stress (effective for sands, total for clay) (psf)	Effect of Cohesion (psf)	L.E.P. w/o Hydrostatic (psf)	L.E.P. incl. Hydrostatic (psf)	Seismic Pressure (psf)
SANDY FILL	0.0	0.47	420	0	420	197	0	197	197	0
SANDY FILL	0.3	0.47	450	0	450	212	0	212	212	0
SANDY FILL	0.5	0.47	480	0	480	226	0	226	226	0
SANDY SILTS AND□SANDY CLAYS	0.6	0.47	480	0	480	226	0	226	226	0
SANDY SILTS AND□SANDY CLAYS	2.8	0.47	744	0	744	350	0	350	350	0
SANDY SILTS AND□SANDY CLAYS	5.0	0.47	1008	0	1008	474	0	474	474	0
COLMA SAND	5.1	0.38	1008	0	1008	387	0	387	387	0
COLMA SAND	9.8	0.38	1619	0	1619	622	0	622	622	0
COLMA SAND	14.5	0.38	2230	0	2230	857	0	857	857	0
ss	14.6	0.18	2230	0	2230	403	0	403	403	0
ss	23.3	0.18	3666	0	3666	663	0	663	663	0
ss	32.0	0.18	5101	0	5101	923	0	923	923	0



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Appendix D

Surcharge Calculations

Project 131558
Doyle Drive Battery Tunnel

Reference: Caltrans Trenching and Shoring Manual p. 6-3

SURCHARGE AVERAGES

SOUTHBOUND TUNNEL

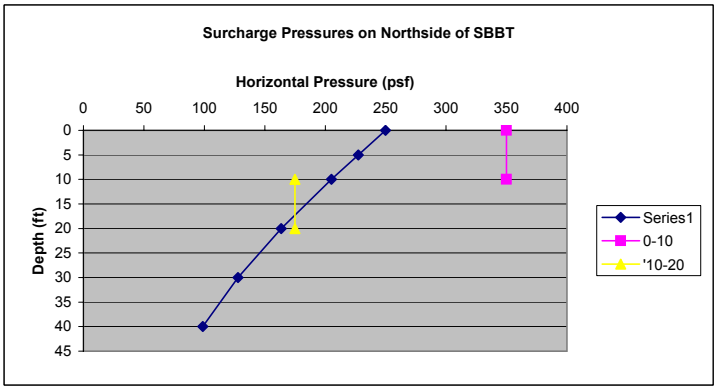
NORTH SURCHARGE
Surcharge is considered to be right at the edge of excavation

Q =	250	psf	Assumed surcharge load
D =	40	ft	Depth of excavation
L1 =	0	ft	Right at the edge of excavation
L2 =	70	ft	Average road width measured from plan

Depth	Beta (rad)	Sigma_h	Avg S_h
0	1.57	250	
5	1.50	227	239
10	1.43	205	216
20	1.29	164	184
30	1.17	128	146
40	1.05	99	113

Equivalent Pressure

Depth	S_h
0	350
10	350
10	175
20	175



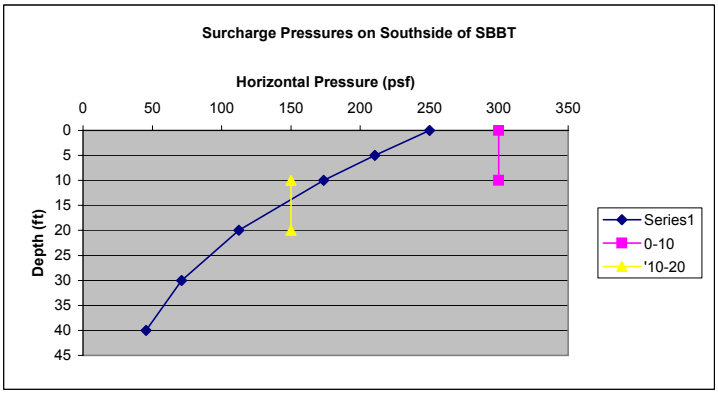
SOUTH SURCHARGE
Surcharge is considered to be right at the edge of excavation

Q =	250	psf	Assumed surcharge load
D =	40	ft	Depth of excavation
L1 =	0	ft	Right at the edge of excavation
L2 =	40	ft	Surcharge extends to maximum of 40 feet by the cemetary

Depth	Beta (rad)	Sigma_h	Avg S_h
0	1.57	250	
5	1.45	211	230
10	1.33	174	192
20	1.11	113	143
30	0.93	71	92
40	0.79	45	58

Equivalent Pressure

Depth	S_h
0	300
10	300
10	150
20	150



APPENDIX F.3

Estimation of Soil Spring Constants for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Estimation of Soil Spring Constants

Southbound Battery Tunnel

July 2009

Prepared By:

Arup PB Joint Venture

Appendix A

Vertical Soil Spring Chart

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Estimation of Soil Spring Constants

July 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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Figures

Figure 1 Estimated Vertical Soil Springs below Southbound Battery Tunnel

Appendices

Appendix A – Vertical Soil Spring Chart
Appendix B – Calculation of Soil Spring Distribution

1 Introduction

The following calculation package presents an overview of the data and methods used to estimate soil spring constants for design of the Southbound Battery Tunnel of the proposed Doyle Drive Replacement Project in the San Francisco Presidio. As site conditions change significantly across the project site, spring constants were estimated at several locations as site conditions dictated.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Estimate average soil spring constants below the Southbound Battery Tunnel
- Distribute the average soil springs below the mat foundation such that the springs in the center are the lowest.

3 Inputs

The following input data was required for the analyses:

3.1 Stratigraphy

In the vicinity of the Battery Tunnels, the subsurface conditions typically consist of the following:

- **FILL:** At the surface is a layer of Fill that varies in thickness from 3 to 23 feet. The composition of the fill is variable and can include gravel, clay, and/or clean sand. The fill is typically loose to medium dense with SPT N-values ranging from as low as 3 to as high as 30 blows per foot.
- **BURIED SOIL HORIZON:** Below the Fill there is a thin layer of a Buried Soil Horizon. Where present, the thickness of the Buried Soil Horizon ranges from about 0.5 to 4.5 feet, but was not encountered in all boreholes. The composition of the Buried Soil Horizon is typically highly organic sandy clay. The Buried Soil Horizon deposits are typically loose with SPT N-values ranging from 0 to 11 blows per foot.
- **SANDY CLAY AND SANDY SILT:** Below the Buried Soil Horizon is a layer of Sandy Clay and Sandy Silt which is probably related to the Colma Sand layer below. The Sandy Clay and Sandy Silt layer ranged from 1.5 to 15.5 feet thick. The Sandy Clay and Sandy Silt layer is typically medium stiff to very stiff with SPT N-values ranging from 7 to 39, with occasional N-values over 50 blows per foot.
- **COLMA SAND:** Below the Sandy Clay and Sandy Silt is a fine to medium grained sand deposit known locally as Colma Sand. Where present, the Colma Sand ranged from 3.5 to 35 feet thick. The Colma Sand is typically medium dense to dense with SPT N-values ranging from 12 to over 60 blows per foot. In places, the Colma Sand is also underlain by another layer of Sandy Clay and Sandy Silt.
- **COLLUVIUM/RESIDUAL SOIL:** Below the Colma Sand or the lower layer of Sandy Clay and Sandy Silt and above the bedrock is a thin layer of either Colluvium or Residual Soil. These layers consisted mainly of stiff to very stiff gravelly clays.
- **BEDROCK:** Bedrock (Franciscan Complex) was encountered below the proposed Battery Tunnels at depths ranging from at the ground surface (at Borehole BTNB-R5-PZ-D) to 54 feet (at Borehole BTNB-R4-PZ). The depth to bedrock generally decreases towards the west end of the Battery Tunnels. The three major types of bedrock

encountered below the Southbound Battery tunnel were Serpentinite, Intensely Fractured Sandstone, and Moderately Fractured Sandstone.

Along the alignment of the Southbound Battery Tunnel, only small amounts of serpentinite may be encountered at the base of the tunnel, but are not anticipated to affect the design.

4 Assumptions

The following assumptions were made in these calculations:

- The Fill acts as a loose sand
- The Colma Sand acts as a medium dense to dense sand
- The Moderately Hard, Intensely Fractured Sandstone acts as a dense to very dense sand
- The Moderately Hard, Moderately Fractured Sandstone acts similar to the high end range of very dense sand

5 Calculations

5.1 Estimation of Soil Spring Constants

The serpentinite was typically encountered below the Colma Sand from the east end of the tunnel to approximately Station 78+50. The hard strength sandstone was typically encountered from Station 78+50 to Station 81+50. Average strength sandstone was encountered from Station 81+50 to the west end of the project.

Average vertical soil springs were determined from the chart presented in the NAVFAC Design Manual 7.01, which is attached to this calculation package at Appendix A.

Soil Unit	Sand Equivalent	Vertical Spring Constant, k_v
Fill	Loose	120 ksf/ft
Colma Sand	Medium Dense to Dense	360 ksf/ft
Intensely Fractured Sandstone	Dense to Very Dense	500 ksf/ft
Moderately Fractured Sandstone	High-end Very Dense	700 ksf/ft

Horizontal soils springs are required for modeling the walls near Station 78+00. A constant lateral spring was determined as the average of the vertical soil springs of Colma Sand and the Fill.

Colma Sand: k_v = 360 ksf/ft

Fill: k_v = 120 ksf/ft

Average k_v = 240 ksf/ft, say 200 ksf/ft

5.2 Distribution of Average Spring Constants

The spring constants estimated from the NAVFAC manual represent average values. In reality, the values of k at the edges of the mat are approximately twice the value at the center of the mat (Coduto). Therefore, the area of the tunnel was divided into three concentric zones. Spring constant values were assigned to each zone such that the outermost zone has a value of twice the inner zone and the average spring constant remains constant across all three zones.

Calculations of the spring constant distributions are shown in Appendix B to this calculation package.

6 Results

The average spring constants range from 360 ksf/ft where the tunnel bears on Colma Sand up to 700 ksf/ft where Hard Sandstone was encountered. The results of the spring constant calculations are shown on Figure 1.

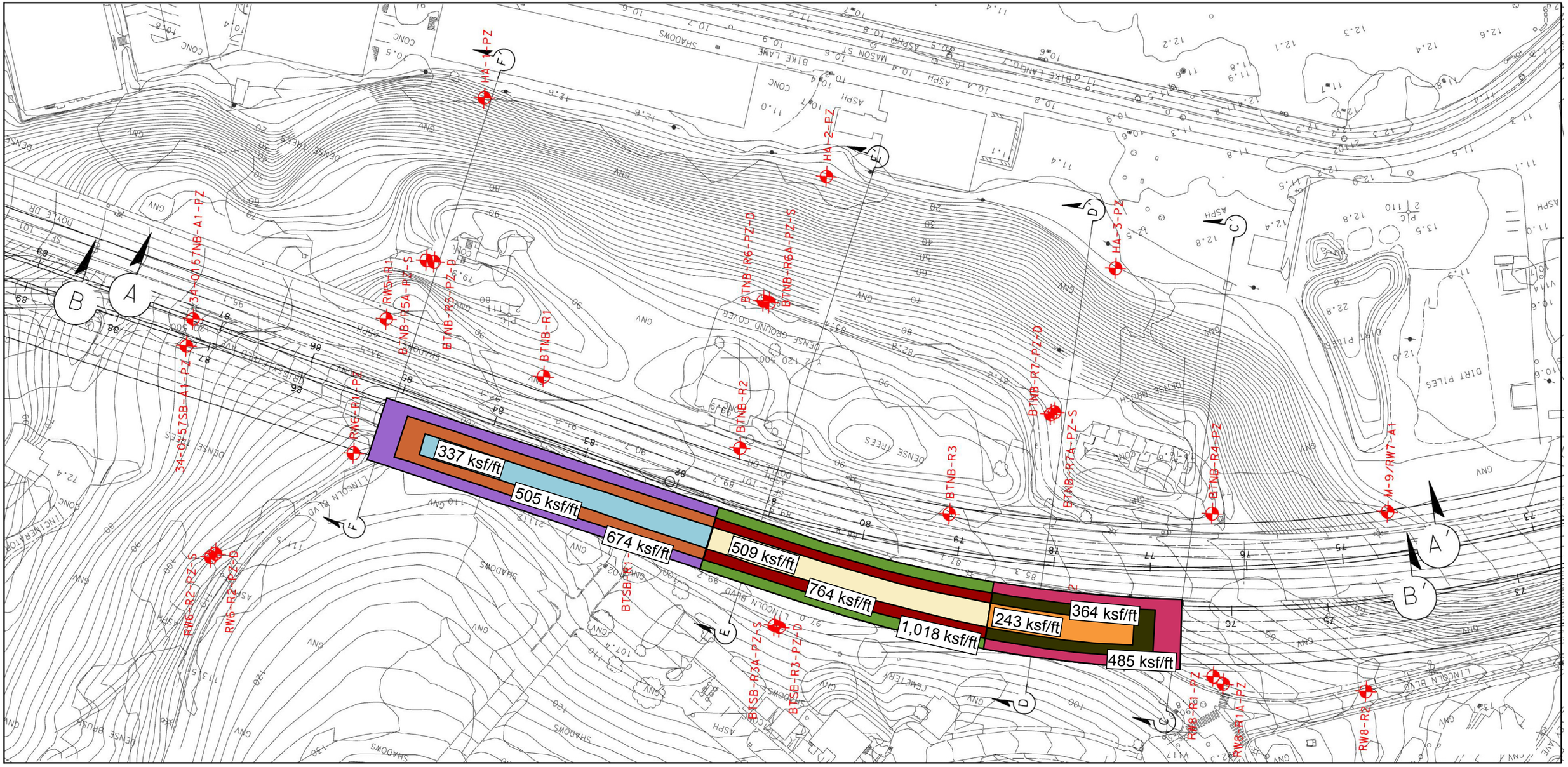
The horizontal soil springs at Station 78+00 are a constant value of 200 ksf/ft.

List of References

[1] Coduto, Donald, P. (2001) Foundation Design: Principles and Practices. Prentice Hall, New Jersey.

[2] Naval Facilities Engineering Command (1986) “Soil Mechanics” Design Manual 7.01, Alexandria, VA.

FIGURES



k_S = 674 ksf/ft	k_S = 1,018 ksf/ft	k_S = 485 ksf/ft
k_S = 505 ksf/ft	k_S = 764 ksf/ft	k_S = 364 ksf/ft
k_S = 337 ksf/ft	k_S = 509 ksf/ft	k_S = 243 ksf/ft

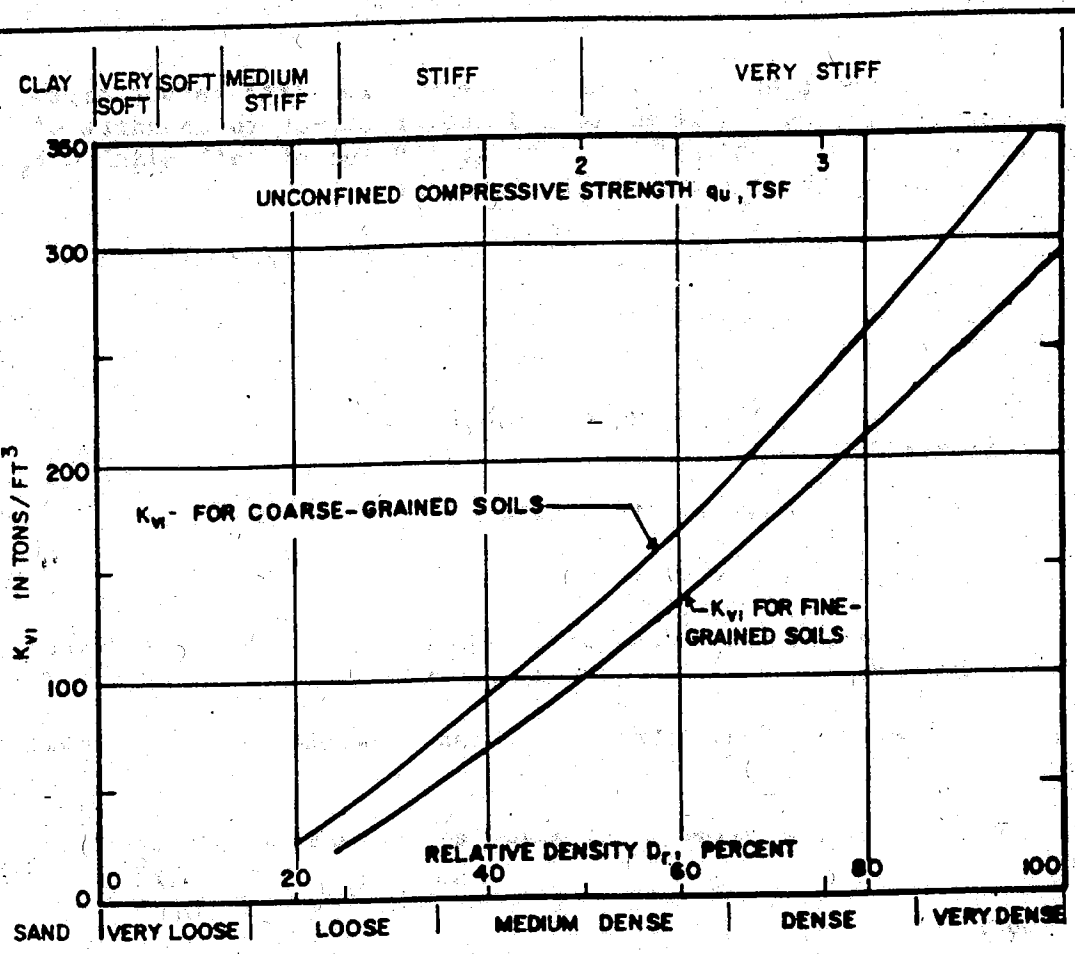
ESTIMATED VERTICAL SPRING CONSTANTS

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
July 2009 San Francisco, California

ARUP PB joint venture

FIGURE 1

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Soil Springs\Spring ConstantsSouthbound.grf



DEFINITIONS

ΔH_i = IMMEDIATE SETTLEMENT OF FOOTING
q = FOOTING UNIT LOAD IN tsf
B = FOOTING WIDTH
D = DEPTH OF FOOTING BELOW GROUND SURFACE
K_{vi} = MODULUS OF VERTICAL SUBGRADE REACTION

COARSE-GRAINED SOILS

(MODULUS OF ELASTICITY INCREASING LINEARLY WITH DEPTH)
SHALLOW FOOTINGS D ≤ B
FOR B ≤ 20 FT:

$$\Delta H_i = \frac{4\,q\,B^2}{K_{vi}\,(B+1)^2}$$

FOR B ≥ 40 FT:

$$\Delta H_i = \frac{2\,q\,B^2}{K_{vi}\,(B+1)^2}$$

INTERPOLATE FOR INTERMEDIATE VALUES OF B

DEEP FOUNDATION D ≥ 5B
FOR B ≤ 20 FT:

$$\Delta H_i = \frac{2\,q\,B^2}{K_{vi}\,(B+1)^2}$$

NOTES: 1. NONPLASTIC SILT IS ANALYZED AS COARSE-GRAINED SOIL WITH MODULUS OF ELASTICITY INCREASING LINEARLY WITH DEPTH.
2. VALUES OF K_{vi} SHOWN FOR COARSE-GRAINED SOILS APPLY TO DRY OR MOIST MATERIAL WITH THE GROUNDWATER LEVEL AT A DEPTH OF AT LEAST 1.5B BELOW BASE OF FOOTING. IF GROUNDWATER IS AT BASE OF FOOTING, USE $K_{vi}/2$ IN COMPUTING SETTLEMENT
3. FOR CONTINUOUS FOOTINGS MULTIPLY THE SETTLEMENT COMPUTED FOR WIDTH "B" BY 2.

FIGURE 6
Instantaneous Settlement of Isolated Footings on Coarse-Grained Soils

Appendix B

Calculation of Soil Spring Distribution

Calculation of Soil Spring Distribution

Southbound	Sta 76+55 to Sta 78+50	
$k_{s,avg}$	360	ksf/ft

Outer Zone

Width of Tunnel	66	ft
Length of Segment	195	ft
Gross Area of Outer Zone	12870	ft^2
Net Area of Outer Zone (A_{outer})	4424	ft^2

Middle Zone

Width	50	ft
Length	171	ft
Gross Area of Middle Zone	8446	ft^2
Net Area of Middle Zone (A_{middle})	3620	ft^2

Inner Zone

Width	33	ft
Length	146	ft
Gross Area of Inner Zone	4826	ft^2
Net Area of Inner Zone (A_{inner})	4826	ft^2

$k_{s,outer}$	$=2(k_{s,inner})$	485	ksf/ft
$k_{s,middle}$	$=1.5(k_{s,inner})$	364	ksf/ft
$k_{s,inner}$	$=k_{s,inner}$	243	ksf/ft

t_{middle}	8.25	ft
t_{inner}	16.5	ft

Note: The calculated average soil spring $k_{s,avg}$ is distributed over the area of each zone so that the weighted average of each soil spring and zone ($k_{s,outer}$, $k_{s,middle}$, and $k_{s,inner}$) remains equal to the original value.

Calculation of Soil Spring Distribution

Southbound	Sta 78+50 to Sta 81+50	
$k_{s,avg}$	700	ksf/ft

Outer Zone

Width of Tunnel	66	ft
Length of Segment	300	ft
Gross Area of Outer Zone	19800	ft^2
Net Area of Outer Zone (A_{outer})	4950	ft^2

Middle Zone

Width	50	ft
Length	300	ft
Gross Area of Middle Zone	14850	ft^2
Net Area of Middle Zone (A_{middle})	4950	ft^2

Inner Zone

Width	33	ft
Length	300	ft
Gross Area of Inner Zone	9900	ft^2
Net Area of Inner Zone (A_{inner})	9900	ft^2

$k_{s,outer}$	$=2(k_{s,inner})$	1018	ksf/ft
$k_{s,middle}$	$=1.5(k_{s,inner})$	764	ksf/ft
$k_{s,inner}$	$=k_{s,inner}$	509	ksf/ft

t_{middle}	8.25	ft
t_{inner}	16.5	ft

Note: The calculated average soil spring $k_{s,avg}$ is distributed over the area of each zone so that the weighted average of each soil spring and zone ($k_{s,outer}$, $k_{s,middle}$, and $k_{s,inner}$) remains equal to the original value.

Calculation of Soil Spring Distribution

Southbound	Sta 81+50 to Sta 85+13	
$k_{s,avg}$	500	ksf/ft

Outer Zone

Width of Tunnel	66	ft
Length of Segment	363	ft
Gross Area of Outer Zone	23958	ft^2
Net Area of Outer Zone (A_{outer})	8236	ft^2

Middle Zone

Width	50	ft
Length	318	ft
Gross Area of Middle Zone	15722	ft^2
Net Area of Middle Zone (A_{middle})	6738	ft^2

Inner Zone

Width	33	ft
Length	272	ft
Gross Area of Inner Zone	8984	ft^2
Net Area of Inner Zone (A_{inner})	8984	ft^2

$k_{s,outer}$	$=2(k_{s,inner})$	674	ksf/ft
$k_{s,middle}$	$=1.5(k_{s,inner})$	505	ksf/ft
$k_{s,inner}$	$=k_{s,inner}$	337	ksf/ft

t_{middle}	8.25	ft
t_{inner}	16.5	ft

Note: The calculated average soil spring $k_{s,avg}$ is distributed over the area of each zone so that the weighted average of each soil spring and zone ($k_{s,outer}$, $k_{s,middle}$, and $k_{s,inner}$) remains equal to the original value.

APPENDIX F.4

Estimation of Bearing Capacity for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Estimation of Bearing Capacity

Southbound Battery Tunnel

June 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Estimation of Bearing Capacity

June 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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Figure 2 Soil Stratigraphy in the Vicinity of the Analysis
Figure 3 Diagram of Foundation Dimensions
Figure 4 Estimation of Bearing Capacity Factors
Figure 5 Estimation of Unit Weight Factor

Appendices

Appendix A – Typical Calculation

1 Introduction

The following calculation package presents an overview of the data and method used to estimate the ultimate bearing capacity for design of the Battery Tunnels of the proposed Doyle Drive Replacement Project in the San Francisco Presidio.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Calculate the ultimate bearing capacity for the design of the Battery Tunnels

For this calculation, the ultimate bearing capacity was calculated at Station 78+00 Southbound (SB). This is the area of the tunnel that is underlain by the thickest soil layer and therefore will have the lowest ultimate bearing capacity. It is conservative to use this value for other areas of the tunnel where the bedrock is closer to or directly beneath the bottom of the footing.

3 Inputs

The following input data was required for the analyses:

3.1 Stratigraphy

In the vicinity of the Battery Tunnels, the subsurface conditions typically consist of the following:

- **FILL:** At the surface is a layer of Fill that varies in thickness from 3 to 23 feet. The composition of the fill is variable and can include gravel, clay, and/or clean sand. The fill is typically loose to medium dense with SPT N-values ranging from as low as 3 to as high as 30 blows per foot.
- **BURIED SOIL HORIZON:** Below the Fill there is a thin layer of a Buried Soil Horizon. Where present, the thickness of the Buried Soil Horizon ranges from about 0.5 to 4.5 feet, but was not encountered in all boreholes. The composition of the Buried Soil Horizon is typically highly organic sandy clay. The Buried Soil Horizon deposits are typically loose with SPT N-values ranging from 0 to 11 blows per foot.
- **SANDY CLAY AND SANDY SILT:** Below the Buried Soil Horizon is a layer of Sandy Clay and Sandy Silt which is probably related to the Colma Sand layer below. The Sandy Clay and Sandy Silt layer ranged from 1.5 to 15.5 feet thick. The Sandy Clay and Sandy Silt layer is typically medium stiff to very stiff with SPT N-values ranging from 7 to 39, with occasional N-values over 50 blows per foot.
- **COLMA SAND:** Below the Sandy Clay and Sandy Silt is a fine to medium grained sand deposit known locally as Colma Sand. Where present, the Colma Sand ranged from 3.5 to 35 feet thick. The Colma Sand is typically medium dense to dense with SPT N-values ranging from 12 to over 60 blows per foot. In places, the Colma Sand is also underlain by another layer of Sandy Clay and Sandy Silt.
- **COLLUVIUM/RESIDUAL SOIL:** Below the Colma Sand or the lower layer of Sandy Clay and Sandy Silt and above the bedrock is a thin layer of either Colluvium or Residual Soil. These layers consisted mainly of stiff to very stiff gravelly clays.
- **BEDROCK:** Bedrock (Franciscan Complex) was encountered below the proposed Battery Tunnels at depths ranging from at the ground surface (at Borehole BTNB-R5-PZ-D) to 54 feet (at Borehole BTNB-R4-PZ). The depth to bedrock generally decreases towards the west end of the Battery Tunnels. The four major types of bedrock were

encountered were Serpentinite, Average Strength Sandstone, Hard Sandstone, and Mélange Matrix.

3.2 Material Properties

At Station 78+00 SB, the majority of the soil is Colma Sand. For the calculation of ultimate bearing capacity, the soil surrounding the tunnel structure was assumed to be uniform and have the same properties of Colma Sand. The following properties were used:

Soil/Rock Unit	Total Unit Weight, γ (pcf)	Friction Angle, ϕ (°)	Cohesion, c (psf)
Colma Sand	130	38	0

3.3 Water Table

The water table was determined from several nearby piezometers, shown in the table below.

Piezometer ID	W.T. Elevation	Distance from Sta. 78+00 SB
RW8-R1-PZ	51.9	200 ft
BTNB-R4-PZ	40.6	200 ft
BTNB-R7-PZ-D	49.0	190 ft

From this data, the water table was estimated at Elevation 45 ft, which at the considered location is approximately 10 ft below the bottom of the footing.

4 Assumptions

The following assumptions were made in these calculations:

- The Battery tunnel structure was assumed to be level. In reality, the structure slopes downward approximately 2% to the north; however, such a slight inclination did not necessitate an inclined slope bearing capacity analysis.
- The depth of the foundation is not uniform on both sides of the tunnel. However, for this analysis, it was assumed uniform and the depth was taken from the north side of the tunnel where the soil is shallower and will produce a more conservative result.
- It was assumed that the Colma Sand extends below the tunnel to the bottom of the failure surface. In reality, the bedrock is approximately 10 feet below the bottom of the foundation but by assuming a uniform soil layer, the calculation is greatly simplified and the result is conservative.

5 Calculations

This section is summarizes the calculations performed to estimate the ultimate bearing capacity for the Battery Tunnels. All documents relating to these calculations can be found at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Calculation Packages\Bearing Capacity.

5.1 Estimation of Ultimate Bearing Capacity

The ultimate bearing capacity was calculated from the equation presented in NAVFAC Design Manual 7.02[1] for rectangular shallow footings where the water table is below the bottom of the foundation. The equation is:

$$q_{ult} = cN_c\left(1+0.3\frac{B}{L}\right)+\gamma_{total}DN_q+\left[\gamma_{eff}+F\left(\gamma_{total}-\gamma_{eff}\right)\right]0.4BN_\gamma$$

Where,

q_{ult} = ultimate bearing capacity, psf

c = cohesion, psf

N_c = bearing capacity factor

B = footing width, ft

L = footing length, ft

γ_{total} = total unit weight of soil, pcf

D = depth of footing, ft

N_q = bearing capacity factor

γ_{eff} = effective unit weight of soil, pcf

F = unit weight factor

N_γ = bearing capacity factor

Since the cohesion of the Colma Sand is zero, the equation reduces to:

$$q_{ult} = \gamma_{total}DN_q+\left[\gamma_{eff}+F\left(\gamma_{total}-\gamma_{eff}\right)\right]0.4BN_\gamma$$

Using the material properties outlines above as well as the dimensions from Figure 3 and the bearing capacity factors and unit weight factor from Figures 4 and 5, the resulting ultimate bearing capacity is 482,000 psf. The calculation of this value can be found in Appendix A.

List of References

[1] Design Manual 7.02, Foundations and Earth Stuctures. Naval Facilities Engineering Command. Alexandria, VA.

FIGURES

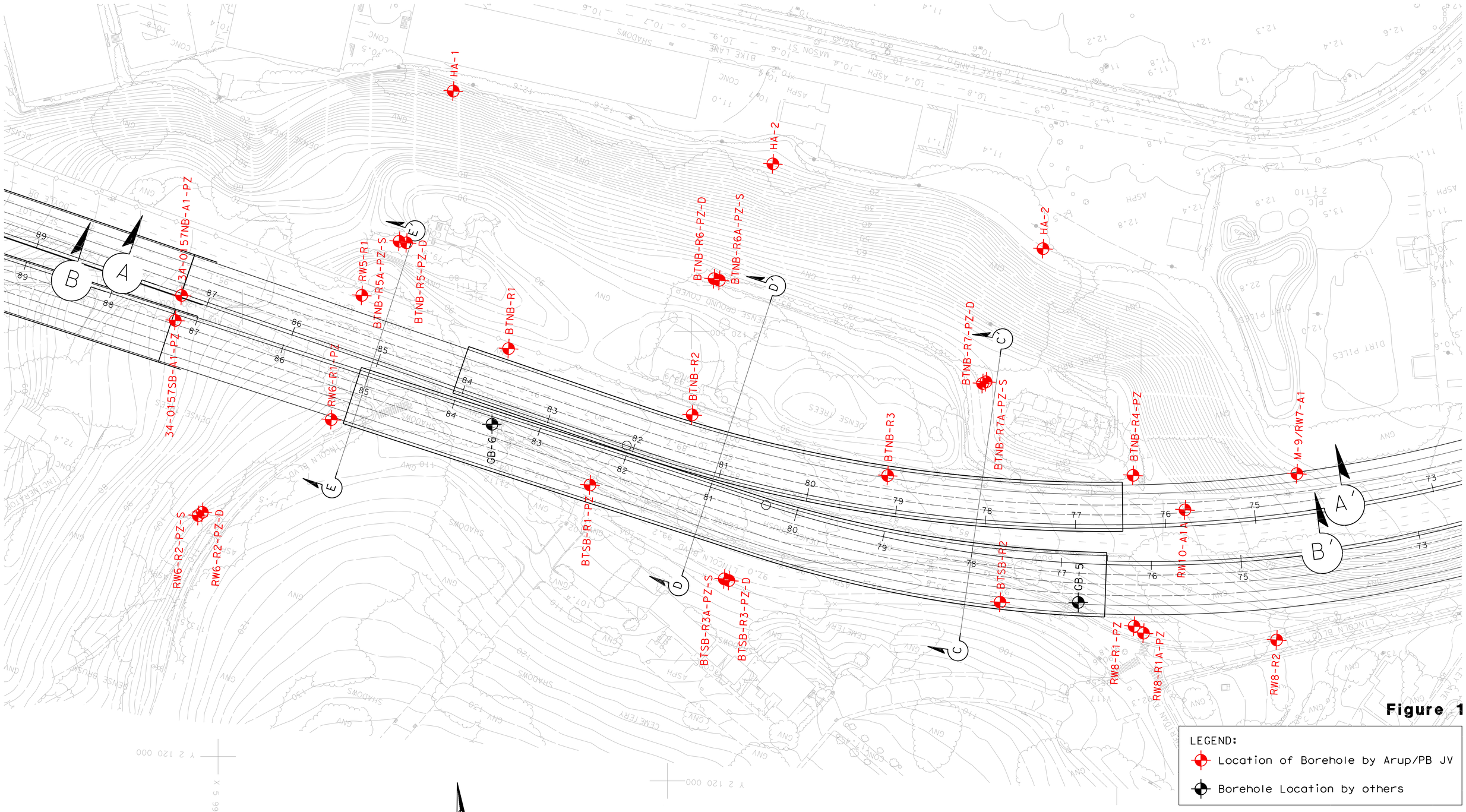


Figure 1

LEGEND:

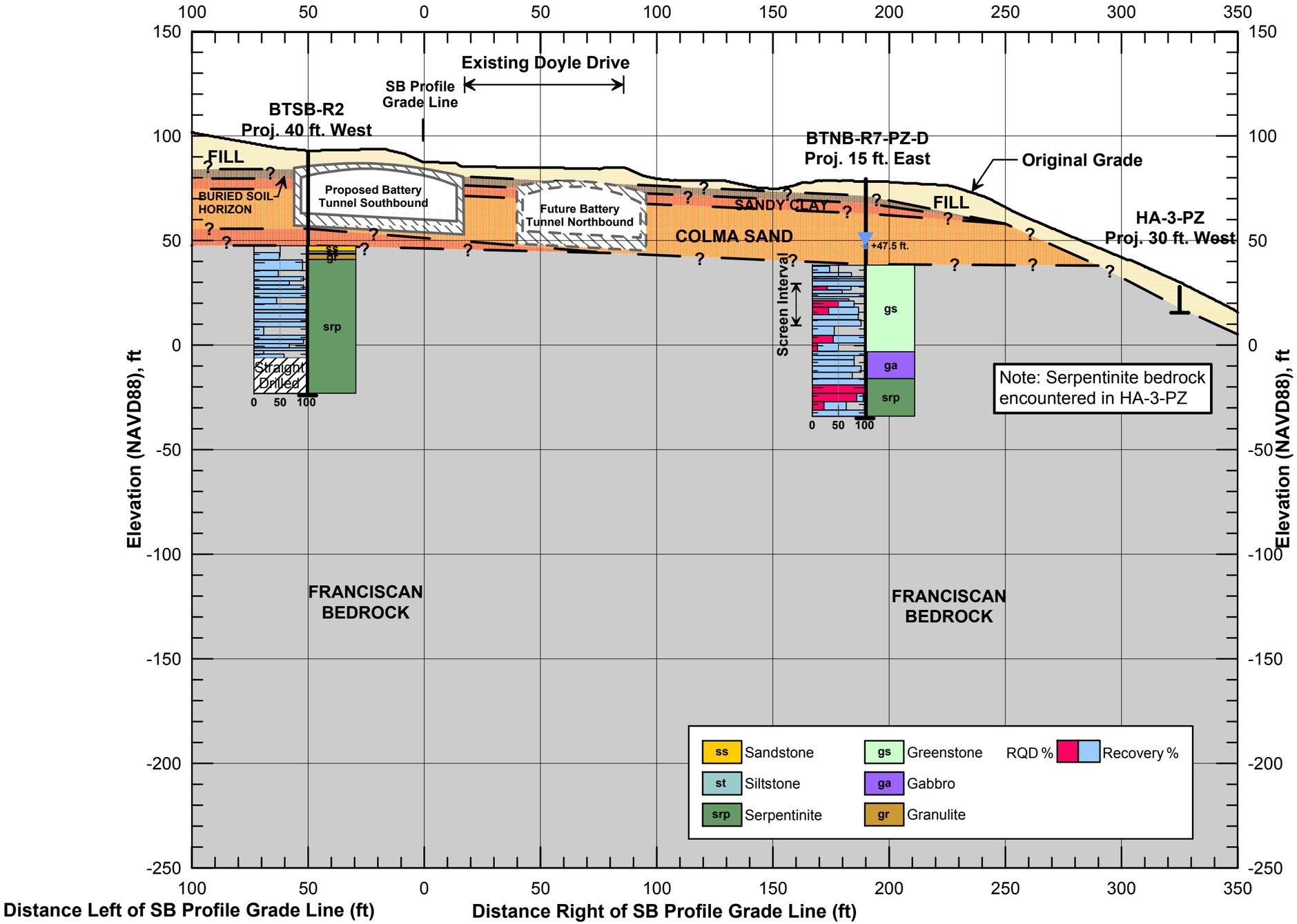
- Location of Borehole by Arup/PB JV
- Borehole Location by others

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

ARUP PB joint venture

SOUTH
D

NORTH
D'

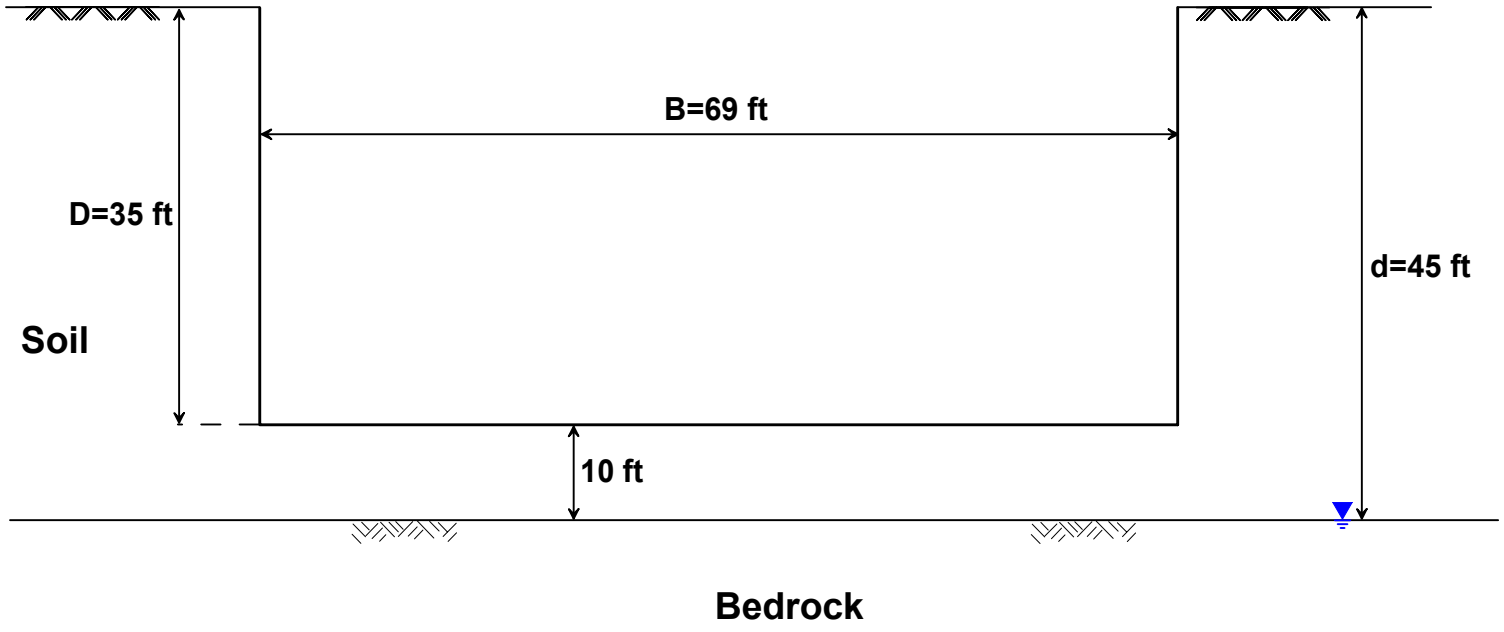


DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy Cross Section D-D'
Transverse Cross Section at Station 78+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 2

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Calculation Packages\Bearing Capacity\78+00 BT Transverse.grf

Foundation Dimensions at Station 78+00 SB



BATTERY TUNNELS FOUNDATION DIMENSIONS

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

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FIGURE 3

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Calculation Packages\Bearing Capacity\Figure 3.grf

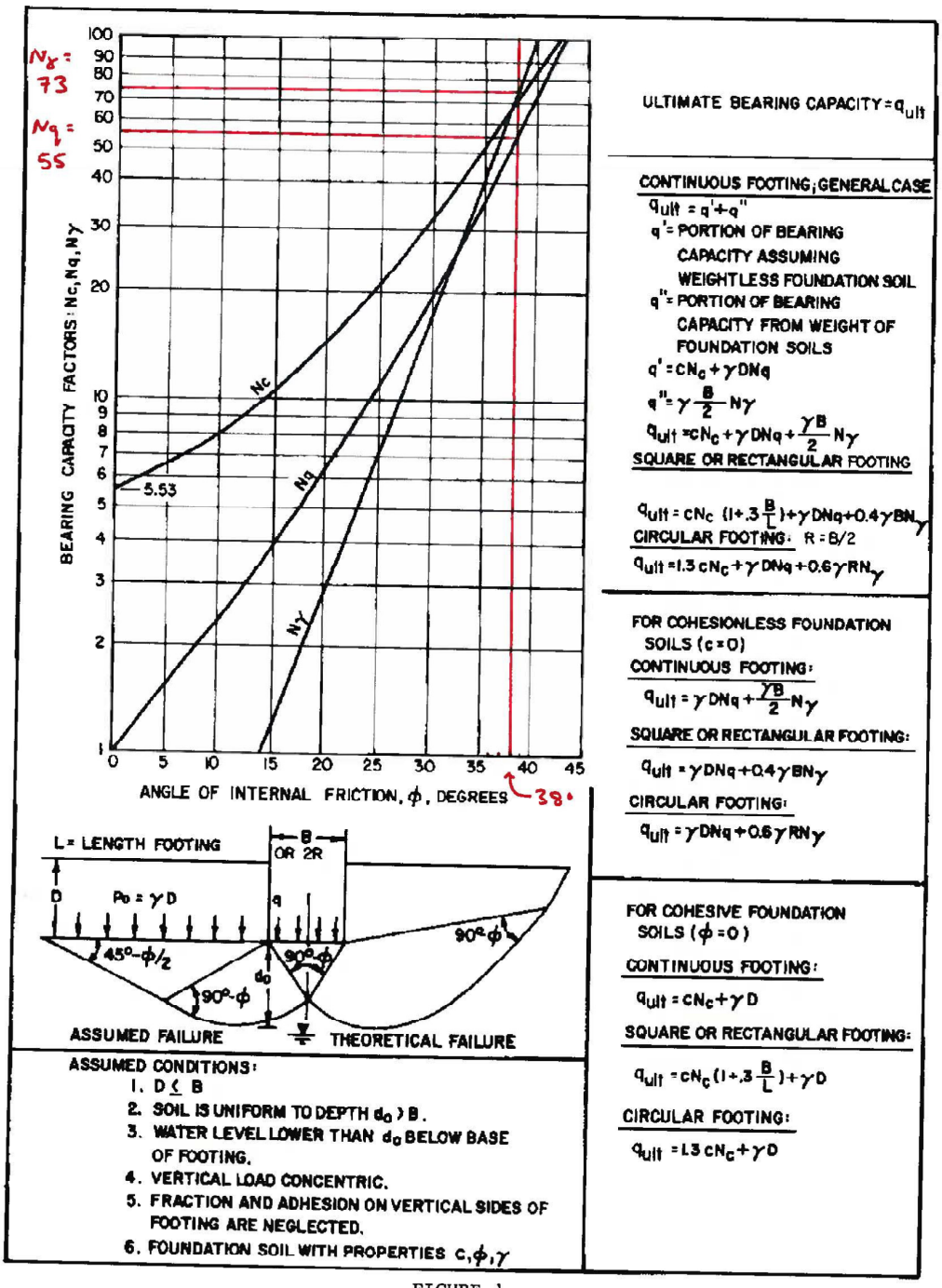

FIGURE 1
Ultimate Bearing Capacity of Shallow Footings With Concentric Loads

7.2-131

DETERMINATION OF BEARING CAPACITY FACTORS

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FIGURE 4

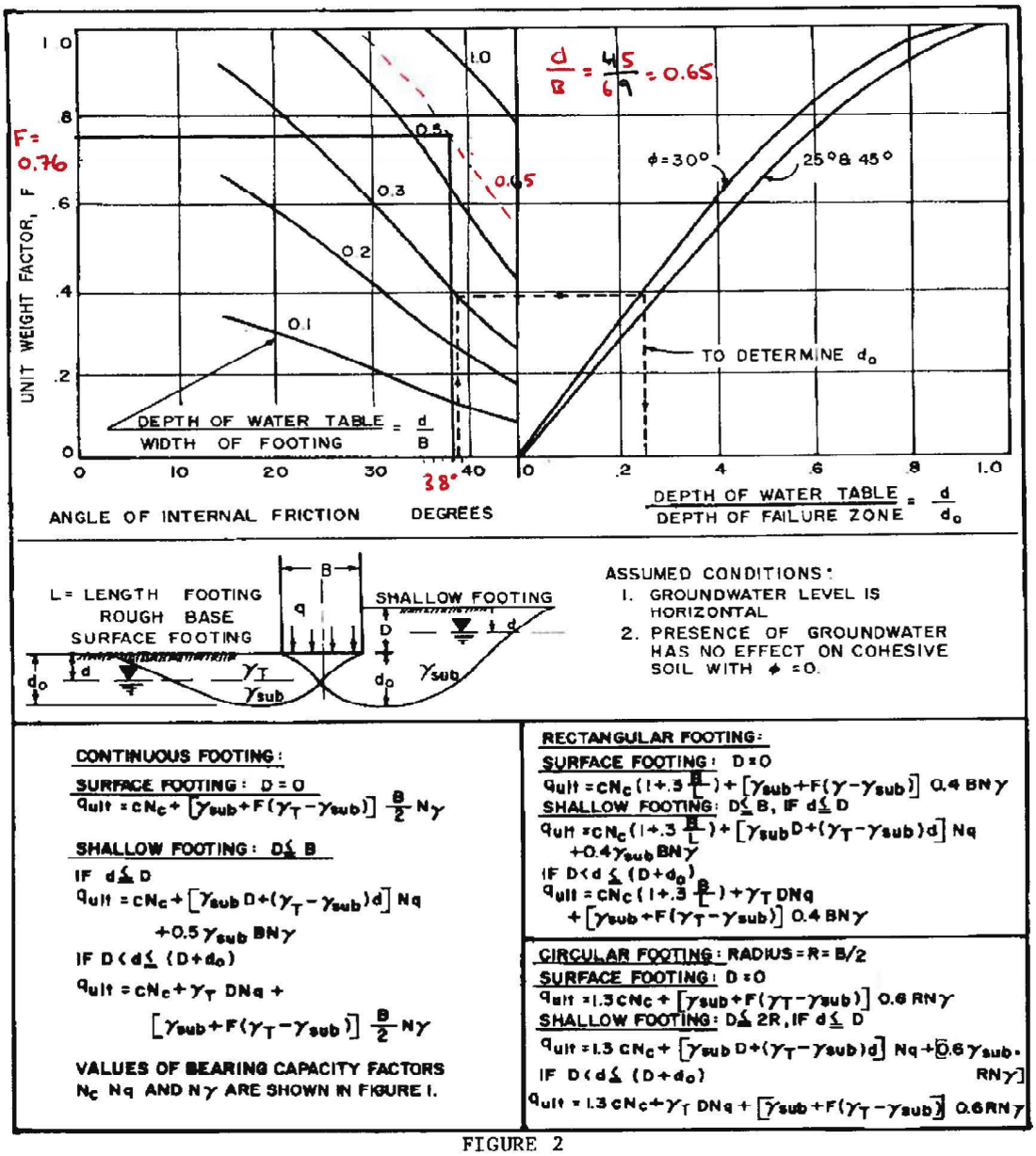

FIGURE 2
Ultimate Bearing Capacity With Groundwater Effect

DETERMINATION OF UNIT WEIGHT FACTOR

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FIGURE 5

Appendix A

Calculations

ARUP Appendix A

Job No. 131558 Sheet No. 1 of 1 Rev.

Member-Location

Job Title Dogle Drive Replacement Project

Drg. Ref.

Ultimate Bearing Capacity Calculation

Made By AS Date 5-21-09 Chd. BK 5/29/09 AS 8/21/09

Cohesionless foundation, square or rectangle footing with a water table below the bottom of footing or $D < d \leq (D + d_o)$:

$$q_{ult} = cN_c\left[1 + 0.3\frac{B}{L}\right] + \gamma_{total} D N_q + \left[\gamma_{eff} + F(\gamma_{total} - \gamma_{eff})\right] 0.4 B N_\gamma$$

$$q_{ult} = 0 + \cancel{120}\ 130\,(35)(55) + \left[\cancel{57.6}\ 67.6 + 0.76\,(\cancel{120 - 57.6}\ 130 - 67.6)\right] 0.4\,(69)\,(73)$$

$$q_{ult} = \cancel{231{,}000}\ 250{,}250 + \cancel{211{,}602}\ 231{,}750$$

$$q_{ult} \approx \cancel{442{,}600}\ 482{,}000 \text{ psf}$$

Variables

$D = 35$ ft (depth of footing)

$d = 45$ ft (depth of watertable)

d_o = depth of failure

$c = 0$ psf (cohesion)

$\gamma_{total} = \cancel{120}\ 130$ psf (total unit weight of soil)

$\gamma_{eff} = \cancel{56.}\ \cancel{57.6}\ 67.6$ psf (effective unit weight of soil)

$B = 69$ ft (foundation width)

L = foundation length

$F = 0.76$ (unit weight factor)

$N_q = 55$

$N_\gamma = 73$

N_c - not needed

} Bearing Capacity Factors

Factor of Safety (FS) = Ultimate Bearing Capacity (q_{ult}) / Foundation Pressure

$$FS = \frac{482 \text{ ksf}}{6 \text{ ksf}}$$

$FS > 3$ AS

APPENDIX F.5

Performance of Temporary Shoring Walls for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Performance of Temporary Shoring Walls for the Southbound Battery Tunnel

July 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Performance of Temporary Shoring Walls for the Southbound Battery Tunnel

July 2009

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This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job number 131558

			Page
1	Introduction		1
2	Scope of Work		1
3	Assumptions		1
4	Calculations		1
	4.1	Wall Deflections	1
	4.2	Settlements Behind the Wall	1
5	Results		2
List of References			4

Appendices

Table 1 – Soil and Interface Properties
Table 2 – Plate Properties
Table 3 – Anchor Properties
Table 4 – Maximum Wall Deflections per Calcuation Stage

Appendices

Appendix A – Calculations

1 Introduction

This package presents the results of our calculations to determine the performance of the temporary shoring walls for the Southbound Battery Tunnel. The southbound Battery Tunnel is a cut and cover tunnel that will be constructed as part of the Doyle Drive Replacement Project in San Francisco, California. These calculations should be used for design of the temporary shoring walls that will be required to support the excavation for construction of the Southbound Battery Tunnel.

The excavation for the Southbound Battery Tunnel is located adjacent to the San Francisco National Cemetery. It is important the performance of the shoring walls is such that the cemetery is not affected. The performance of the shoring walls will be evaluated by lateral deflection and vertical settlement behind the wall.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Estimate the lateral deflection of the temporary shoring walls due to the excavation. This work was performed by the structural designer.
- Estimate the vertical settlement behind the temporary shoring walls due to the excavation. This work was performed by the structural designer.

3 Assumptions

The following assumptions were made in these calculations:

- The walls will be internally braced to support the excavation and limit deflections.
- The ground surface is level behind the excavation.

4 Calculations

4.1 Wall Deflections

The horizontal deflections of the temporary retaining walls were estimated by the structural engineer using the computer program PLAXIS. The maximum horizontal displacement was calculated for each stage of construction from beginning of excavation until the tunnel is constructed.

Tables 1, 2 and 3 present the material parameters that were used for Soils and Interfaces, Plates, and Anchors, respectively.

4.2 Settlements Behind the Wall

The vertical settlements behind the temporary retaining walls were estimated by the structural engineer using the computer program PLAXIS. The vertical settlements was calculated for each stage of construction from beginning of excavation until the tunnel is constructed.

The settlements behind the wall were also checked using empirical charts provided by Clough and O'Rourke.

Clough and O'Rourke indicate that stiff walls typically deflect laterally at 0.2% of the height of the wall and settle approximately 0.15% of the height of the wall as shown below.

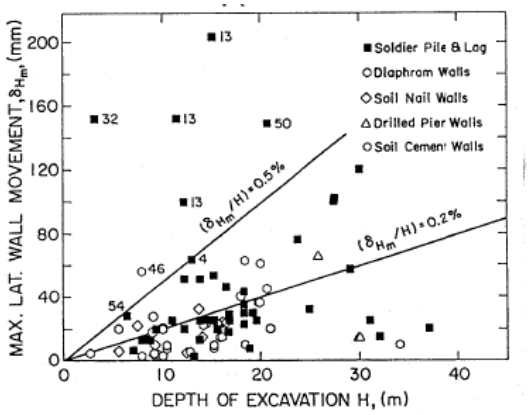


Figure 2. Observed Maximum Lateral Movements for Insitu Walls in Stiff Clays, Residual Soils and Sands.

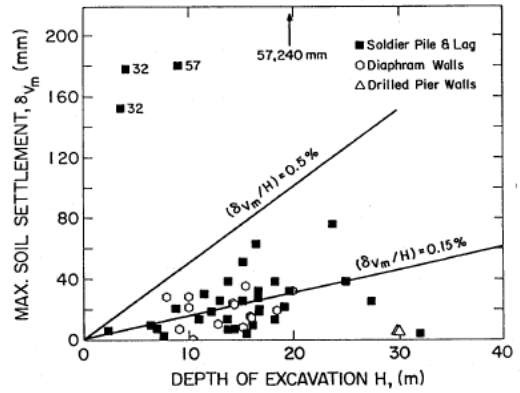
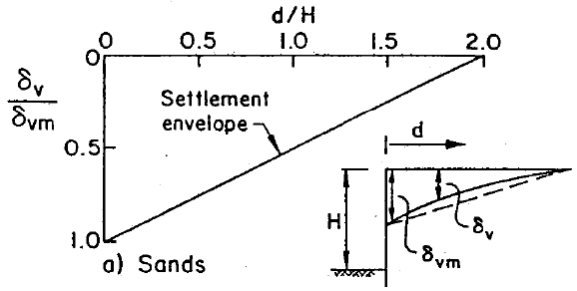


Figure 3. Observed Maximum Soil Settlements in the Soil Retained by Insitu Walls.

By relating these two equations, the settlement behind the wall can be determined in terms of the expected lateral deflection of the wall. In this way, the stiffness of the wall is taken into account in the determination of the settlement. Therefore:

$$\delta_{vertical} = \delta_{vertical}/1.3$$

The study by Clough and O'Rourke shows that the for sandy soils, the vertical settlement behind the wall is maximum directly behind the wall and is reduced to zero at a distance behind the wall of approximately twice the height of the wall. The figure below shows that the settlement reduces linearly.



5 Results

This section presents the results of calculations performed to assess the performance of the temporary shoring to support the excavation for the Southbound Battery Tunnel.

The PLAXIS model predicts a maximum deflection is 0.45 inch, or less than ½ inch. This deflection occurs immediately after removal of the 2nd Strut. The model predicts that at this

stage of construction, the ground will settle vertically about 0.33 inch behind the wall. Calculation results are presented in Appendix A.

Table 4 presents the maximum horizontal deflection predicted for each stage of construction.

The Clough and O'Rourke correlations predict that for a wall deflection of 0.45 inch, the vertical soil settlements behind the wall are expected to be less than 3/8 of an inch.

The PLAXIS model predicts a vertical settlement of 0.18 inches at a distance of 65 feet behind the wall. These settlements are a result of the construction surcharge loads that were being applied to the model, implying that settlements caused by the deflection of the wall have reduced to near zero at this distance.

According to the Clough and O'Rourke correlations, the vertical settlement should be reduced to zero at a distance of 80 feet behind the wall for a wall height of 40 feet. The PLAXIS model predicts better performance than the empirical correlations. Considering both analysis procedures, ground within the cemetery is not expected to settle more than ¼ inch.

List of References

[1] Fang, His-Yang. (1991) Foundation Engineering Handbook. 2nd Ed. Van Nostrand Reinhold, New York.

[2] Clough and O'Rourke (1990) "Construction Induced Movements of In-Situ Walls", Design and Performance of Earth Retaining Structures, ASCE Geotechnical Special Publications, 25: pp. 439-470

Tables

TABLE 1
SOIL AND INTERFACE PROPERTIES

Soil Type	Material Model	Material Type	γ_{sat} (pcf)	γ_{unsat} (pcf)	k_x (ft/day)	k_y (ft/day)	E_{ref} (psf)	v	c_{ref} (psf)	ϕ	ψ	R_{inter}
Colma Sand	Mohr-Coulomb	Drained	130	130	3	3	1.0E+07	0.25	250	40	0	0.3
Compacted Fill	Mohr-Coulomb	Drained	125	125	3	3	2.8E+06	0.25	200	40	0	0.67
Crushed Aggregate	Mohr-Coulomb	Drained	135	135	300	300	5.0E+06	0.25	10	40	0	0.67
Embankment Fill	Mohr-Coulomb	Drained	120	120	3	3	1.4E+06	0.25	200	35	0	0.67
Fill/Buried Horizon	Mohr-Coulomb	Drained	128	128	0.3	0.3	3.0E+05	0.275	750	0	0	0.67
Regular Strength Concrete	Mohr-Coulomb	Drained	150	150	0.001	0.001	5.0E+08	0.2	320000	0	0	0.3
Sandy Clay and Sandy Silt	Mohr-Coulomb	Drained	128	128	0.3	0.3	8.0E+05	0.275	100	35	0	0.67

TABLE 2
PLATE PROPERTIES

Plate	EA (plf)	EI (lbs-ft^2/ft)	w (plf/ft)	v	M_P (pft/ft)	N_P (plf)
Wall Section	7.11E+07	2.69E+07	0.05	0.3	70	122

TABLE 3
ANCHOR PROPERTIES

Anchor	EA (lbs)	$L_{spacing}$ (ft)
Roof	1.66E+09	1
Slab	2.65E+09	1
Strut	1.74E+08	12

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TABLE 4 MAXIMUM WALL DEFLECTIONS PER CALCULATION STAGE	
Stage	**Maximum Horizontal Deflection in Wall (inch)**
Excavate Below First Strut	0.02
Install First Strut	-0.08
Excavate Below Second Strut	0.12
Install Second Strut	0.08
Excavate Below Third Strut	0.16
Install Third Strut	0.16
Excavate to Bottom	0.34
Backfill with Aggregate	0.34
Construct Invert Slab	0.34
Remove Third Strut	0.36
Construct Tunnel Wall	0.36
Remove Second Strut	0.45
Construct Tunnel Roof	0.41
Remove First Strut	0.41
Backfill on Top of Tunnel	0.44

Appendix A

Calculations

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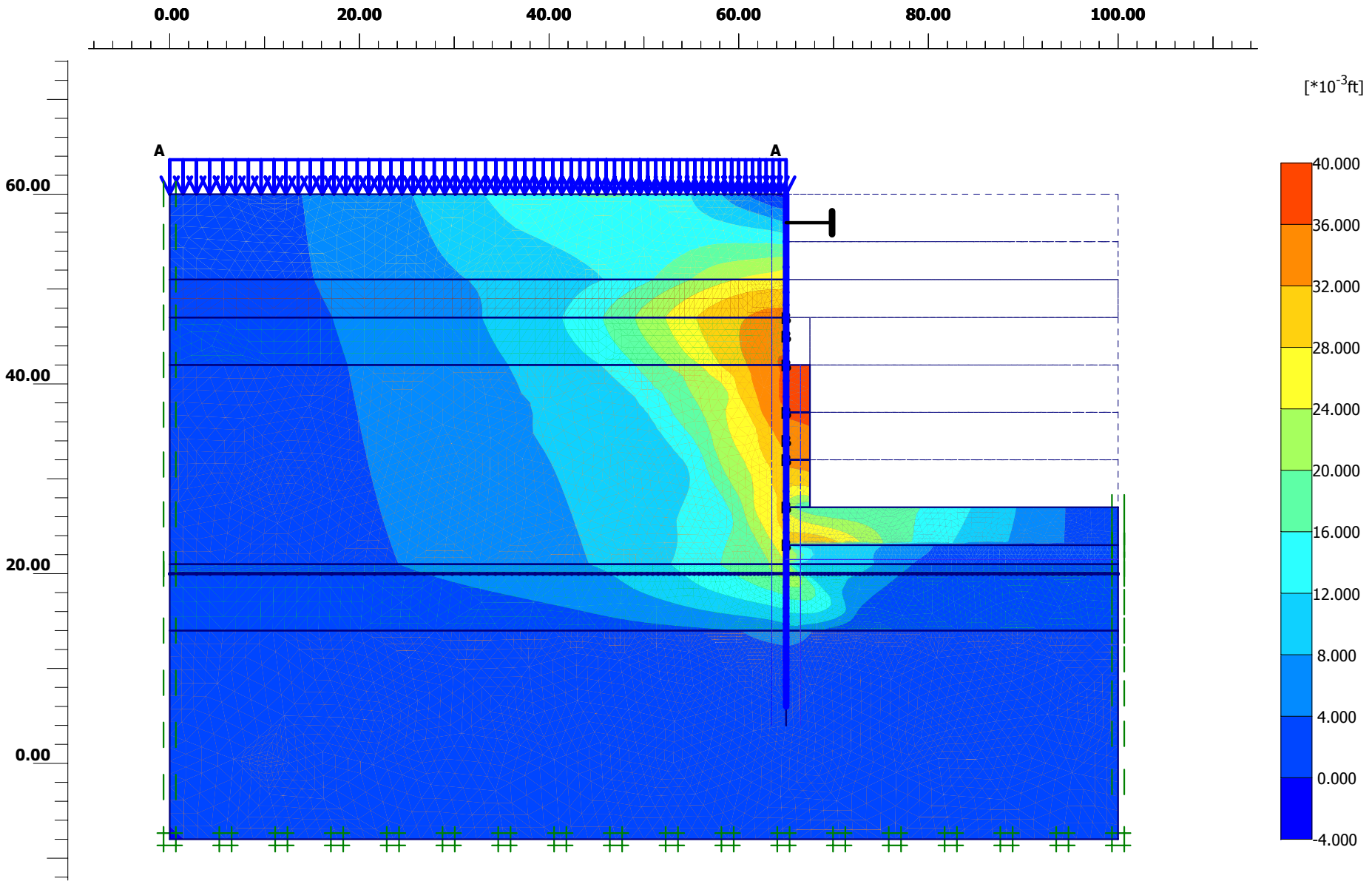


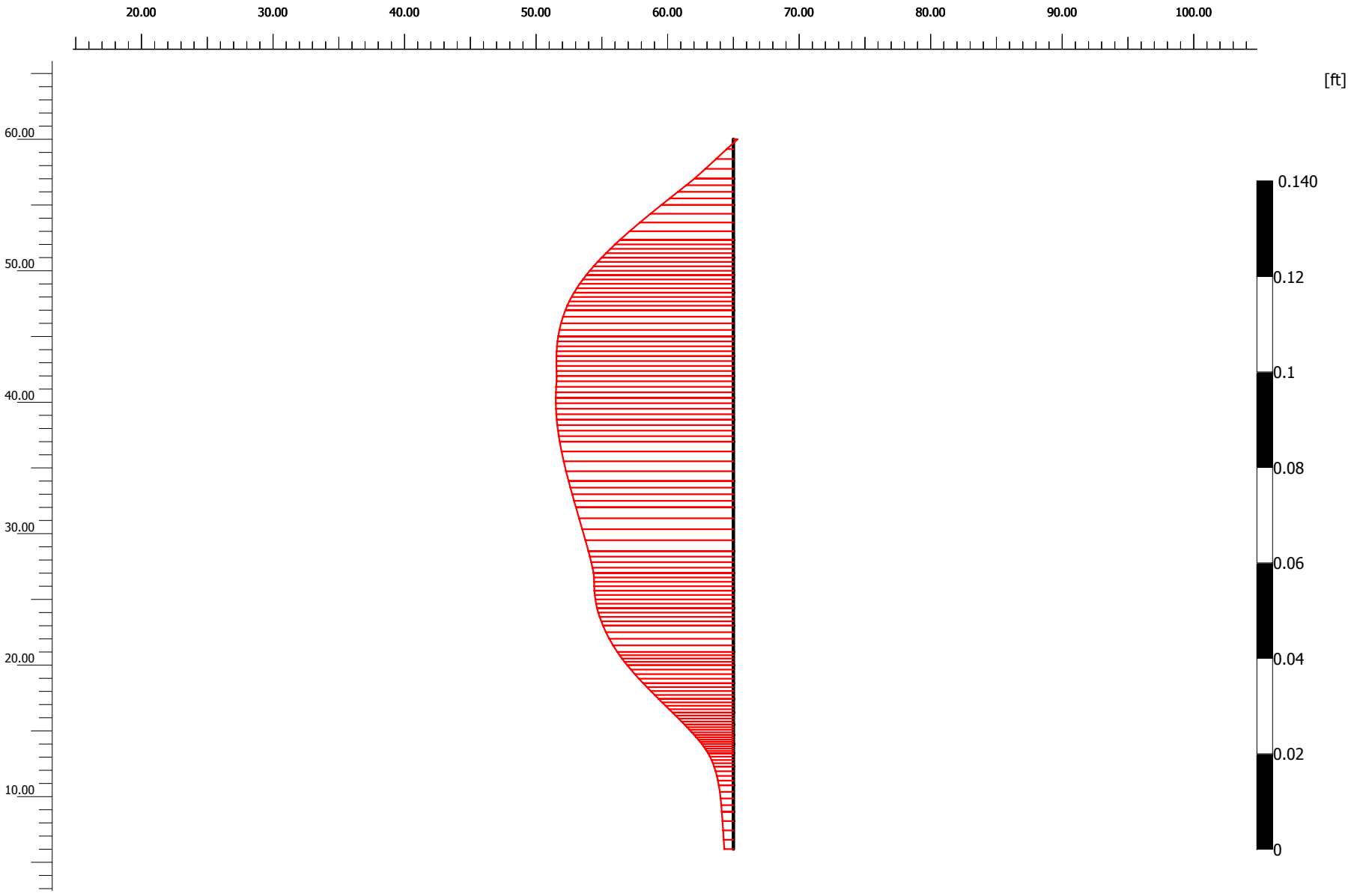
Horizontal displacements (Ux)

Extreme Ux $37.14*10^{-3}$ ft

PLAXIS

Finite Element Code for Soil and Rock Analyses

Project description			
Retaining WallA			
Project name	*Step*	*Date*	*User name*
3strut071309	96	07/19/09	Arup USA



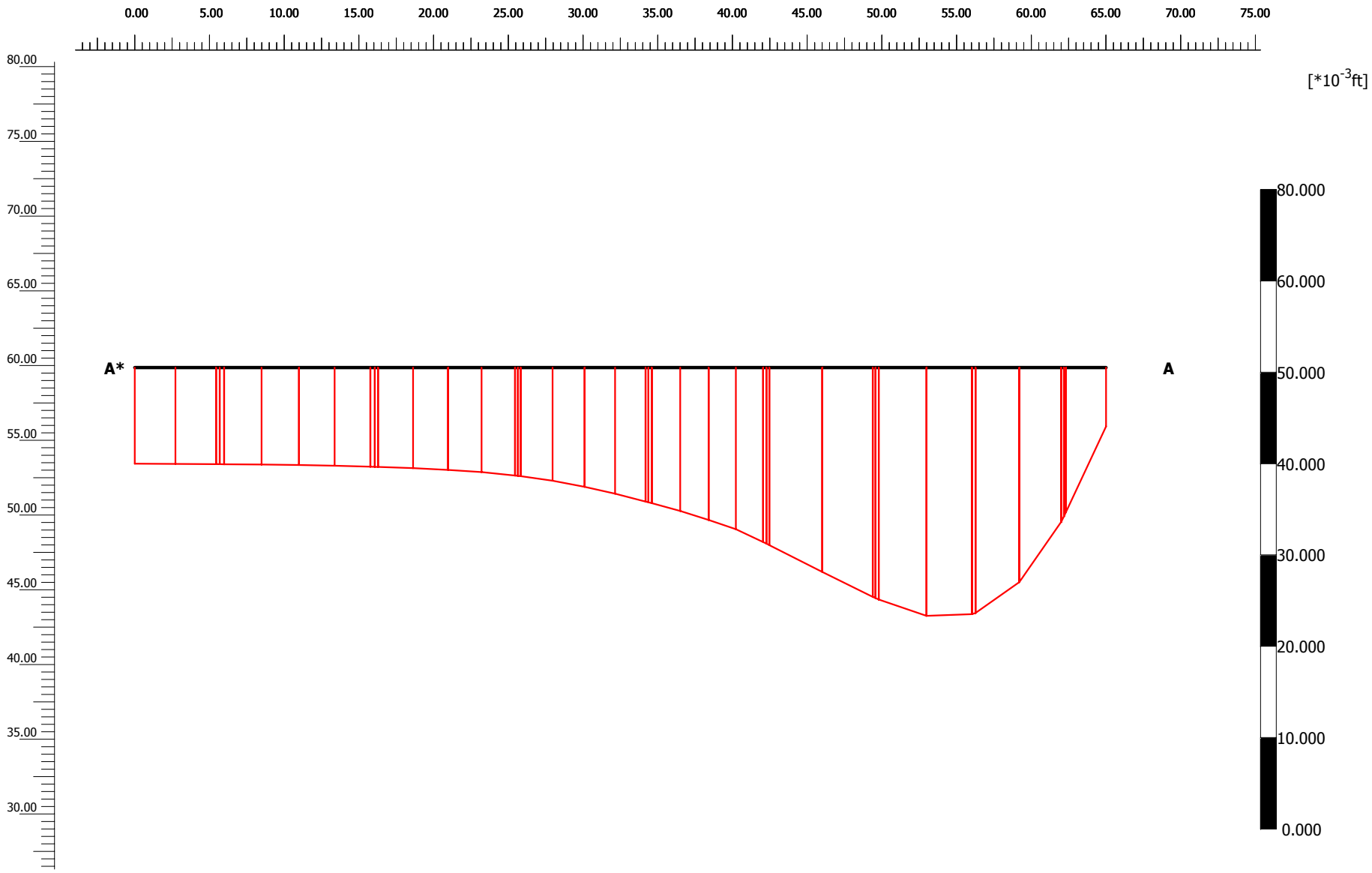
Horizontal displacements (Ux)

Extreme Ux $37.17*10^{-3}$ ft

PLAXIS

Finite Element Code for Soil and Rock Analyses

Project description			
Retaining WallA			
Project name	*Step*	*Date*	*User name*
3strut071309	96	07/19/09	Arup USA



Vertical displacements Uy

Extreme Uy -27.16*10^{-3} ft

PLAXIS

Finite Element Code for Soil and Rock Analyses

Project description

Retaining WallA

Project name	*Step*	*Date*	*User name*
3strut071309	96	07/19/09	Arup USA

APPENDIX F.6

Lateral Pile Analyses at the West End of the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Lateral Pile Analyses at the West End of the Southbound Battery Tunnel

August 2009

Prepared By:

Caltrans and Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Lateral Pile Analyses at the West End of the Southbound Battery Tunnel

August 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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Figure 3 Long-term Seismic Earth Pressure Diagram For The Southbound Battery Tunnel at Station 85+00
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Figure 5 Diagram of Lateral Earth Pressures on the Southbound Battery Tunnel
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Figure 7 Bending Moments Due to Lateral Earth Pressures at the Base of the Northern Wall of the Southbound Battery Tunnel at Station 85+00
Figure 8 Shear Forces Due to Lateral Earth Pressures at the Base of the Northern Wall of the Southbound Battery Tunnel at Station 85+00
Figure 9 Pile Deflection Versus Depth Due to the Excavation of the Southbound Battery Tunnel at Station 85+00
Figure 10 Bending Moment Versus Depth Due to the Excavation of the Southbound Battery Tunnel at Station 85+00
Figure 11 Shear Force Versus Depth Due to the Excavation of the Southbound Battery Tunnel at Station 85+00

1 Introduction

This package presents the results of our lateral pile analyses at the west end of the Southbound Battery Tunnel portion of the Doyle Drive Replacement Project. The Battery Tunnels are cut-and-cover tunnels that will be constructed as part of the Doyle Drive Replacement Project in San Francisco, California.

In their final configurations, the Southbound and Northbound Tunnels will be embedded into the Bluff soils on both the south and north sides of the tunnels, providing equal and opposite lateral soil pressures on the sides of the Tunnels. However, the Southbound Tunnel is longer than the Northbound Tunnel and beyond approximately Southbound Station 83+90, the Northbound alignment will be constructed at-grade and as such, cannot resist the lateral pressures on the Southbound Tunnel. In order to resist these loads, the soldier piles for Retaining Wall B will be extended deeper into the bedrock and become part of the permanent design.

Beyond approximately Station 84+00, the ground surface behind Retaining Wall B slopes down reducing the passive resistance capacity to the wall. Without full passive resistance behind the wall for support, the strut loads from the internally braced excavation will cause large displacements in both Retaining Walls A and B.

In order to provide lateral support to limit wall deflections, external rakers will be installed at the location of each strut. The rakers will connect from the backside of Retaining Wall B to drilled piers embedded into the bedrock.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Determine the lateral earth pressures acting on the southern and northern walls of the SB Battery Tunnel at Station 85+00.
- Determine the length of pile required at the base of the northern wall of the SB Battery Tunnel to prevent movement of the tunnel due to lateral earth pressures after construction.
- Determine the length and size of pile required at the base of the raker supports to prevent movement on the retaining walls during the excavation of the SB Battery Tunnel.

3 Inputs

The following input data was required for the analyses.

3.1 Stratigraphy

The stratigraphy used for this analysis was determined from the field investigation. Figure 1 shows the location of boreholes that were drilled in relation to the Battery Tunnel structures. Figures 2 shows idealized cross section at Station 85+00. The major soil types are as follows:

- The surficial unit is Sandy Fill which is approximately 4 ft thick. The Sandy Fill is primarily comprised of loose to medium dense sand with some silt and clay.
- Sandy Clay underlay the Sandy Fill. At this location, the unit it about 5 ft thick and is typically medium stiff.
- Below the Sandy Clay lies the Colma Sand. At this location, this unit is about 9 ft thick. It is generally dense to very dense.

- Franciscan Formation bedrock is found about 18 ft below the site at this location. The bedrock typically consists of sandstone. Mélange matrix and serpentinite have also been encountered in adjacent boreholes.

For this analysis, the most critical layer is the Franciscan Formation as this layer will provide the required resistance. The Colma Sand is also important as there will be a thin layer of it above the bedrock during the excavation phase of the project.

3.2 Material Properties

For the Colma Sand, a total unit weight (γ_t) of 130 pcf (0.075231 pci) and a friction angle of 38 degrees will be used for this analysis. These are typical values based on laboratory data.

The material properties of the sandstone bedrock required for this analysis include total unit weight (γ_t) and uniaxial compressive strength (UCS). The values of these properties are based on laboratory and field testing conducted for the project. A unit weight of 165 pcf is used and is based on averages from all rock in the Battery Tunnel area while the unconfined compressive strength used is 1,940 psi and is based on data from boreholes RW5-R1 and RW6-R1-PZ, which are both near Station 85+00.

3.3 Water Table

The water table varies by location from 18 to 33 ft below the ground surface. However, a drainage plan will be implemented and the water table is assumed to be at the base of the Battery Tunnels.

4 Assumptions

The following assumptions were made in these calculations:

- Ultimate loads were assumed so appropriate load factors or factors of safety should be used.
- Any surcharge or seismic pressures on the northern wall of the SB Battery Tunnel were ignored to simplify the calculations since they are small enough that they would not significantly affect the results.

5 Calculations

This section summarizes the calculations performed for the pile analysis for the SB Battery tunnel at Station 85+00. The LPILE files containing these calculations as well as the EXCEL file that summarizes the data are located at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis as well as Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\ LPILE analysis at West End with braced struts.

5.1 Lateral Earth Pressures

The lateral earth pressures on the southern wall of the SB Battery Tunnel at Station 85+00 have already been calculated as part of a separate calculation package. Both the long-term seismic and at-rest cases were examined and are shown in Figures 3 and 4. When the pressures are summed over the vertical length of the tunnel wall, the active plus long-term seismic earth pressures result in a value of 28,832 lb/ft while the at rest earth pressure result in a value of 27,000 lb/ft. Since the active plus seismic earth pressure value is slightly

higher, it will be used for this analysis. The piles will be located 6 ft on center so the active earth pressure that will be transferred to the pile head is 172,992 lb, as shown in Figure 5.

The passive earth pressure on the northern wall of the SB Battery Tunnel is calculated for the 3.2 feet of rock extending from the base of the NB roadway to the bottom of the SB tunnel. The soil between the SB tunnel and NB retaining wall is ignored since the earth pressures exerted by it on the northern wall of the SB tunnel are minimal. Using a unit weigh of 165 pcf and a k_p of 10 based on a fiction angle of 55, the resulting earth pressure is 844 lb/ft or 50,688 lb for each 6 ft section.

Since these two forces act in opposite directions, the force on the northern wall is subtracted from the force on the southern wall, resulting in a net force of 122,304 lb acting on the pile head.

5.2 LPILE Analysis on the Tunnel Structure

To determine the length of the pile required to prevent movement of the SB Battery Tunnel at Station 85+00 due to the excavation of the NB road bed, the program LPILE was used. LPILE predicts the deflection, shear force, and bending moment in a pile over its entire length and the point at which these values become zero signifies the minimum pile embedment depth. For these analysis, a Type I analysis was done, which is a computation of the pile response using elastic pile stiffness.

A pile length of 15 ft was used since it is greater than the expected length and therefore it can be determined where the bending moment decreases to zero. The piles are 3 feet or 36 inches in diameter and 6 ft on center. A W21x101 steel member will be installed within the concrete pile. A moment of inertia of 2,420 in^4 and a modulus of elasticity of 29,000 ksi were used for design. These two values are for the steel pile only since it is the properties of the steel that will tend to dominate the reaction.

Static loading was used with no distributed loads. A boundary condition of shear force and bending moment at the pile head was used (LPILE boundary condition #1), with the shear force equal to the net earth pressure of 122,304 lb and the bending moment equal to zero since the earth pressure acts laterally.

The Strong Rock (Vuggy Limestone) soil model was used with an effective unit weight of 165 pcf (0.095486 pci) and a UCS of 1,940 psi. The weak rock model was not used because the recommended maximum UCS for that model is 1,000 psi. A parametric study was also performed by varying the UCS from 1,000 psi (the minimum for the strong rock model), to 1,200 psi (the minimum of all UCS tests on Battery tunnel rock), to 7,435 psi (the average), to 16,800 psi (the maximum).

5.3 LPILE Analysis on the Temporary Retaining Walls

For this analysis, two different cases were analyzed based on depth of Colma Sand above the bedrock. For each case, a steel beam surrounded by 30” diameter concrete pile and a W14x99 beam was used with the following transformed properties: modulus of elasticity (E_c) = 3,500 ksi, moment of inertia (I_x) = 48,962.7 in^4 , and area (A) = 948.1 in^2. The depth of the Colma Sand was varied between 2 ft and 5 ft to represent varying conditions at the site.

The force on the pile from the raker is 100 kips, which translates to 70.7 kips in both the horizontal and vertical direction. In LPILE, boundary condition #1 was used, with both the shear force and axial load as 70.7 kips and the bending moment as zero. The Strong Rock (Vuggy Limestone) soil model is used because the weak rock model has a maximum recommended UCS of 1,000 psi. For the sand layer, the Sand (Reese) model was used.

Each analysis was initially run with a pile length of 20 ft to determine where the shear forces and bending moments become zero. Then each pile was shortened to reflect that depth to more accurately depict the movements and forces within the pile.

6 Results

6.1 Results of the Analysis on the Tunnel Structure

The results of the analysis of the piles at the base of the tunnel wall after construction are shown in Figures 6 to 8. In Figure 6, the deflection at the pile head varies from approximately 0.001 to 0.011 inches depending on the UCS used. For the higher UCS values, the deflection decreases to zero at approximately 5 ft, for a UCS of 1,940 psi, the deflection decreases to zero at approximately 7 ft, and for the lower UCS values, the deflection decreases to zero at approximately 9 ft.

In Figure 7, the maximum bending moment varies from 450 to 900 kips-in. For the higher UCS values, the bending moment decreases to zero at approximately 7 ft, for a UCS of 1,940 psi, the bending moment decreases to zero at approximately 9.5 ft, and for the lower UCS values, the bending moment decreases to zero at approximately 12 ft.

The shear force in the pile is shown in Figure 8. For the higher UCS values, the shear force decreases to zero at approximately 7 ft, for a UCS of 1,940 psi, the shear force decreases to zero at approximately 9 ft, and for the lower UCS values, the shear force decreases to zero at approximately 11 ft.

GRAPHER files depicting the results are located in the folder Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis.

6.2 Results of the Analysis on the Temporary Retaining Walls

The results of the analysis of the piles at the base of the rakers during the excavation of the west end of the SB Battery Tunnel are shown in Figures 9 to 11. Figure 9 shows the lateral deflection of the pile. It varies at the pile head from 0.016 inches with two feet of soil over the bedrock and 0.08 inches with five feet of soil over the bedrock.

Figure 10 shows the bending moments within the pile. With two feet of soil over the bedrock, the maximum bending moment is approximately 2,000 kips-in and decreases to zero at a depth of approximately 8 ft. With five feet of soil over the bedrock, the maximum bending moment is approximately 4,000 kips-in and decreases to zero at a depth of approximately 12 ft.

Figure 11 shows the shear forces within the pile. With two feet of soil over the bedrock, the shear forces decrease to zero at approximately 8.5 ft. With five feet of soil over the bedrock, the shear forces decrease to zero at approximately 11.5 ft.

In order to verify the results generated in LPILE, a hand calculation of deflection (Appendix A) was done with a 40 ft, 30” diameter concrete pile with a W14x99 steel beam using the methods outlined in the Naval Facilities Engineering Command’s “Soil Mechanics” Design Manual 7.01. To simplify the calculation and to be conservative, the entire soil profile was assumed to be Colma Sand. The resulting deflection at the pile head was 0.48 inches.

The recommendation based on this analysis is to use the W14x99 beam and the pile should be a minimum of 10 ft long and at least 5 ft into the bedrock.

List of References

[1] Manual of Steel Construction, Allowable Stress Design, 9th Edition. American Institute of Steel Construction. January 1991.

[2] Naval Facilities Engineering Command (1986) "Soil Mechanics" Design Manual 7.01, Alexandria, VA.

[3] Reese, et al. Technical Manual, LPILE PLUS 5.0 for windows. Ensoft, Inc. July 2004.

[4] Reese, et al. User's Manual, LPILE PLUS 5.0 for windows. Ensoft, Inc. July 2004.

FIGURES

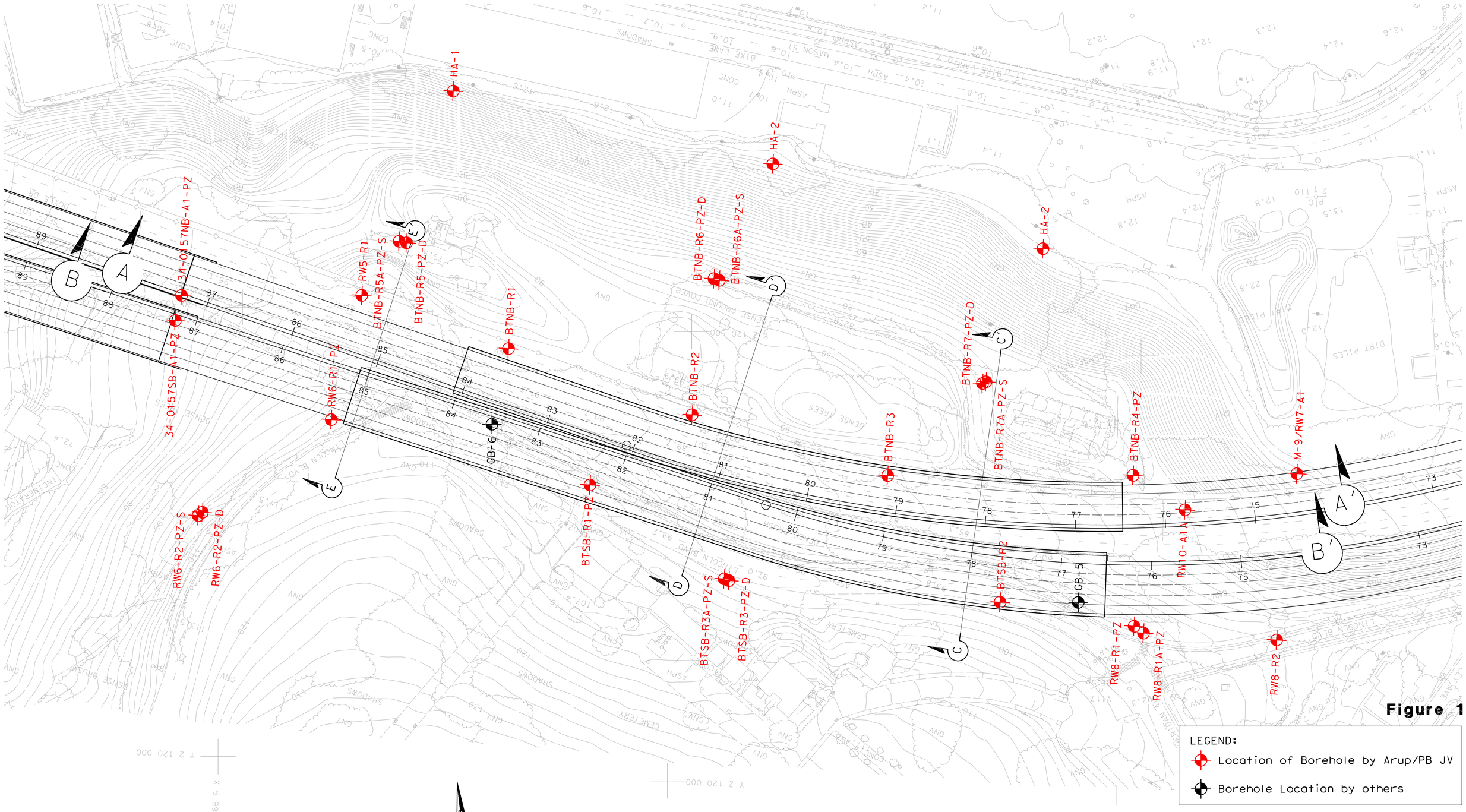

Figure 1

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

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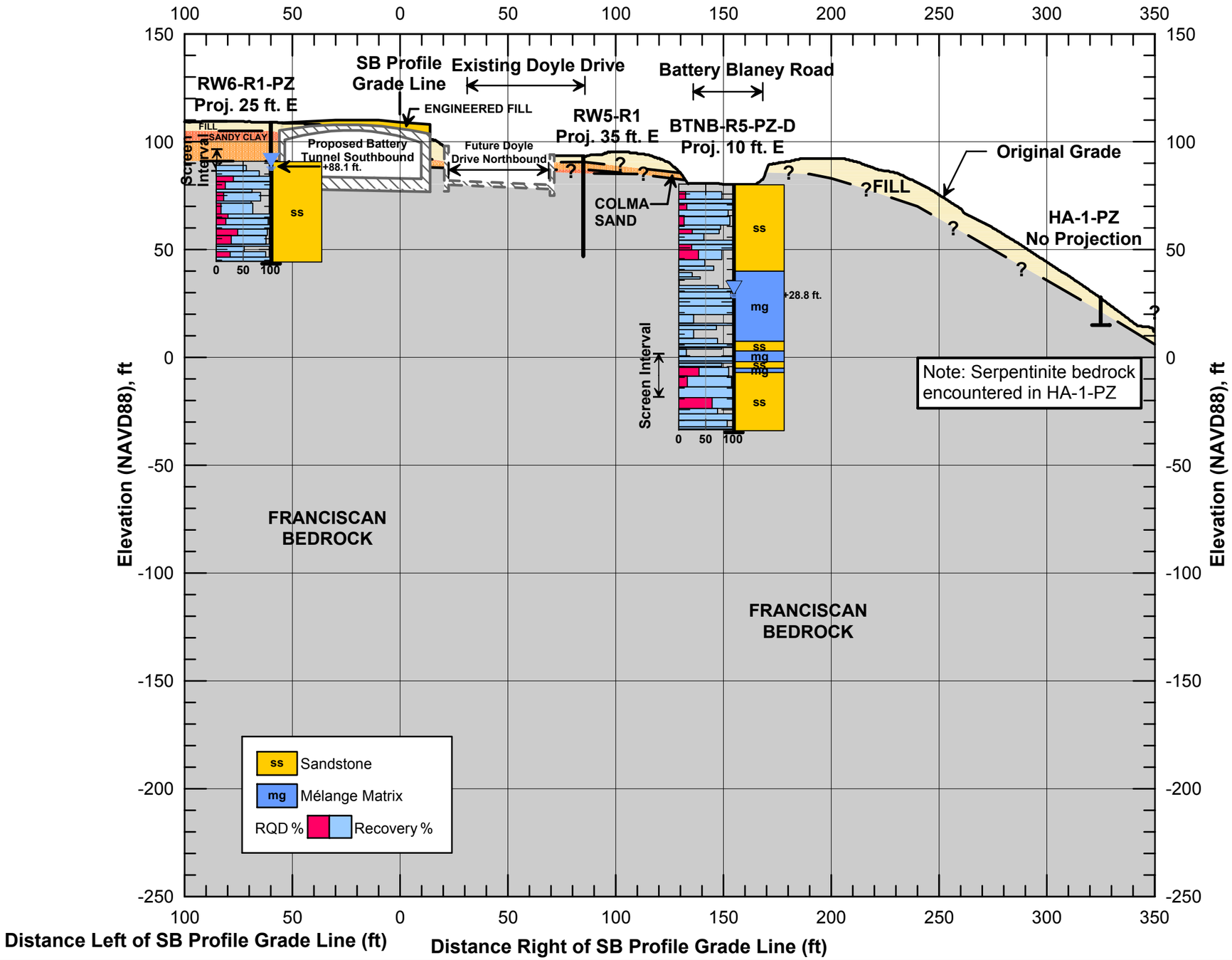
SOUTH

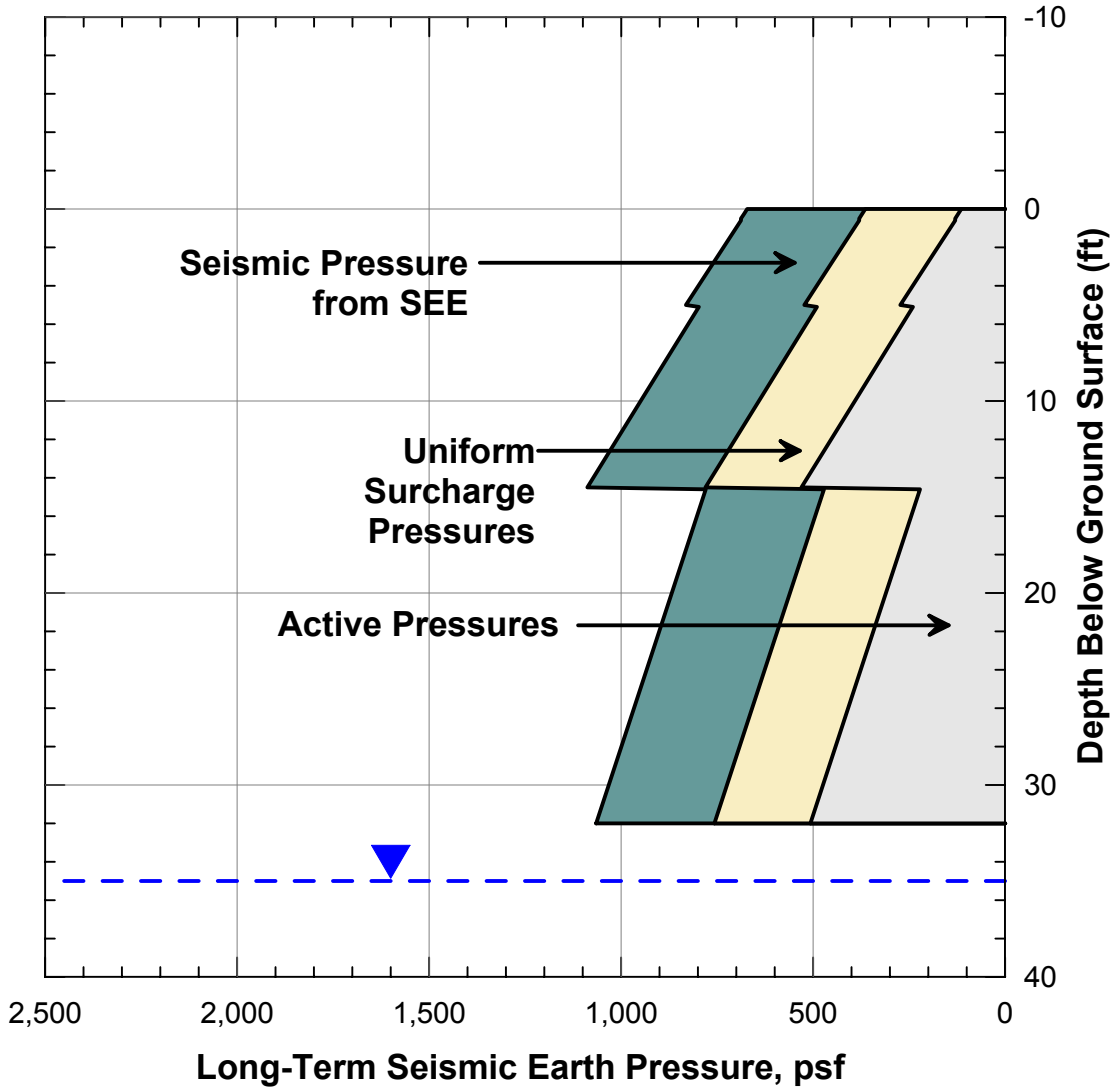
NORTH

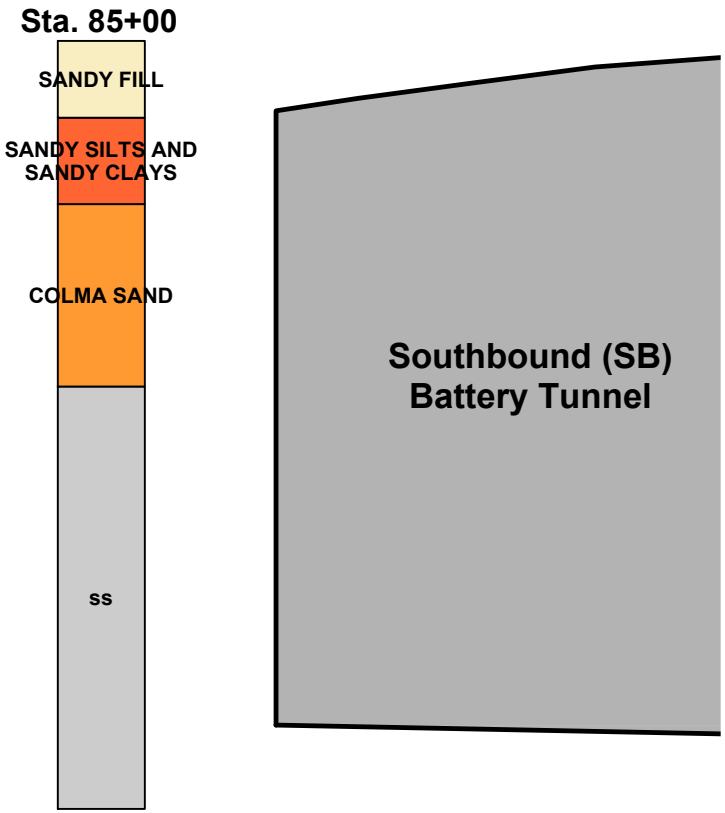


DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy, Section F-F'
Transverse Cross Section at Station 85+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

Figure 2

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Calculation Packages\Lateral Earth Pressures\LPILE Analysis of LEP at Station 85+00\Figure 2.grf





LONG-TERM SEISMIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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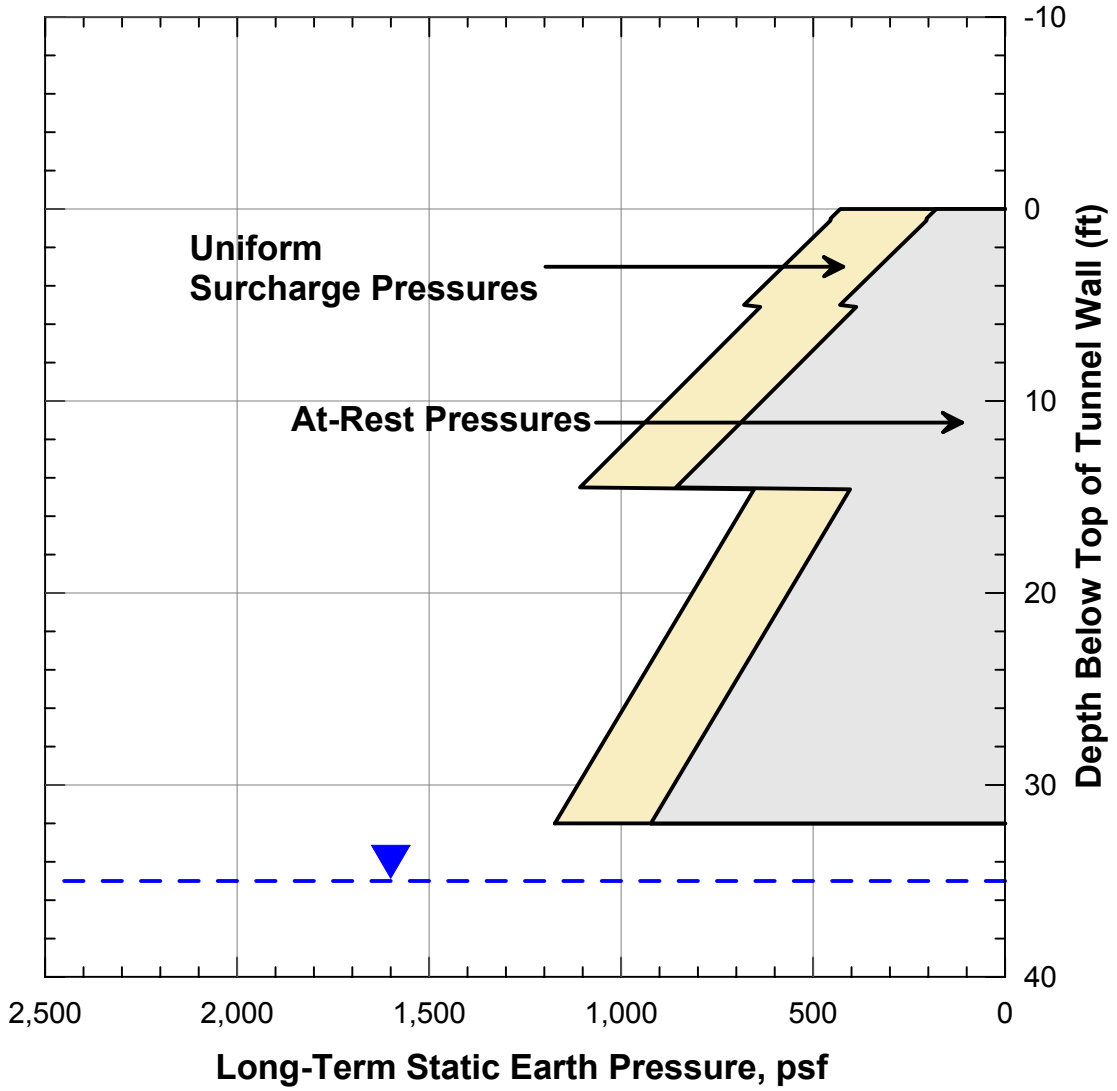
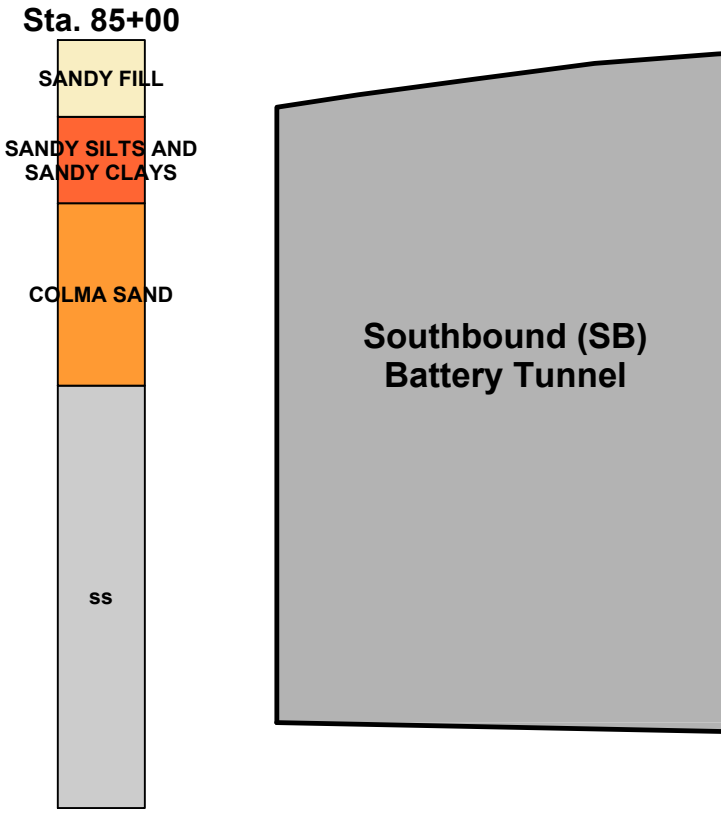
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
June 2009 San Francisco, California

ARUP PB joint venture

FIGURE 3

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\Active Earth Pressures BT 85SB-S.grf





LONG-TERM STATIC EARTH PRESSURE DIAGRAM FOR THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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June 2009 San Francisco, California

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FIGURE 4

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\At Rest Earth Pressures BT 85SB-S.grf

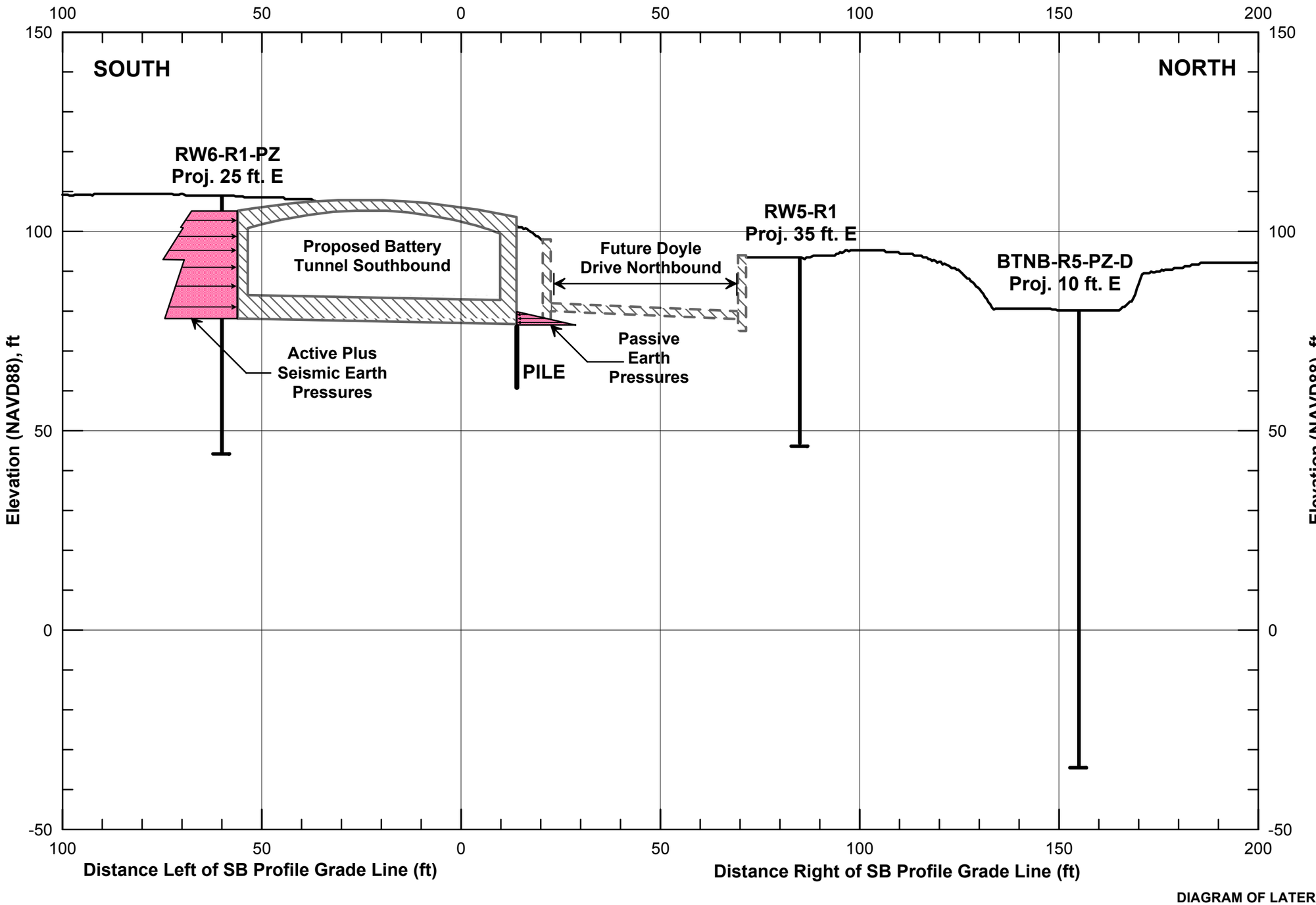

DIAGRAM OF LATERAL EARTH PRESSURES ON THE SOUTHBOUND BATTERY TUNNEL

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San Francisco County Transportation Authority
June 2009 San Francisco, California

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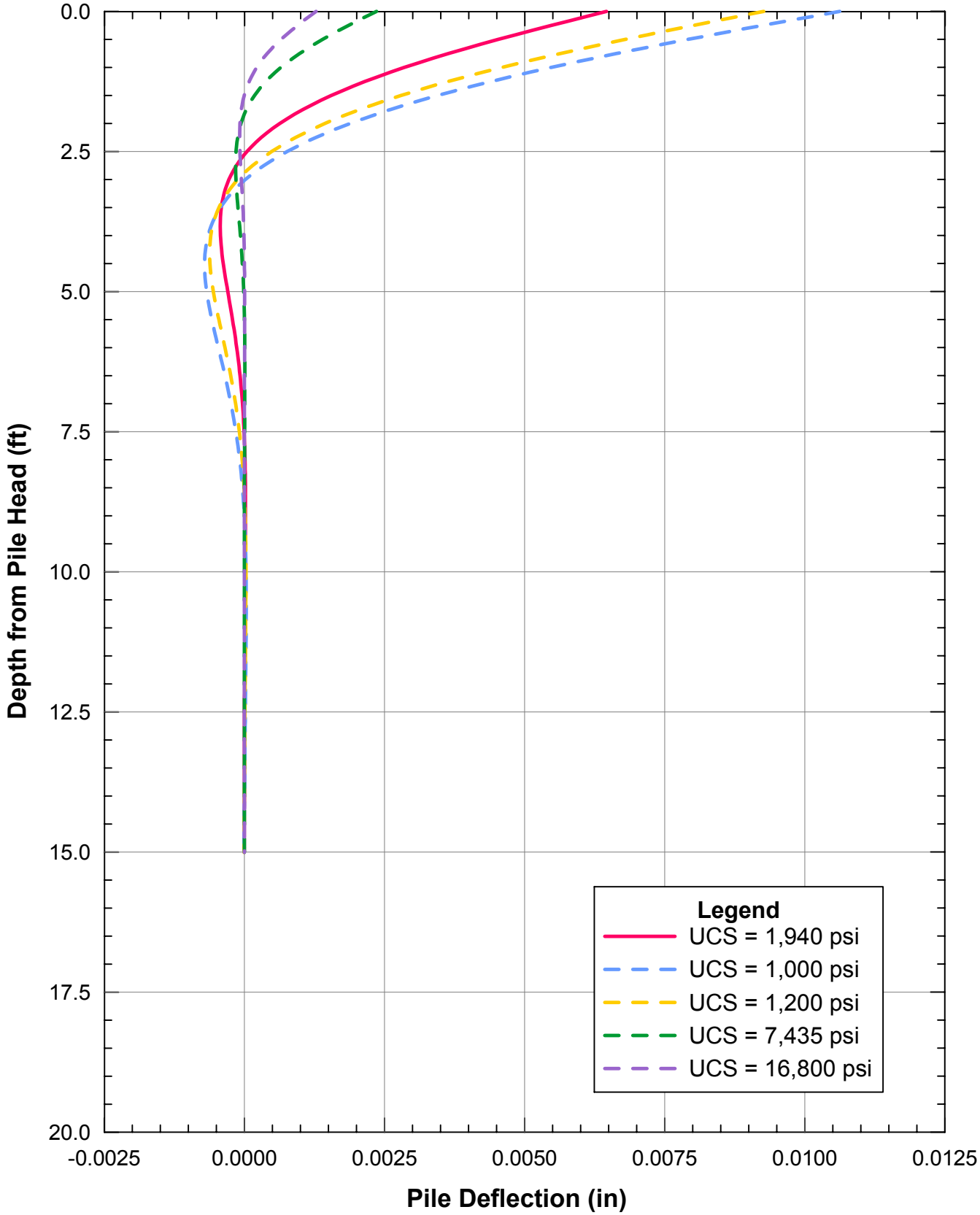
FIGURE 5

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis\85+00 BT.grf



PILE DEFLECTIONS DUE TO LATERAL EARTH PRESSURES AT THE BASE OF THE NORTHERN WALL OF THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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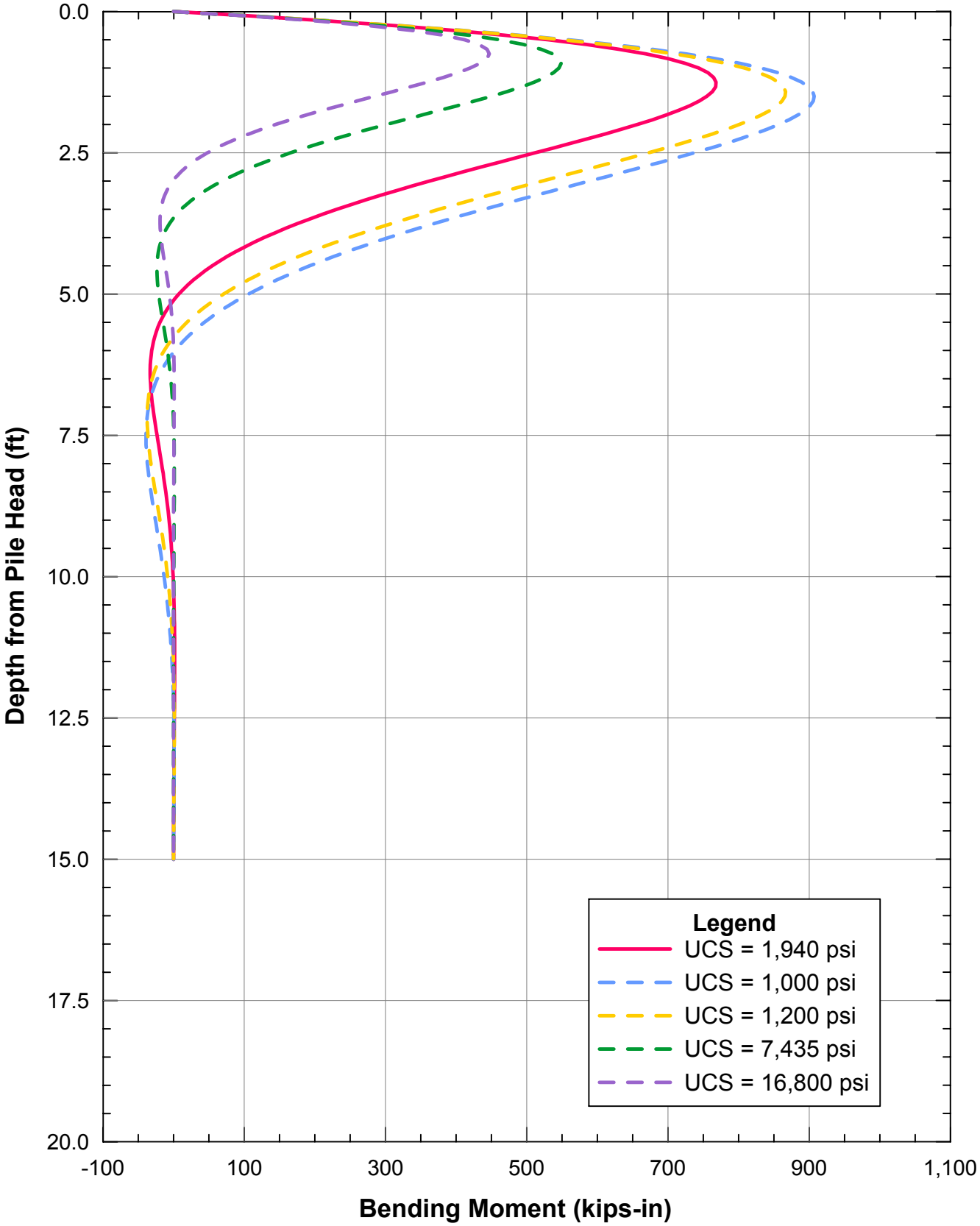
FIGURE 6

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis\Pile Deflections at Sta 85.grf



BENDING MOMENTS DUE TO LATERAL EARTH PRESSURES AT THE BASE OF THE NORTHERN WALL OF THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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San Francisco County Transportation Authority
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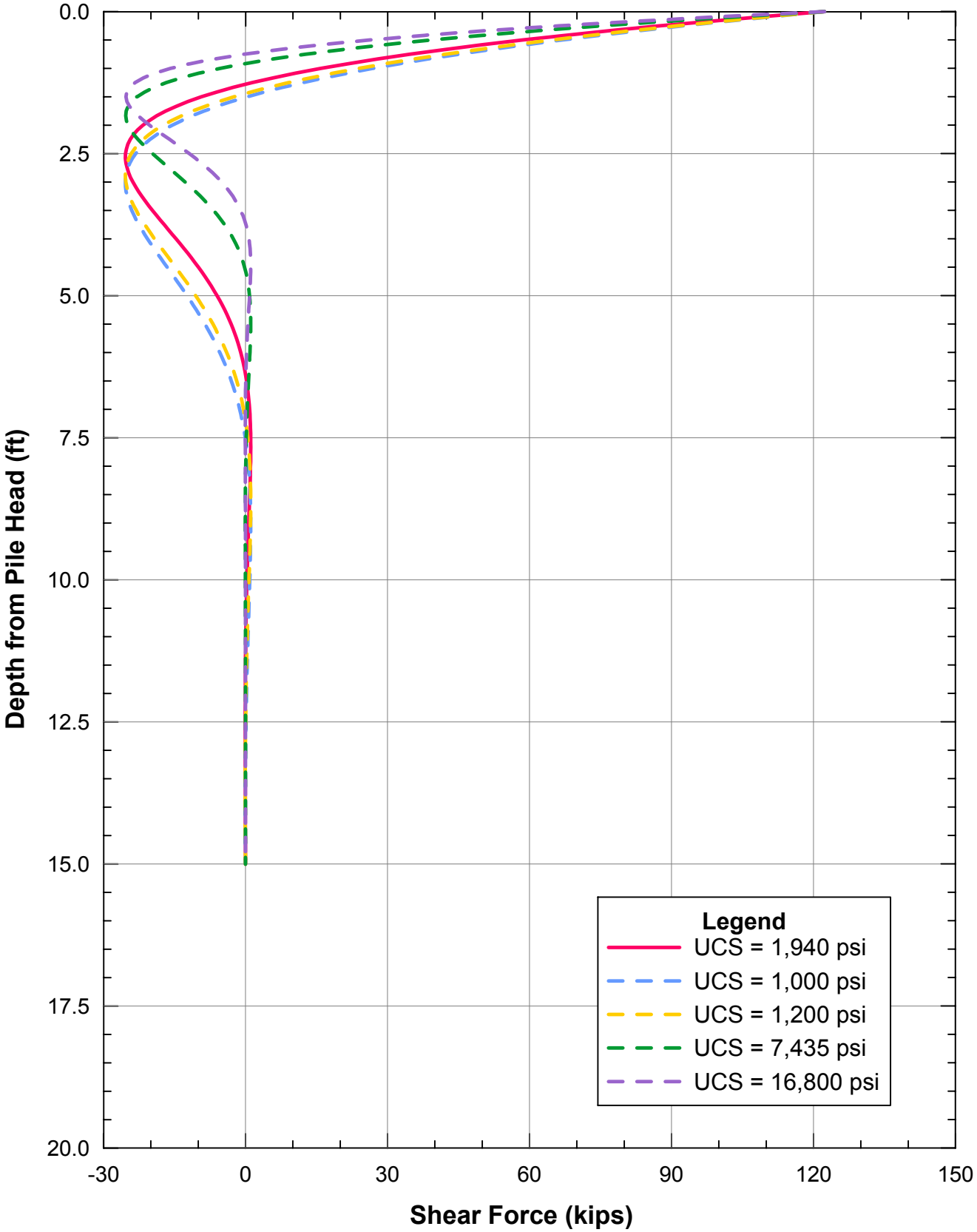
FIGURE 7

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis\Bending Moment at Sta 85.grf



SHEAR FORCES DUE TO LATERAL EARTH PRESSURES AT THE BASE OF THE NORTHERN WALL OF THE SOUTHBOUND BATTERY TUNNEL AT STATION 85+00

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San Francisco County Transportation Authority
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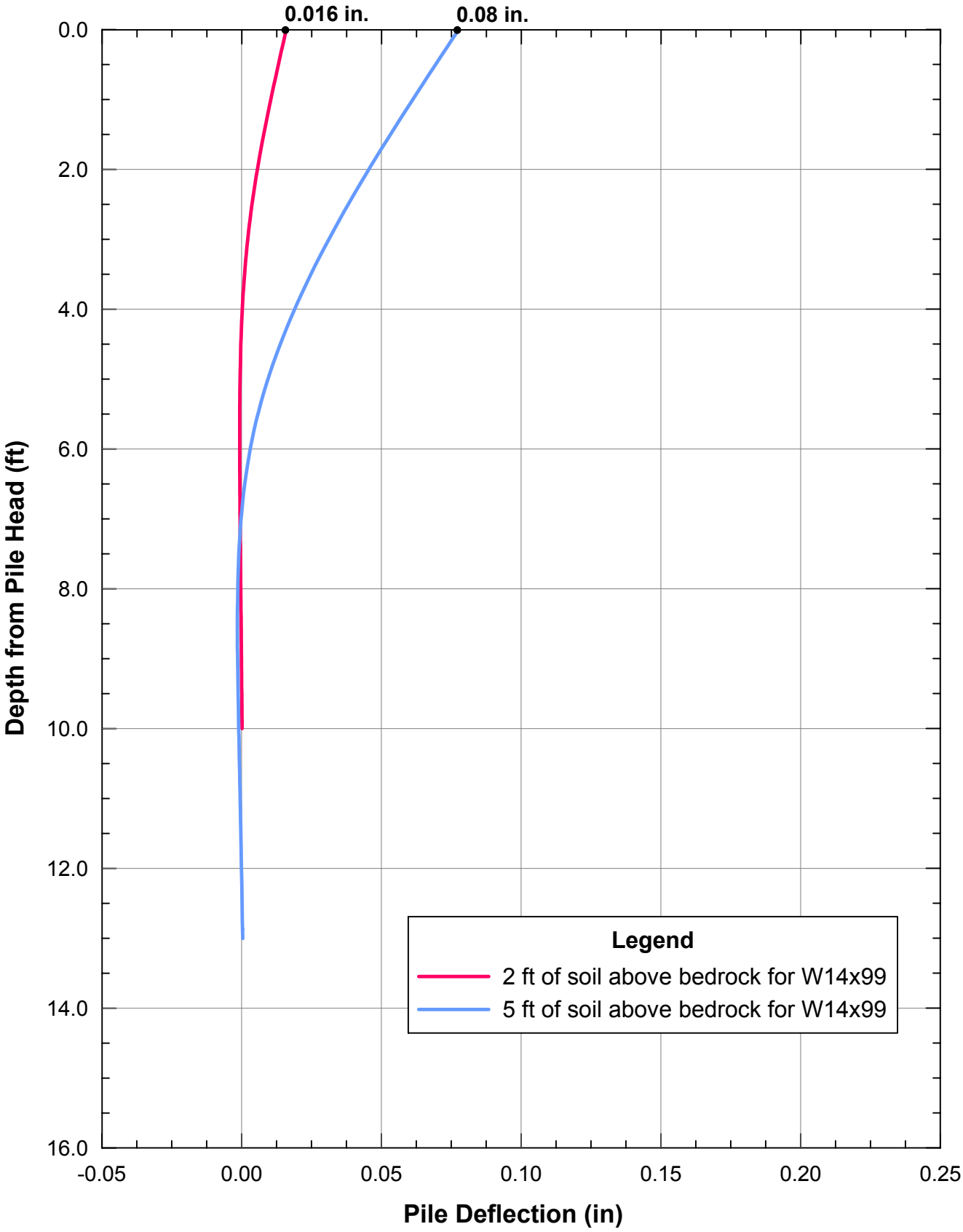
FIGURE 8

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis\Shear Force at Sta 85.grf



PILE DEFLECTION VERSUS DEPTH DUE TO THE EXCAVATION OF THE SOUTH-BOUND BATTERY TUNNEL AT STATION 85+00

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Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
August 2009 San Francisco, California

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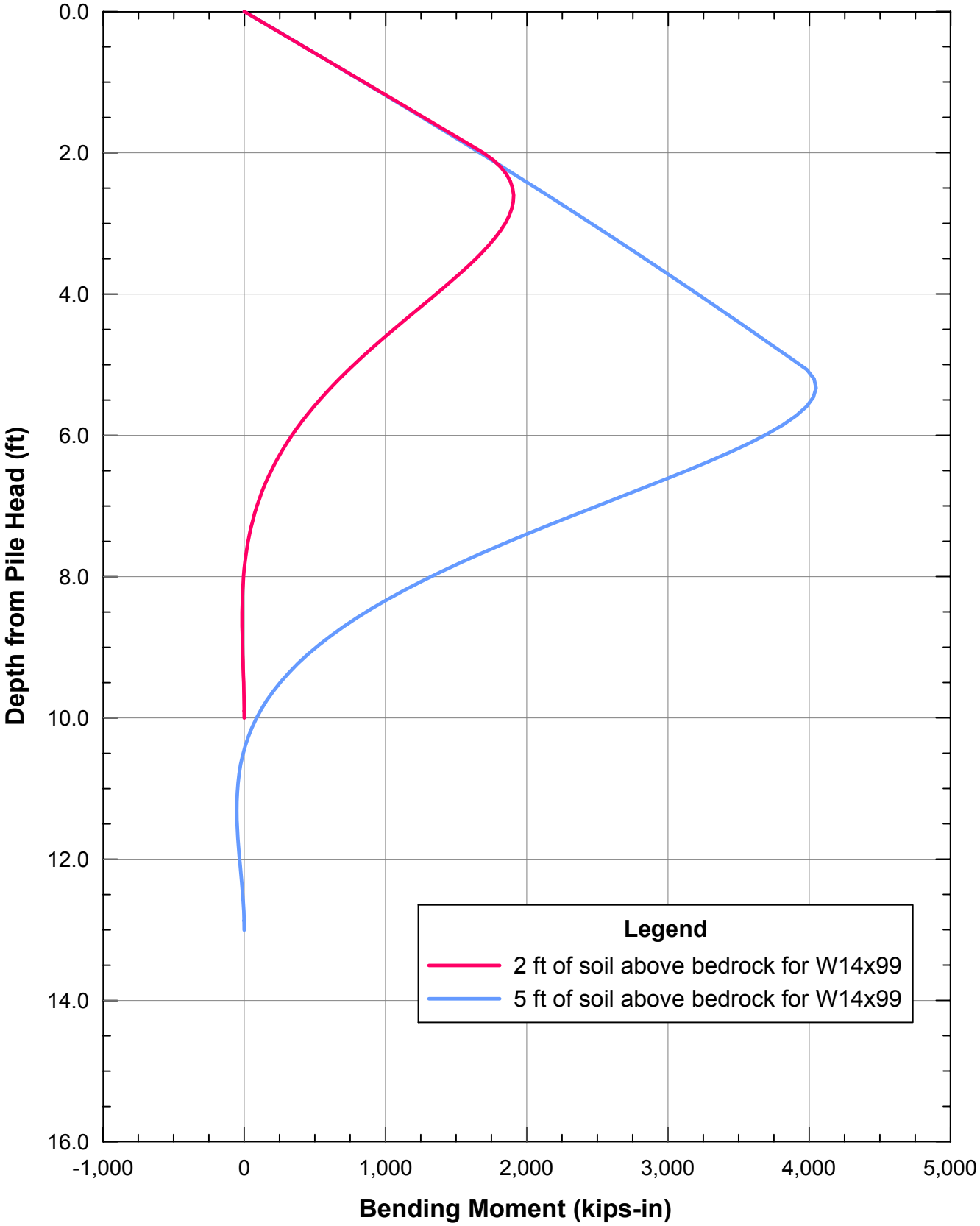
FIGURE 9

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis at West End with braced struts\Pile Deflections rev1.grf



BENDING MOMENT VERSUS DEPTH DUE TO THE EXCAVATION OF THE SOUTH-BOUND BATTERY TUNNEL AT STATION 85+00

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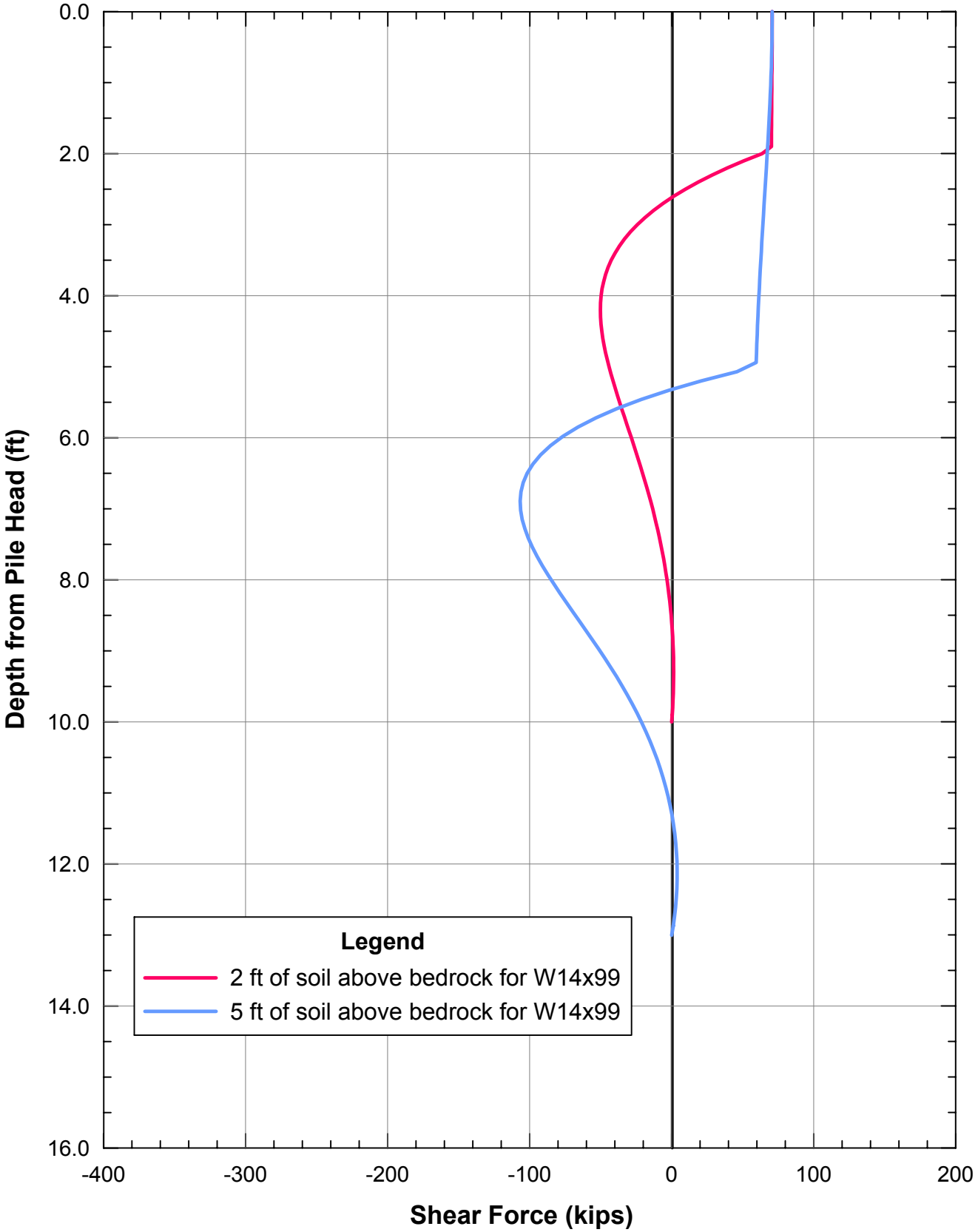
FIGURE 10

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis at West End with braced struts\Bending Moment rev1.grf



SHEAR FORCE VERSUS DEPTH DUE TO THE EXCAVATION OF THE SOUTH-BOUND BATTERY TUNNEL AT STATION 85+00

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FIGURE 11

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Lateral Earth Pressures\LPILE analysis at West End with braced struts\Shear Force rev1.grf

Appendix A

Hand Calculations

ARUP

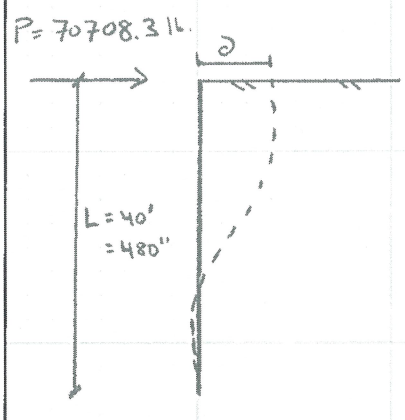
Job No. 131558 Sheet No. 1 Rev.

Member-Location

Job Title Dock Drive - Max deflection of 30" pile in Colma Sand.

Drg. Ref.

Made By A. Sreboro Date 7-20-09 Chd.



① Assume $D_r = 80\%$ so $f = 45$ tons/ft³ from Figure 9

[f = coefficient of variation of lateral subgrade reaction]

$$45 \text{ tons/ft}^3 \times \left[\frac{\text{ft}}{12 \text{ in}}\right]^3 \times \frac{2 \text{ kip}}{\text{ton}} = 0.052083 \text{ kip/in}^3$$

② Compute relative stiffness factor from Figure 10.

$$T = \left[\frac{EI}{f}\right]^{1/5}$$

$E = 3{,}500$ ksi

$I = \cancel{59{,}846.78}\ 48{,}962.7 \text{ in}^4$ for ~~W21×101~~ W14×99

$$T = \left[\frac{(3{,}500 \text{ ksi})(\cancel{59{,}846.78}\ 48{,}962.7 \text{ in}^4)}{0.052083 \text{ kip/in}^3}\right]^{1/5} = \cancel{83.35}\ 80.07 \text{ in.}$$

③ Compute deflection coefficient from Figure 11 (free head).

$$\frac{L}{T} = \frac{480 \text{ in}}{\cancel{83.35}\ 80.07 \text{ in}} = \cancel{5.75}\ 6.00 \quad \text{and} \quad Z = 0$$

so $F_\partial = 2.25$

④ Compute deflection (Figure 11)

$$\partial = F_\partial \left(\frac{PT^3}{EI}\right)$$

$$\partial = 2.25 \left[\frac{(70708.3 \text{ lb})(\cancel{83.35}\ 80.07 \text{ in})^3}{(3{,}500 \text{ ksi})(\cancel{59{,}846.78}\ 48{,}962.7 \text{ in}^4)}\right]$$

$$\boxed{\partial = \cancel{0.411 \text{ in.}}\ 0.48 \text{ in.}}$$

AS 8/21/09

Note: This calculation assumes all Colma Sand to be conservative and compatible with the methods outlined in DM 7.01.

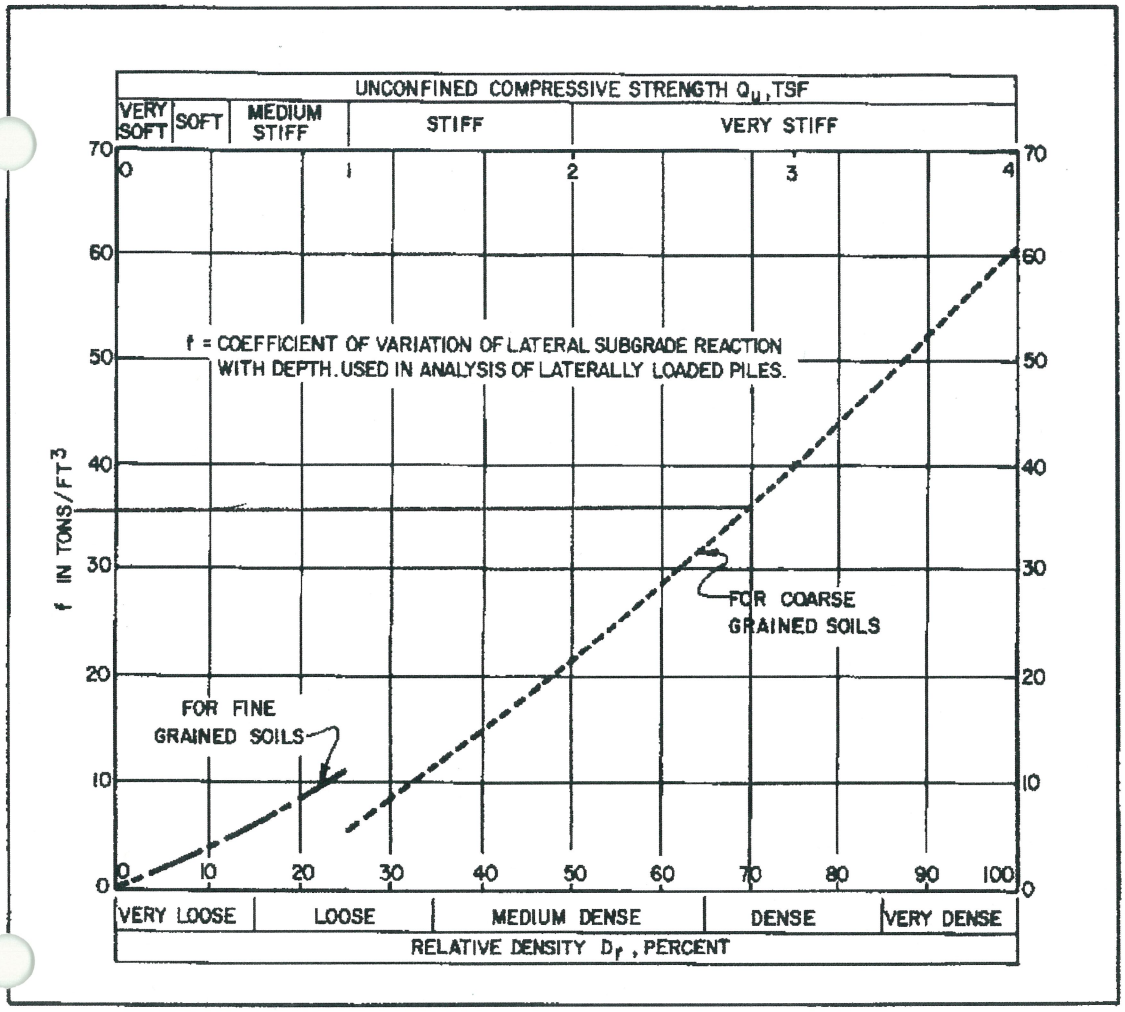


FIGURE 9
Coefficient of Variation of Subgrade Reaction

<table>
<tr><th colspan="3">CASE I. FLEXIBLE CAP, ELEVATED POSITION</th></tr>
<tr><th>CONDITION</th><th>LOAD AT GROUND LINE</th><th>DESIGN PROCEDURE</th></tr>
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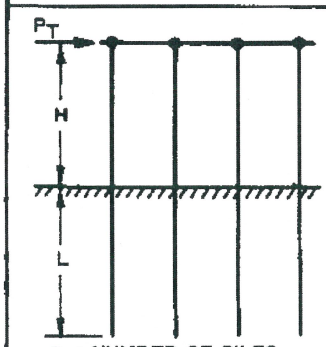
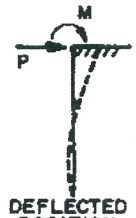
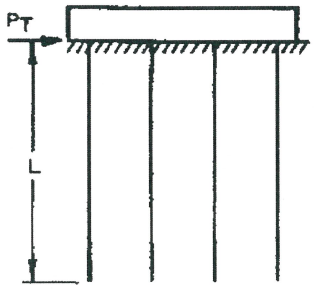
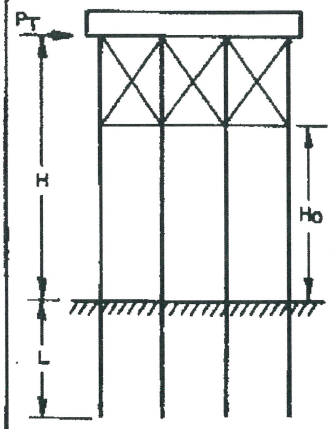
<td> 
</td>
<td>FOR EACH PILE:
$P = \frac{P_T}{n}$
$M = PH$
 
</td>
<td>FOR DEFINITION OF PARAMETERS SEE FIGURE 12
1. COMPUTE RELATIVE STIFFNESS FACTOR. $T = \left(\frac{EI}{f}\right)^{1/5}$
2. SELECT CURVE FOR PROPER $\frac{L}{T}$ IN FIGURE 11.
3. OBTAIN COEFFICIENTS F_δ, F_M, F_V AT DEPTHS DESIRED.
4. COMPUTE DEFLECTION, MOMENT AND SHEAR AT DESIRED DEPTHS USING FORMULAS OF FIGURE 11.

NOTE: "f" VALUES FROM FIGURE 9 AND CONVERT TO LB/IN^3.</td>
</tr>
<tr><th colspan="3">CASE II. PILES WITH RIGID CAP AT GROUND SURFACE</th></tr>
<tr>
<td> 
</td>
<td>
</td>
<td>1. PROCEED AS IN STEP 1, CASE I.
2. COMPUTE DEFLECTION AND MOMENT AT DESIRED DEPTHS USING COEFFICIENTS F_δ, F_M AND FORMULAS OF FIGURE 12.
3. MAXIMUM SHEAR OCCURS AT TOP OF PILE AND EQUALS $P = \frac{P_T}{n}$ IN EACH PILE.</td>
</tr>
<tr><th colspan="3">CASE III. RIGID CAP, ELEVATED POSITION</th></tr>
<tr>
<td> 
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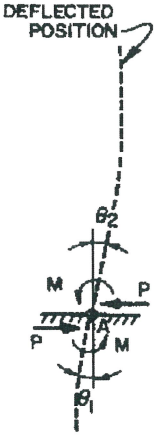
<td> 
</td>
<td>1. ASSUME A HINGE AT POINT A WITH A BALANCING MOMENT M APPLIED AT POINT A.
2. COMPUTE SLOPE θ_2 ABOVE GROUND AS A FUNCTION OF M FROM CHARACTERISTICS OF SUPERSTRUCTURE.
3. COMPUTE SLOPE θ_1 FROM SLOPE COEFFICIENTS OF FIGURE 13 AS FOLLOWS:
$\theta_1 = F_\theta \left(\frac{P_T^2}{EI}\right) + F_\theta \left(\frac{MT}{EI}\right)$
4. EQUATE $\theta_1 = \theta_2$ AND SOLVE FOR VALUE OF M.
5. KNOWING VALUES OF P AND M, SOLVE FOR DEFLECTION, SHEAR, AND MOMENT AS IN CASE I.
NOTE: IF GROUND SURFACE AT PILE LOCATION IS INCLINED, LOAD P TAKEN BY EACH PILE IS PROPORTIONAL TO I/H_o^3.</td>
</tr>
</table>

FIGURE 10
Design Procedure for Laterally Loaded Piles

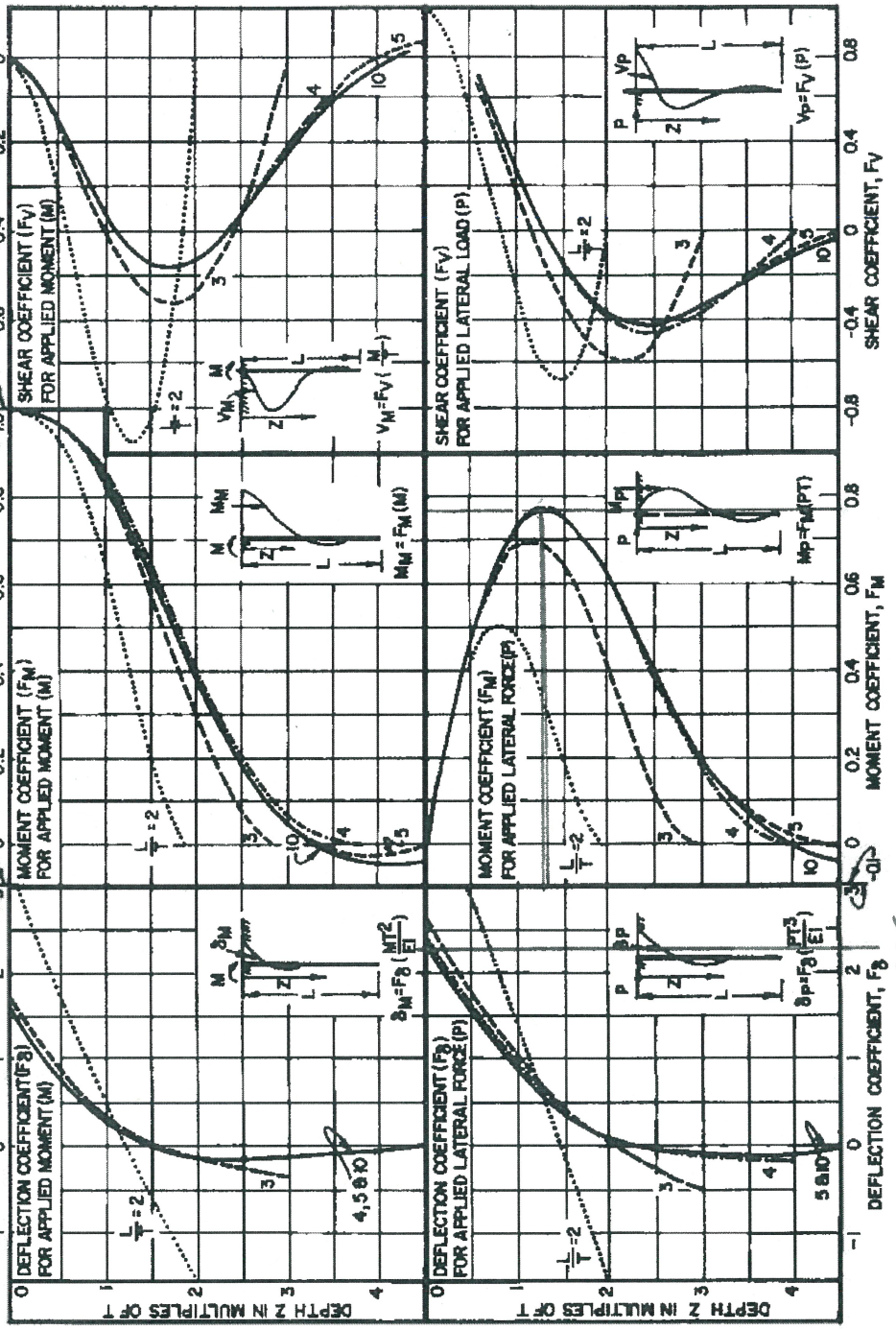


FIGURE 11
Influence Values for Pile with Applied Lateral Load and Moment
(Case 1, Flexible Cap or Hinged End Condition)

225

APPENDIX F.7

Ground Anchor Requirements for the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Ground Anchor Requirements for the Southbound Battery Tunnel

August 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Ground Anchor Requirements

August 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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Appendix A – Calculations

1 Introduction

This package presents the results of our calculations of ground anchor forces and unbonded lengths required for portions of the temporary retaining walls supporting the excavation for the Southbound Battery Tunnel. The Southbound Battery Tunnel is a cut and cover tunnel that will be constructed as part of the Doyle Drive Replacement Project in San Francisco, California. These calculations should be used for design of temporary Retaining Walls A and B that cannot be supported with internal bracing.

Temporary ground anchors will be required at the east ends of Retaining Walls A and B. The ground anchors will be required between Station 76+32 (Solider Pile PA-25) and Station 76+62 (Solider Pile PA-30) for Retaining Wall A and Station 75+71 (Solider Pile PB-15) and Station 76+55 (Solider Pile PB-30) for Retaining Wall B, as internal bracing cannot be used at these locations. Ground anchors for Retaining Wall B in this location will have to extend below the existing Doyle Drive and would be removed during construction of the Northbound Tunnel

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Determine the required un-bonded tieback length at each row of tiebacks required to ensure the bonded zone is beyond the limits of the failure plane.

3 Assumptions

The following assumptions were made in these calculations:

- Three rows of tiebacks were assumed to be at an angle of declination of 15º, at depths of 6, 20, and 34 feet from the top of the wall.
- A wall height of 40 feet
- The ground anchors will be installed into Colma Sand and a soil friction angle of 35 degrees was used for the analyses.
- Apparent pressures were used to develop loads.

4 Calculations

This section summarizes the calculations performed to determine tieback forces and the required bonded and un-bonded tieback lengths required for wall sections east of the east portal of the southbound Battery Tunnel. EXCEL file containing these calculations is located at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Tiebacks\BT Tiebacks.xls. Printouts of the excel file are attached in Appendix A.

4.1 Un-bonded Tieback Lengths

The un-bonded tieback length, L_{Unbond}, was calculated from the following equation:

$$L_{Unbond} = \frac{z + \frac{H}{4}}{\cos(\alpha)}, \text{ where}$$

$$z = \frac{H \tan(\psi)}{1 + \tan(\alpha)\tan(\psi)}, \text{ and}$$

H = Height of tieback from the base of wall

ψ = Angle of failure surface from wall = 45 - ϕ/2

α = Tieback angle of declination

5 Results

This section presents the results of calculations performed to determine required un-bonded ground anchor lengths for Retaining Wall sections of the southbound Battery Tunnel.

Depth of Tieback from Top of Wall	Unbonded Length (ft)
6	27
14	20
34	14

Table 1: Results of tieback analysis for 40 ft high wall

List of References

[1] Fang, His-Yang. (1991) Foundation Engineering Handbook. 2nd Ed. Van Nostrand Reinhold, New York.

Appendix A

Calculations

Battery Tunnel East Portal

Three rows of tiebacks: 1st row 6 feet from top of wall, 2nd row 20 feet from top of wall, 3rd row 34 feet from top of wall

Station 78+00 Upper Tieback	
α (angle of declination)	15
H_{wall} (ft)	40
H_{soil} (ft)	40
Depth to 1st tieback (ft)	6
Depth to 2nd tieback (ft)	20
Depth to 3rd tieback (ft)	34
$F_{Horizontal}$ (kips)	100
φ_{soil}	35
ψ (Angle of Failure Plane)	27.5
$F_{vertical}$ on Wall (kips)	26
L_{Unbond} (ft)	27

Station 78+00 Middle Tieback	
α (angle of declination)	15
H_{wall} (ft)	40
H_{soil} (ft)	40
Depth to 1st tieback (ft)	6
Depth to 2nd tieback (ft)	20
Depth to 3rd tieback (ft)	34
$F_{Horizontal}$ (kips)	90
φ_{soil}	35
ψ (Angle of Failure Plane)	27.5
$F_{vertical}$ on Wall (kips)	23
L_{Unbond} (ft)	20

Station 78+00 Lower Tieback	
α (angle of declination)	15
H_{wall} (ft)	40
H_{soil} (ft)	40
Depth to 1st tieback (ft)	6
Depth to 2nd tieback (ft)	20
Depth to 3rd tieback (ft)	34
$F_{Horizontal}$ (kips)	80
φ_{soil}	35
ψ (Angle of Failure Plane)	27.5
$F_{vertical}$ on Wall (kips)	21
L_{Unbond} (ft)	14

APPENDIX F.8

Evaluation of Axial Loads on Temporary Soldier Piles

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Evaluation of Axial Loads on Temporary Soldier Piles for the Southbound Battery Tunnel

August 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Evaluation of Axial Loads on Temporary Soldier Piles

August 2009

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Appendices

Appendix A – Calculations

1 Introduction

The following calculation package presents an overview of the data and methods used to evaluate the effect of axial loads on the temporary retaining walls that will be constructed as part of the Southbound Battery Tunnel of the proposed Doyle Drive Replacement Project in the San Francisco Presidio.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Estimate the required embedment depth to limit settlements on the soldier piles to less than 0.5 inch for solider piles that are subject to axial (downward) loads in addition to self weight.
- Estimate the required embedment depth to limit uplift movements on the solider piles to less than 0.5 inch for solider piles on Retaining Wall B subject to uplift forces caused by external rakers

3 Inputs

The following input data was required for the analyses:

3.1 Stratigraphy

In the vicinity of the Southbound Battery Tunnel, the subsurface conditions typically consist of the following:

- **FILL:** At the surface is a layer of Fill that varies in thickness from 3 to 23 feet. The composition of the fill is variable and can include gravel, clay, and/or clean sand. The fill is typically loose to medium dense with SPT N-values ranging from as low as 3 to as high as 30 blows per foot.
- **BURIED SOIL HORIZON:** Below the Fill there is a thin layer of a Buried Soil Horizon. Where present, the thickness of the Buried Soil Horizon ranges from about 0.5 to 4.5 feet, but was not encountered in all boreholes. The composition of the Buried Soil Horizon is typically highly organic sandy clay. The Buried Soil Horizon deposits are typically loose with SPT N-values ranging from 0 to 11 blows per foot.
- **SANDY CLAY AND SANDY SILT:** Below the Buried Soil Horizon is a layer of Sandy Clay and Sandy Silt which is probably related to the Colma Sand layer below. The Sandy Clay and Sandy Silt layer ranged from 1.5 to 15.5 feet thick. The Sandy Clay and Sandy Silt layer is typically medium stiff to very stiff with SPT N-values ranging from 7 to 39, with occasional N-values over 50 blows per foot.
- **COLMA SAND:** Below the Sandy Clay and Sandy Silt is a fine to medium grained sand deposit known locally as Colma Sand. Where present, the Colma Sand ranged from 3.5 to 35 feet thick. The Colma Sand is typically medium dense to dense with SPT N-values ranging from 12 to over 60 blows per foot. In places, the Colma Sand is also underlain by another layer of Sandy Clay and Sandy Silt.
- **COLLUVIUM/RESIDUAL SOIL:** Below the Colma Sand or the lower layer of Sandy Clay and Sandy Silt and above the bedrock is a thin layer of either Colluvium or Residual Soil. These layers consisted mainly of stiff to very stiff gravelly clays.
- **BEDROCK:** Bedrock (Franciscan Complex) was encountered below the proposed Battery Tunnels at depths ranging from at the ground surface (at Borehole BTNB-R5-PZ-D) to 54 feet (at Borehole BTNB-R4-PZ). The depth to bedrock generally decreases

towards the west end of the Battery Tunnels. The four major types of bedrock were encountered were serpentinite, sandstone, and Mélange Matrix.

3.2 Material Properties

The following properties were used:

Soil/Rock Unit	Total Unit Weight, γ (pcf)	Friction Angle, ϕ (°)	Cohesion, c (psf)
Colma Sand	130	38	0
Sandstone	165	55	0

4 Assumptions

The following assumptions were made in these calculations:

- The fractured sandstone can be modeled as a soil with a friction angle of 55º.
- Only friction acts to resist the axial forces

5 Calculations

This section is summarizes the calculations performed to estimate the ultimate bearing capacity for the Battery Tunnels. All documents relating to these calculations can be found at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Pile Schedule

5.1 Estimation of Required Embedment to Resist Uplift Forces

The solider piles subject to uplift forces will be embedded in fractured sandstone, which was modeled as a high-friction angle sand.

The required embedment depth was calculated using the following procedure:

A critical length to diameter ratio, $(L/D)_{critical}$, was determined based on the ratio L_{embed}/D and the relative density, D_r, of the sandstone (taken to be 100). The method used is not valid if $L_{embed}/D>(L/D)_{critical}$. A maximum ratio of $(L/D)_{critical}$ equal to 14.5 was determined, based on the assigned friction angle of sandstone.

The ratio of δ/φ was then determined based on D_r and using the chosen φ, δ was determined.

K_u, the uplift coefficient,

The uplift capacity was then determined using the equation:

$$\text{Frictional Resistance} = \frac{1}{2} P_p \gamma' \left(\frac{L}{D}\right)_{critical} K_u \tan\delta \text{, where:}$$

P_p = Perimeter of the pile

γ' = Effective unit weight of the sandstone

Ku = nominal uplift coefficient taken to be 1.0 for the fractured sandstone

The calculations are attached in Appendix A.

5.2 Estimation of Required Embedment to Resist Axial (Downward) Forces

The piles that will receive axial forces will be embedded into Colma Sand. The Colma Sand provides both side (frictional) resistance and tip resistance. However, if tip resistance is sufficient to resist the axial loads, then frictional resistance can be neglected.

For estimation of the tip resistance of the piles, the Janbu method, as presented in Das (1999) following equation was used:

$$Q_p = A_p q' N_q^*, \text{ where}$$

Q_p = Tip resistance

A_p = Area of pile tip

q' = vertical effective stress at pile tip

N_q^* = Janbu bearing capacity factor (η taken equal to 105 degrees)

Additionally, settlements were calculated for the axially loaded piles. The elastic settlement in the pile was calculated using the equation:

$$S_{pile} = \frac{\xi Q_{shaft}}{A_{pile} E_{pile}}, \text{ where}$$

Q_{shaft} = Load in the shaft

ξ = A factor relating the distribution of skin friction resistance, taken to be triangular here

A_{pile} = Area of the pile (transformed section)

E_{pile} = Young's modulus of the pile (transformed section)

The settlement was estimated using the equation:

$$S_{friction} = \left(\frac{q_{wp} D}{E_{soil}}\right)\left(1 - \upsilon_{soil}^{\ 2}\right) I_{wp}, \text{ where}$$

q_{wp} = Load per area at pile tip (Q/A)

E_{soil} = modulus of elasticity of the soil at the pile tip

υ_{soil} = Poisson's ratio of the soil

I_{wp} = influence factor equal to $2+0.35\sqrt{(L/D)}$

The calculations are attached in Appendix A.

6 Results

6.1 Uplift Forces

The results of the analyses indicate that solider piles with an uplift force of 150 kips embedded in sandstone require a minimum of 5 feet of embedment into the sandstone. The effect of any soils over the rock is ignored. The piles should extend through the soils and the pile tips should be located a minimum of 5 feet into the sandstone.

6.2 Axial (downward) Forces

The results of the analyses indicate that solider piles with an axial (downward) force of 112 kips embedded in Colma Sand require a minimum of 8 feet of embedment. Provided the minimum required embedment is achieved, settlement in the piles should be less than 0.5 inch.

List of References

[1] Das, B. M. (1999) *Principles of Foundation Engineering – 4th Edition.* Van Nostrand Reinhold, NY>

Appendix A

Calculations

Uplift Capacity of Solider Piles

D	2.5	ft
W_{W18x65}	0.065	klf
A_{W18x65}	0.133	ft^2
$\gamma_{concrete}$	0.145	kcf
W	34	kips
Uplift	150	kips
W	34.1	kips
Perimeter	7.85	ft
L_{wall}	40	ft
L_{embed}	5	ft
L_{total}	45	
D_r	100	
L/D	2	
$(L/D)_{critical}$	14.5	
δ/ϕ	1.45	
ϕ	55	
δ	79.8	
K_u	4	
γ	92.6	pcf
F.S.	1	FS = 1 because factored loads are used
Capacity	235	kips

OK

Estimation of embedment required for axial (downward) forces on solider piles

Pile	External Load (kips)	Ground Anchor Load (kips)	Total Load (kips)
PB10-PB14	42	0	42
PB15-PB23	42	70	112
PB24-PB30	Self Weight	70	70
PB31-PB191	Self Weight	N/A	Self Weight

Note: Loads are factored

Check maximum load = 112 kips + Self Weight

D	2.5	ft
W_{W18x65}	0.065	klf
A_{W18x65}	0.133	ft^2
$\gamma_{concrete}$	0.145	kcf
W_{pile}	38	kips
Axial Force	112	kips
$Axial_{total}$	149.9	
Perimeter	7.85	ft

Find required embedment to resist loads (5 ft minimum)

L_{wall}	40	ft
L_{embed}	10.0	ft
L_{total}	50.0	ft
q'	676	psf
N*q	105	
A_{pile}	4.9	ft^2
Qp	348	kips

Elastic settlement in pile

Q_{tip}	112.0	kips
Q_{shaft}	0	kips
ξ	0.67	
L	10	ft
A_{pile}	4.9	ft^2
E_{pile}	116560	ksf
E_{steel}	4.18E+06	ksf
f'c	4500	psf
E_{conc}	3824	ksf
Asteel	0.133	ft^2
Aconc	4.8	ft^2
S_{pile}	0.002	ft
	0.023	in

Soil Settlement

E_{soil}	3.75E+03	ksf
υ_{soil}	0.35	
Q_{tip}	112.0	kips
A_{pile}	4.9	ft^2
D	2.5	ft
I_{wp}	0.85	
S	0.01	ft
	0.14	in

total settlement

0.2 inch

APPENDIX F.9

Slope Stability Analysis for the Proposed Re-Grading at the West Portal of the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Slope Stability Analysis for Proposed Re-Grading at the West Portal of the Southbound Battery Tunnel

August 2009

Prepared By:

Caltrans and Arup PB Joint Venture

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Figure 1 Locations of Geotechnical Explorations Battery Tunnels
Figure 2 Subsurface Stratigraphy; Transverse Cross-Section at Station 85+00 SB; Section F-F'
Figure 3 Stability Analysis of the Proposed Re-Grading at the West Portal of the Southbound Battery Tunnel

Appendices

Appendix A Grading Plan; Southbound Doyle Drive; High Viaduct East Abutment

1 Introduction

This package presents the results of our Slope Stability calculations for the Southbound Battery Tunnel portion of the Doyle Drive Replacement Project. The Southbound Battery Tunnel is a cut and cover tunnel that will be constructed as part of the Doyle Drive Replacement Project in San Francisco, California. These calculations should be considered when designing the tunnel as well when planning the construction activities near the site.

A stability analysis at the West Portal of the Southbound Battery Tunnel was performed to evaluate the proposed re-grading plan. Two sections were modeled for the stability analysis; a north-south oriented section that crosses the Southbound Battery Tunnel alignment, and an east-west oriented section adjacent to the Battery Tunnel structure.

2 Scope of Work

The work involved in this calculation consists of the following scope of analyses:

- Examine the slope stability at the West Portal of the Southbound Battery Tunnel and determine the factor of safety of slope failure at two representative locations.
- Calculate the pseudostatic coefficient necessary for a factor of safety of 1.0 at both locations analyzed for stability.

3 Inputs

The following input data was required for the analyses.

3.1 Stratigraphy

The stratigraphy used for this analysis was determined from the field investigation. Figure 1 shows the location of boreholes that were drilled in relation to the Battery Tunnel structure. Figure 2 shows an idealized cross section at Station 85+00. The major soil types are as follows:

- The surficial unit is generally Sandy Fill or Compacted Fill. The Sandy Fill is primarily comprised of loose to medium dense sand with some silt and clay. The Compacted Fill is similar to the Sandy Fill but is primarily medium dense sand.
- Sandy Silts and Sandy Clays underlay the Sandy Fill and Compacted Fill. This unit is approximately 5 feet thick near the West Portal of the tunnel structure and is typically medium stiff.
- Below the Sandy Silts and Sandy Clays lies the Colma Sand. This unit is approximately 10 feet thick near the West Portal and is generally dense to very dense.
- Franciscan Formation bedrock ranges between 20 to 25 feet below the top of the proposed slope near the West Portal.

3.2 Material Properties

The material properties required for this analysis included total unit weight (γ_t), friction angle (ϕ), and cohesion (c). The material properties are summarized in the table presented in Figure 3. The values of these properties were based on laboratory testing conducted for the project.

4 Assumptions

The following assumptions were made in these calculations:

- The Southbound Tunnel structure was assumed to be 32.5 ft high and 66 ft wide, and the locations are approximate. Minor changes to these dimensions and locations are not expected to cause significant changes to these calculations.
- All layers were assumed to act as purely cohesionless soils except for the Sandy Fill and Compacted Fill layers which were given a small amount of cohesion in order to prevent surface raveling.
- The groundwater table was assumed to be at the top of the bedrock for this analysis. The location of the groundwater table is shown on the Figure 3.
- The Battery Tunnel structure was assumed to be an impenetrable material in slope stability calculations.

5 Calculations

This section summarizes the calculations performed for the slope analysis for the Battery Tunnels. The computer files containing these calculations are located at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stability Calcs\Battery Tunnel.

5.1 Stability Analysis

The computer program SlopeW (GeoStudio 2007, Version 7.03, Build 3678) was used to perform the stability analysis proposed re-grading at the West Portal of the Southbound Battery Tunnel. Each soil layer was modeled as Mohr-Coulomb except the bedrock, which was modeled as an impenetrable material. The reported Factors of Safety are based on the Spencer Method. The Spencer method was chosen because it satisfies horizontal, vertical, and rotational equilibrium for all slices, and is therefore potentially more accurate than less refined methods that make more assumptions. Nonetheless, the more traditional Bishop, Janbu, and Ordinary Methods were also checked for consistency.

To determine the most critical failure surface, the 'Auto Locate' slip surface option was used first, which searches all potential failure surfaces. Then the 'Grid and Radius' and the 'Entry and Exit' options were also used to check the results from Auto Locate as well as to examine several different modes of failure for presentation purposes. The Grid and Radius option specifies a rectangular grid within the soil, which the failure surface must pass through; and, another rectangular area above the soil, in which the center of the failure circle must lie. This option is ideal for examining failures through a specific soil layer. The Entry and Exit option specifies sections of the soil surface as entry and exit points of the failure surface. This option is ideal for examining failures that enter or exit the ground surface at a specific point, such as toe failures.

5.2 Pseudostatic Analysis

For the pseudostatic analysis, an iterative approach was used within SlopeW where the horizontal pseudostatic coefficient, k_h, was varied to determine the yield coefficient, k_y. The yield coefficient is the horizontal pseudostatic coefficient that results in a Factor of Safety, (F.S.), of 1.0 for the slope. Therefore, if an earthquake produces a horizontal pseudostatic coefficient greater than the calculated yield coefficient, the slope would become unstable. Typically, in areas where the earthquake threat is major and great, k_h will range from 0.10 to 0.15 [3].

6 Results

6.1 Proposed Re-Grading

From analyzing the proposed re-grading plan at a north-south section that crosses the Southbound Battery Tunnel, the F.S. was calculated to be 2.5. Similarly, from analyzing an east-west section, the F.S. was calculated to be 2.7. Generally, a F.S. >1.5 is acceptable for long-term stability.

For the pseudostatic analysis, the yield coefficient, k_y, was determined to be 0.38. This yield coefficient is well above the horizontal pseudostatic coefficient range of 0.10 to 0.15 for major earthquake threats. Therefore, this proposed re-grading slope is expected to remain stable during predicted seismic events.

List of References

[1] Bowles, Joesph, E. (1996). Foundation Analysis and Design, 5th ed. The McGraw-Hill Companies, Inc., New York.

[2] Coduto, Donald (2001). Foundation Design: Principles and Practices, 2nd ed. Prentice Hall, New Jersey.

[3] The Army Corps of Engineers (1982). The Corps of Engineering Manual EM-1110-2-1902.

[4] Das, Braja J. (2005). Fundamentals of Geotechnical Engineering, 2nd ed. Thomson, Canada.

[5] Fang, His-Yang (1991). Foundation Engineering Handbook, 2nd ed. Van Nostrand Reinhold, New York.

FIGURES

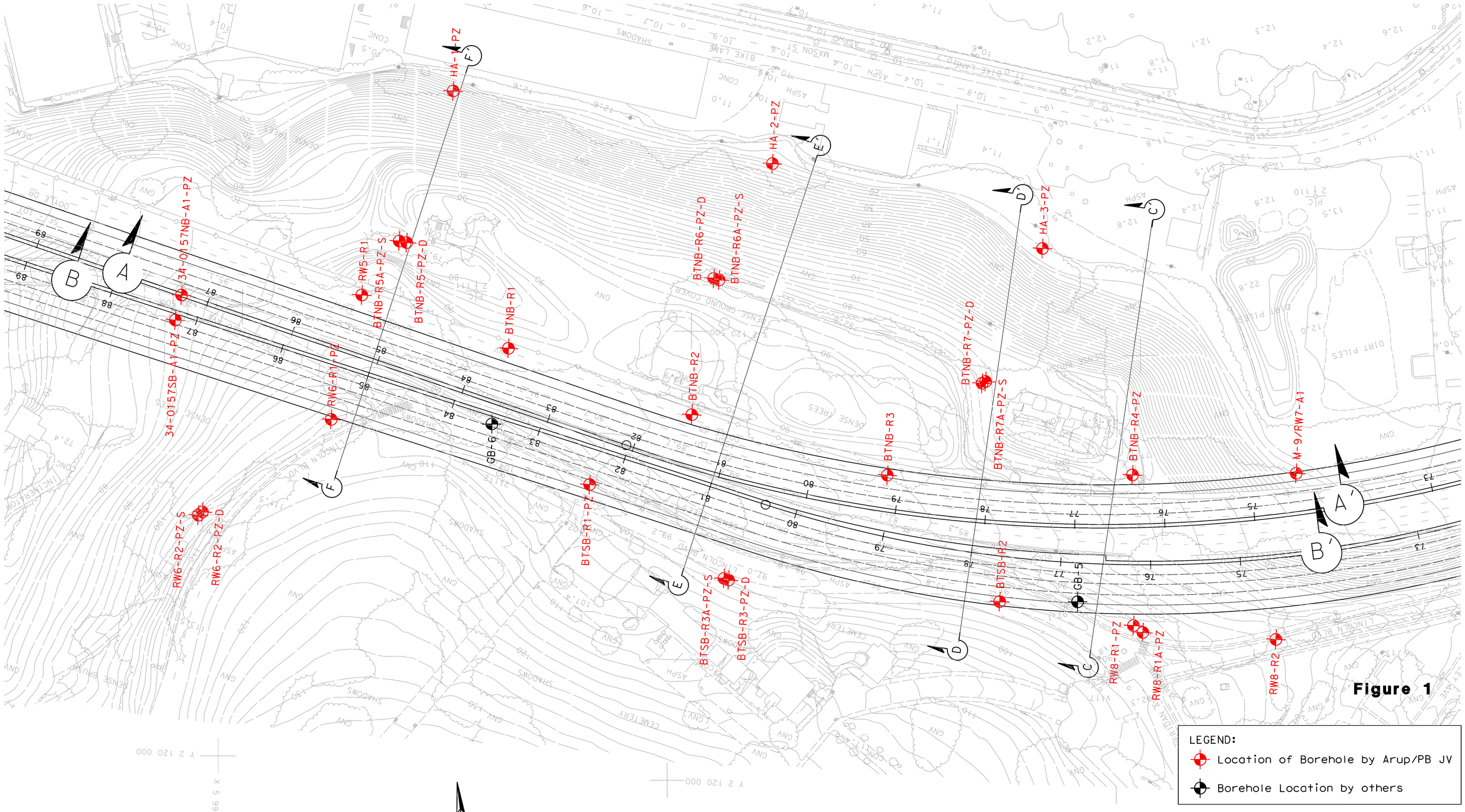


Figure 1

LEGEND:

- Location of Borehole by Arup/PB JV
- Borehole Location by others

ARUP PB joint venture

DOYLE DRIVE REPLACEMENT PROJECT
Locations of Geotechnical Explorations Battery Tunnels

SOUTH
F

NORTH
F'

RW6-R1-PZ
Proj. 25 ft. E

SB Profile
Grade Line

Existing Doyle Drive

Battery Blaney Road

ENGINEERED FILL

RW5-R1
Proj. 35 ft. E

BTNB-R5-PZ-D
Proj. 10 ft. E

FILL
SANDY CLAY

Screen Interval

Proposed Battery
Tunnel Southbound
+88.1 ft.

Future Doyle
Drive Northbound

COLMA
SAND

Original Grade

?FILL

HA-1-PZ
No Projection

+28.8 ft.

Screen Interval

Note: Serpentinite bedrock
encountered in HA-1-PZ

FRANCISCAN
COMPLEX

FRANCISCAN
COMPLEX

ss Sandstone
mg Mélange Matrix
RQD % Recovery %

Elevation (NAVD88), ft

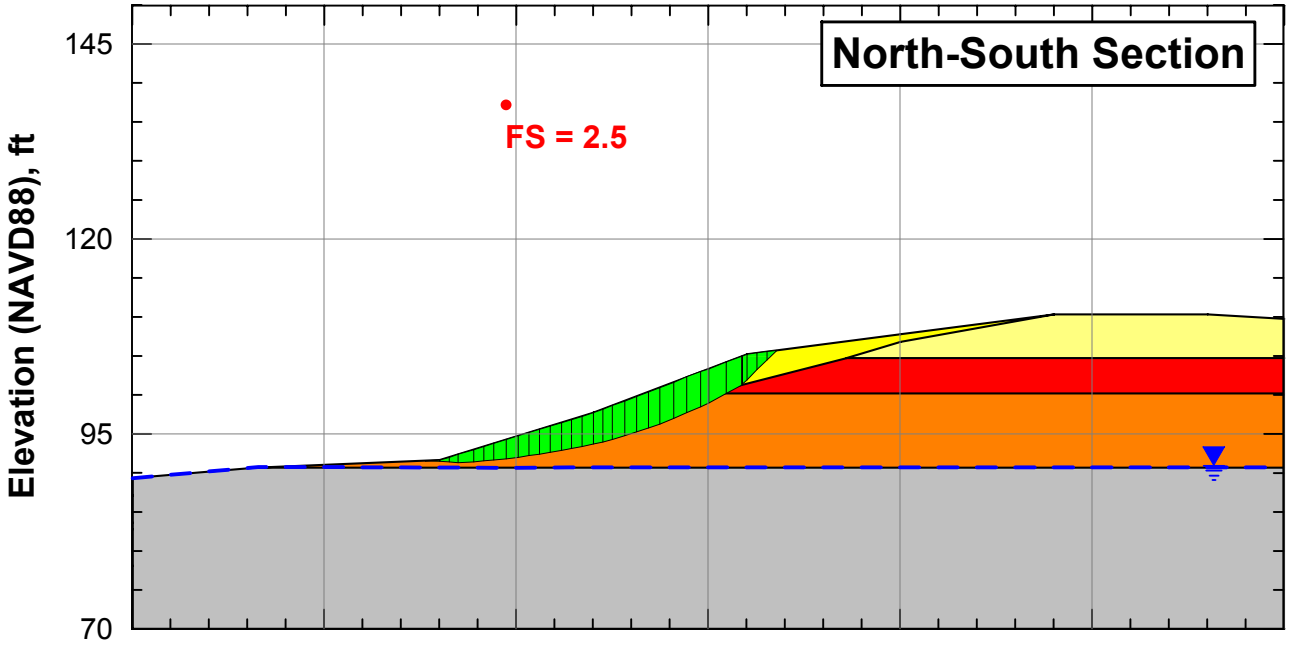
Distance Left of SB Profile Grade Line (ft)

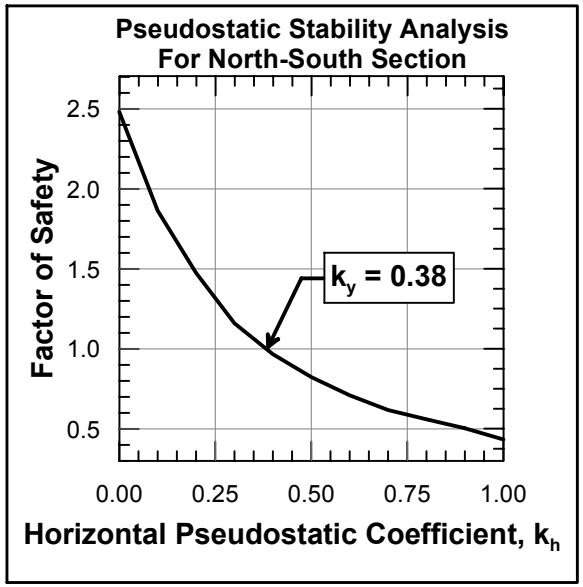
Distance Right of SB Profile Grade Line (ft)

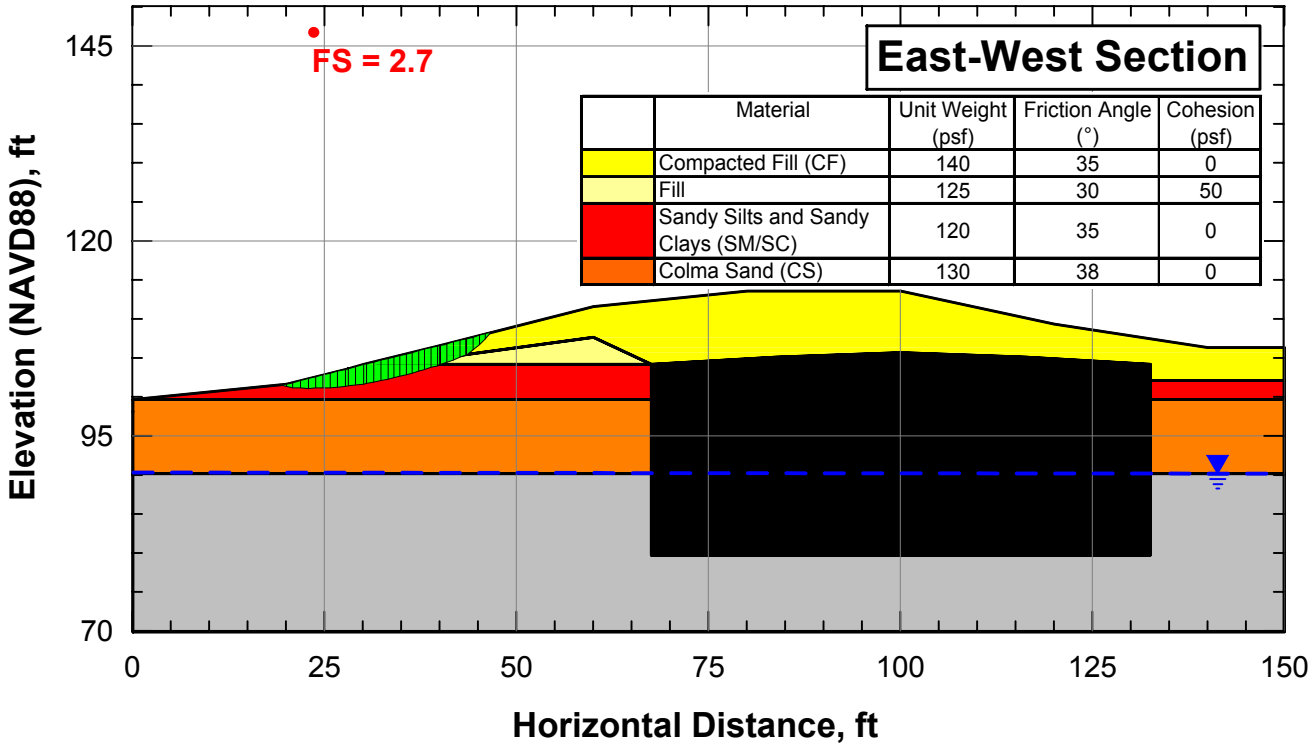
DOYLE DRIVE REPLACEMENT PROJECT
Subsurface Stratigraphy, Section F-F'
Transverse Cross Section at Station 85+00 SB
Across Battery Tunnels (Bridge No. 34-0161 R/L)

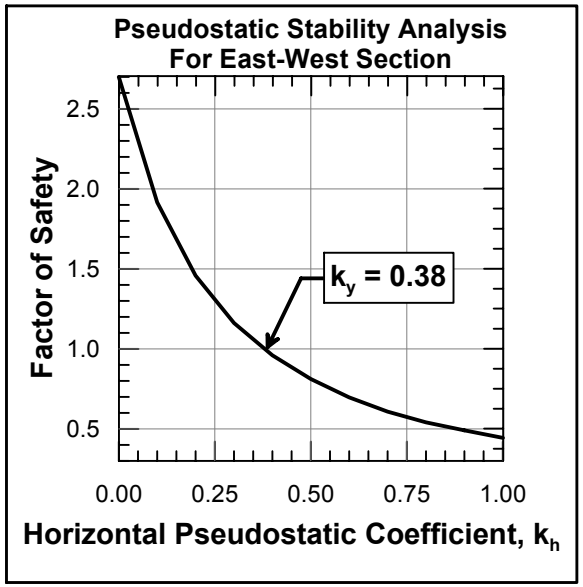
Figure 2

Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Stratigraphy\Cross Sections 04_2009\85+00 BT Transverse.grf









STABILITY ANALYSIS OF THE PROPOSED RE-GRADING AT THE WEST PORTAL OF THE SOUTHBOUND BATTERY TUNNEL

Doyle Drive Replacement Project
Southbound Battery Tunnel Foundation Report
San Francisco County Transportation Authority
August 2009 San Francisco, California

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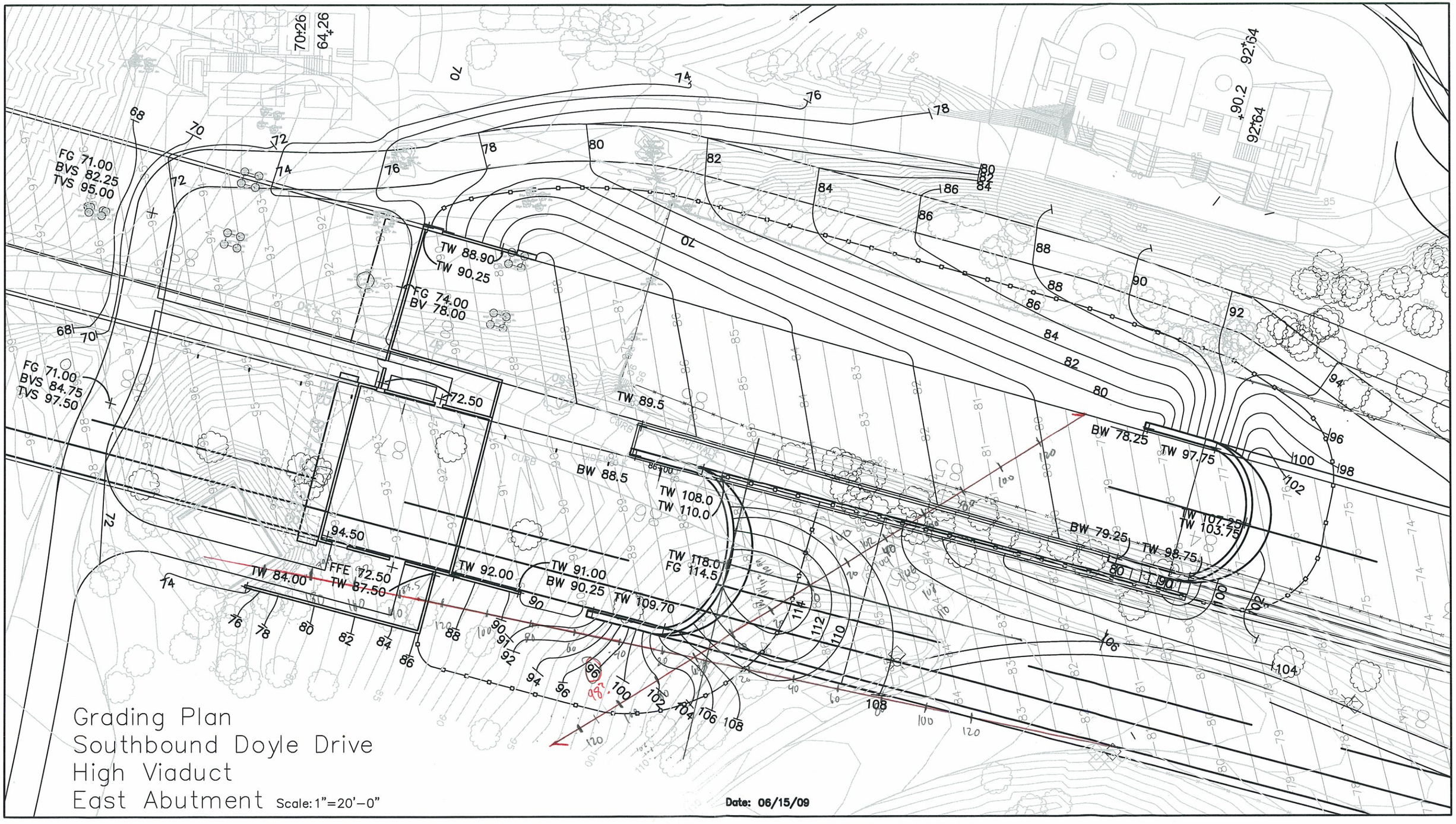
FIGURE 3

Appendix A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TVS 95.00
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BVS 84.75
TVS 97.50
TW 88.90
TW 90.25
FG 74.00
BV 78.00
72.50
TW 89.5
BW 88.5
TW 108.0
TW 110.0
94.50
FFE 72.50
TW 84.00
TW 87.50
TW 92.00
TW 91.00
BW 90.25
TW 109.70
TW 118.0
FG 114.5
BW 78.25
TW 97.75
BW 79.25
TW 98.75
TW 107.25
TW 103.75
70+26
64+26
92+64
+90.2
92+64
Grading Plan
Southbound Doyle Drive
High Viaduct
East Abutment
Scale: 1"=20'-0"
Date: 06/15/09

APPENDIX F.10

Evaluation of Light Post Foundations Above the Southbound Battery Tunnel

SFCTA Contract Number 06/07-29

SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Calculation Package

Evaluation of Light Post Foundations above the Southbound Battery Tunnel

August 2009

Prepared By:

Arup PB Joint Venture

San Francisco County Transportation Authority

Doyle Drive Replacement Project

Calculation Package

Evaluation of Light Post Foundations Above the Southbound Battery Tunnel

August 2009

This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

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Job number 131558

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Appendices

Appendix A – Calculations

1 Introduction

The following calculation package presents an overview of the data and methods used to evaluate the light post foundations that will be constructed as part of the Southbound Battery Tunnel of the proposed Doyle Drive Replacement Project in the San Francisco Presidio. The Southbound Battery Tunnel is a cut and cover tunnel. The tunnel will typically be covered with compacted structural fill, but lightweight fill will be required in some areas.

Six light posts will be installed over the Southbound Battery Tunnel. The light posts will be supported on either Caltrans Standard Cast-in-Drilled-Hole (CIDH) foundations or shallow spread footings

Caltrans Standard, 5 foot long, 30 inch diameter CIDH piles will be used where possible. However, in several locations, the spread footings will be required because the thickness of cover is less than 5 feet.

2 Scope of Work

The work involved in this calculation consisted of the following scope of analyses:

- Evaluate the CIDH and spread footing light post foundations for over turning.
- Estimate the deflection of the CIDH pile.
- Evaluate resistance to sliding of the spread footings.

3 Inputs

The following input data was required for the analyses:

3.1 Loads Provided by Structural Engineer

The following *factored* loads were provided by the structural engineer:

Vertical Load at top of Footing = 279 pounds

Lateral Load at top of Footing (wind load) = 562 pounds

3.2 Material Properties

The following properties were used:

Soil/Rock Unit	Total Unit Weight, γ (pcf)	Friction Angle, ϕ (°)	Cohesion, c (psf)
Lightweight Fill	65	32	0

4 Assumptions

The following assumptions were made in these calculations:

- Bearing capacity is not an issue because the foundations will be installed directly on or just above the roof of the Southbound Battery Tunnel.
- In order to be conservative, all foundations were assumed to be installed in lightweight fill.

5 Calculations

This section is summarizes the calculations performed to evaluate sliding and overturning for both the CIDH pile foundation and the shallow spread footings. All documents relating to these calculations can be found at Q:\131558\4a Arup Internal Project Data\4a-04 Calculations\4a-04-02 Geotech\Light Poles

5.1 Cast-in-Drilled-Hole Pile Foundation

5.1.1 Evaluation of Deflection of the CIDH Foundations

Deflection of the CIDH piles were evaluated as shallow piers using the Evans and Duncan (1982) procedure as presented in Coduto (2001).

The Evans and Duncan procedure determines a characteristic shear load, V_c. V_c is then normalized by the applied shear load, V, and related to the deflection.

$$V_c = \lambda B^2 E \cdot R_I \left(\frac{\sigma_p}{E \cdot R_I} \right)^m (\varepsilon_{50})^n \text{, where}$$

V_c = Characteristic shear load

λ = Dimensionless parameter based on stress-strain behavior of the soil

B = Diameter of the CIDH

E = Modulus of the CIDH

R_I = Moment of inertia ratio, equal to 1.0 for a circular cross-section

σ_p = Passive pressure of the soil

ε_{50} = Axial strain at 50% of soil strength

m,n = Empirical values used to determine characteristic shear

The value of V/V_c is then related to y_t/B through empirical charts provided by Evans and Duncan, where y_t is equal to the deflection at the pile head.

The calculations are attached in Appendix A.

5.1.2 Evaluation of Overturning

Overturning was calculated by comparing the driving and resisting forces about the base of the CIDH pile and a factor of safety was determined. Because factored loads were used, a factor of safety of 1.0 is acceptable.

The resisting forces are the weight of the CIDH pile, the vertical load from the light post, and the passive resistance of the soil. The driving force is the wind load acting at the head of the CIDH pile.

The calculations are attached in Appendix A.

5.2 Shallow Spread Footings

5.2.1 Evaluation of Sliding

The spread footings were evaluated for sliding using the following equation:

$$V_{resist} = (P + W)\mu + \frac{1}{2} K_p \gamma H^2 \text{, where:}$$

V = Resistance to sliding

P+W = Applied vertical load plus the weight of the spread footing

μ = Friction factor equal to tan(φ)

The calculations are attached in Appendix A.

5.2.2 Evaluation of Overturning

Overturning was calculated by comparing the driving and resisting forces about the base of the CIDH pile and a factor of safety was determined. Because factored loads were used, a factor of safety of 1.0 is acceptable.

The resisting forces are the weight of the spread footing and the vertical load from the light post. The driving force is the wind load acting at the top of the spread footing.

The calculations are attached in Appendix A.

6 Results

6.1 CIDH Piles

The results of the analyses indicate that the for the given wind and axial loads, the light posts supported on Caltrans Standard CIDH piles will deflect less than 0.5 inch and are not susceptible to overturning.

6.2 Axial (downward) Forces

The results of the analyses indicate that light posts supported on the shallow spread footings will not be susceptible to sliding or overturning.

List of References

[1] Coduto, D.P. (2001) *Foundation Design, Principles and Practices – 2nd Edition.* B Prentice-Hall, Inc. NJ 883pp.

Appendix A

Calculations

Spread Footings

B	6	ft
D	2.5	ft
γ	65	pcf
ϕ	32	degrees
V	562	lbs
P	279	lbs
W_{ftg}	9375	lbs

Check for Bearing Capacity

N/A only 1 ft of soil over tunnel
not enough to develop passive wedge

d_0 > 1 ft

Check for Sliding Resistance

μ	0.625	
P+W	9654	lbs
K_p	3.25	
H	1.5	ft
V_{resist}	6270	lbs
$V_{driving}$	562	lbs

$FS_{sliding}$ >3

Check for Overturning

L_{ftg}	6	ft
M_{ftg}	28125	lbs-ft
P	279	lbs
M_P	837	lbs-ft
M_{resist}	28962	lbs-ft
V	562	lbs
H_{ftg}	4	ft
$M_{driving}$	2108	lbs-ft

$FS_{overturn}$ >3

Shallow Piers
Evans and Duncan 1982 procedure

λ	1	for sands
B	30	inches
E	3604997	psi
R_I	1	for circular cross-section
σ_p	24	
γ	0.038	pci
ϕ'	32	degrees
C_p	3.2	
ε_{50}	0.002	for sands
m	0.57	for V_c
n	-0.22	for V_c
V_c	14094515	lbs
V	562	lbs
V/V_c	0.00004	
y_t/B	0.001	From Chart

Deflection

y_t	0.03	inches

overturning

D	2.5	ft
L	5	ft
γ_{conc}	145	pcf
W_{conc}	3559	lbs
P_{axial}	279	lbs
W_{ftg}	3838	lbs
ϕ	35	degrees
k_p	3.69	
$\gamma_{l\text{-}w\ fill}$	65	pcf
$FS_{passive}$	1.5	
V	562	lbs
$M_{driving}$	2810	lbs-ft
$M_{resist\text{-}ftg}$	4797	
$M_{resist\text{-}soil}$	666	w/ FS on passive
$M_{resist\text{-}total}$	5463.6	lbs-ft
FS	1.94	

Appendix B

Results of Laboratory Testing

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Table B-12 Summary of Slake Durability Test Results
Table B-13 Summary of Petrographic Analysis (Thin Section Microscopy) Test Results

1 Introduction

An extensive laboratory testing program was performed to determine the index and engineering properties of the major subsurface strata encountered at the site. The laboratory testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to refine some of the engineering parameters where it was deemed appropriate.

Tests on overburden soil specimens were performed at the Signet Testing Laboratories in Hayward, California.

Tests on Mélange Matrix specimens were performed at the Signet Testing Laboratories in Hayward, California.

Tests on rock specimens were performed at Advanced Terra Testing, Inc., in Lakewood, Colorado and the Arup laboratory in San Francisco, California.

This appendix briefly describes the testing program and procedures used for the different test types and presents summary tables and data plots of the test results.

1.1 Tests Performed on Soil and Rock Samples

In order to adequately determine the engineering properties of the soil and rock, a series of laboratory tests were performed on various samples of Fill, , Buried Soil Horizon, Sandy Clay, Sandy Silt, Colma Sand, Colluvium, Residual Soil, and the underlying bedrock.

1.2 Index Tests

Index tests were performed on both soil and rock samples to aid in classification and correlation with other engineering parameters. Index tests included Atterberg limits, grain size analyses, organic content, and moisture content and density determinations. Atterberg limits tests were performed in accordance with standard test method ASTM D 4318-00 (wet method). Grain-size analyses were performed in accordance with standard test method ASTM D 422-63. Organic content tests were performed in accordance with the standard test method ASTM D 2974-87. Moisture content tests were performed in accordance with standard test method ASTM D 2216-98. Total density tests were performed following the standard test method ASTM D 2216-98. In addition to tests performed to directly measure the properties stated above, moisture and density measurements were performed on samples for One-Dimensional Consolidation, Direct Shear, and Unconsolidated Undrained Triaxial Compression tests.

A summary of the results of index tests performed on soil and rock is presented in Table B-1. The individual laboratory reports for Atterberg limits, sieve analyses and moisture and density tests are presented in Attachment B-1 of the accompanying CD.

1.3 One-Dimensional Consolidation Tests

One-Dimensional Consolidation Tests were performed on samples of Sandy Clay to evaluate their compressibility characteristics and past geologic-stress history. Consolidation tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 2435-04.

The maximum past pressure values (σ'_p) were estimated from end-of-primary consolidation compression curves using the Pacheco-Silva (1970) and Casagrande

(1934) constructions, as well as the Becker et al. (1987) work method. The overconsolidation ratio (OCR) was then computed from an estimated maximum past pressure (σ'_p) and the calculated in situ vertical effective stress (σ'_{vo}) at the depth from which the sample was taken using the following expression:

$$OCR = (\sigma'_p)/(\sigma'_{vo})$$

A summary of the results from the consolidation tests performed on overburden soils is presented in Table B-2. The laboratory consolidation test reports showing the compression curves (vertical strain at the end of load increment versus log effective stress) are included in Attachment B-2 of the accompanying CD.

1.4 Direct Shear Test

Direct Shear Tests were performed on samples of Fill, Buried Soil Horizon, and Colma Sand to determine the drained strength parameters of these materials.

A summary of the results from the Direct Shear Tests is presented in Table B-3. The laboratory reports are included in Attachment B-3 of the accompanying CD.

1.5 Organic Content Tests

An Organic Content Test was performed on a Buried Soil Horizon sample in general accordance with the procedures outlined in the standard test method ASTM D 2974-87.

A summary of the results from the Organic Content Test is presented in Table B-4. The laboratory reports are included in Attachment B-4 of the accompanying CD.

1.6 Unconsolidated Undrained Triaxial Compression Test

Unconsolidated Undrained (UU) Triaxial Compression Tests were performed on samples of Buried Soil Horizon, Sandy Clay, Colma Sand, Serpentinite, Mélange Matrix, Sandstone, and Gabbro to evaluate the undrained shear strength of the material. The undrained Young's Modulus can also be determined from this test. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 2850-95.

A summary of the results of UU Triaxial Compression Tests is presented in Table B-5. Before testing and after testing photographs of selected samples and the laboratory reports for all samples for these tests are included in Attachment B-5 of the accompanying CD.

1.7 Isotropically consolidated Undrained Triaxial Compression Test

Isotropically Consolidated Undrained (ICU) Triaxial Compression Tests were performed on Colma Sand samples to determine the effective friction angle. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 4767-95 with pore pressure measurements.

A summary of the results of ICU Triaxial Compression Tests is presented in Table B-6. Before testing and after testing photographs of selected samples and the laboratory reports for all samples for these tests are included in Attachment B-6 of the accompanying CD.

1.8 Uniaxial Compressive Strength Tests with Stress Strain Measurements

Uniaxial Compressive Strength Tests were performed on intact rock samples of four to six inches long to determine the compressive strength. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 3148-02. Stress-strain measurements during the tests were used to determine the elastic stiffness parameters of the rock specimen, namely the Young's modulus and the Poisson's ratio.

A summary of the results from the Uniaxial Compressive Strength Tests performed is presented in Table B-7. The laboratory stress-strain curves and photographs for these tests are included in Attachment B-7 of the accompanying CD.

1.9 Point Load Index Tests

Diametral Point Load Index Tests were performed to determine point load index strength of intact rock core specimens. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 5731-02. This index test is an inexpensive way to measure the strength of the rock specimens without the specimen preparation and setup required for the Uniaxial Compressive Strength Test. Point load tests were performed on portions of rock core having a length-to-diameter ratio of at least 1.0, with appropriate corrections being made to account for size effects. In the point load test, rock specimens are loaded between steel cone tips and the load at the time of rupture is recorded. The corrected point load strength, $I_{s-(50)}$, is given by the expression:

$$I_{s(50)} = F(P/D_e^2)$$

Where:

P = load at rupture

D_e = distance between the steel points at failure (typically slightly smaller than the core diameter)

F = specimen size correction factor to standardize the results to 50 mm core size.

The uniaxial compressive strength, σ_a, is computed from:

$$\sigma_a = C \times I_{s(50)}$$

Where:

C = factor that depends on the core size.

A summary of the results from Point Load Index Tests performed is presented in Table B-8. Plots of uniaxial compressive strength versus elevation for each borehole tested are included in Attachment B-8 of the accompanying CD.

1.10 Indirect Tensile Strength (Brazilian) Tests

Indirect Tensile Strength Tests, also referred to as the Brazilian Test Method, were performed on five rock core samples to determine the tensile strength of the rock. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 3967-95a. The significant advantage of this test is that it is a simple and inexpensive way to measure the tensile strength.

A summary of the results from the Indirect Tensile Strength Tests performed is presented in Table B-9. The laboratory reports, photographs and stress curves for these tests are included in Attachment B-9 of the accompanying CD.

1.11 Punch Penetration Test

A Punch Penetration Test was performed on one intact rock core specimen indicating relative boreability and excavatability of the rock formation, i.e., the energy needed for efficient chipping. This is affected by the stiffness, brittleness, and porosity of the sample. The rock sample was broken in the same way that a disc cutter will during tunnel construction. The test takes into account both the crushing strength of the rock (failure mechanism beneath the cutter edge) and its resistance to chipping (failure mechanism between cutters).

A summary of the results from the Punch Penetration Test performed is presented in Table B-10. The laboratory report for this test, which includes a summary sheet, load versus penetration plots and before and after test photographs, is presented in Attachment B-10 of the accompanying CD.

1.12 Cerchar Abrasivity Index Tests

Cerchar Abrasivity Index Tests were performed on three rock specimens to determine rock abrasivity for cutter wear. A series of sharpened steel pins of a known hardness are pulled across a freshly broken surface of the rock. The average dimensions of the resultant wear can be related directly to cutter life in field operation. The geometry of the planned excavation then allows calculation of the expected cutter wear per unit distance of cutter travel.

A summary of the results from the Cerchar Abrasivity Index Tests performed is presented in Table B-11. The laboratory data sheet and before and after test photographs are presented in Attachment B-11 of the accompanying CD.

1.13 Slake Durability Tests

Slake Durability Tests were performed on three rock core specimens in order to quantitatively estimate the durability of weak rocks and their resistance to weathering. These tests were performed in general accordance with the procedures outlined in the standard test method ASTM D 4644-87. Serpentinite and similar weak rocks absorb moisture when subjected to a simulated weathering process. Moisture absorption may cause disaggregation in the form of powdering, spalling, flaking of the sample surface, or separations along bedding planes.

A summary of the results from the Slake Durability Tests performed is presented in Table B-12. Laboratory data reports and before and after test photographs are presented in Attachment B-12 of the accompanying CD.

1.14 Thin-Section Petrographic Analyses

Thin-Section Petrographic Analyses were performed on four rock samples to provide insight into the microscopic properties of the different rock types that may significantly impact its boreability behavior. Such features include grain suturing/interlocking, certain alignment/ orientation of hard minerals, tight matrix, micro fractures, etc.

A summary of the results from the Thin-Section Petrographic Analyses performed is presented in Table B-13. The report prepared by the laboratory, and thin-section photographs are included in Attachment B-13 of the accompanying CD.

TABLES

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Liquid Limit, w_l (%)	Plastic Limit, w_p (%)	Plasticity Index, I_p (%)	Liquidity Index, LI	Dry Unit Weight, γ_d (pcf)	Percent Fines (%)
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	22	15	7	-0.67	135.6	
BTNB-R3	11.6	74.7	Sandy Clay	18.9	130.0	41	17	24	0.08	109.4	
BTNB-R3	18.3	68.0	Colma Sand	18.2							
BTNB-R3	31.7	54.6	Colma Sand	23.1	125.6					102.1	12.6
BTNB-R4-PZ	8.3	62.2	Sandy Clay	13.7	130.7	32	16	16	-0.14	114.9	81.1
BTNB-R4-PZ	13.4	57.1	Sandy Silt	14.1	136.8					119.8	54.4
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.5	131.9					110.4	14.3
BTNB-R4-PZ	23.5	47.0	Colma Sand	19.4	129.0					108.0	
BTNB-R4-PZ	23.5	47.0	Colma Sand	18.8	127.8					107.6	
BTNB-R4-PZ	33.1	37.4	Colma Sand	20.1	132.9					110.7	9.5
BTNB-R4-PZ	48.1	22.4	Colma Sand	21.2	134.2					110.8	14.2
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	Non-Plastic	Non-Plastic	Non-Plastic		119.7	
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.2							
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.0							
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	Non-Plastic	Non-Plastic	Non-Plastic		118.6	
BTNB-R4-PZ	96.5	-26.1	Serpentinite		142.4						
BTNB-R5A-PZ-S	25.1	54.3	Sandstone		167.5						
BTNB-R5A-PZ-S	25.1	54.3	Sandstone								
BTNB-R5A-PZ-S	25.5	53.9	Sandstone		165.6						
BTNB-R5-PZ-D	54.5	25.1	Mélange Matrix	9.3	158.6	27	16	11	-0.61	145.1	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTNB-R5-PZ-D	88.4	-8.7	Sandstone		163.8						
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8					73.1	31.8
BTNB-R6-PZ-D	8.2	75.4	Fill	14.7	124.3					108.3	9.5
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	34	17	17	0.21	107.3	
BTNB-R6-PZ-D	18.3	65.3	Sandy Silt	18.0	134.0					113.5	59.1
BTNB-R6-PZ-D	23.6	60.0	Colma Sand	15.7	136.3					117.8	17.9
BTNB-R6-PZ-D	27.6	56.0	Colma Sand	14.9	124.4					108.3	10.9
BTNB-R6-PZ-D	47.7	35.9	Serpentinite		132.1						
BTNB-R6-PZ-D	83.8	-0.2	Serpentinite		151.1						
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	39	33	6	-3.02	122.2	
BTNB-R7A-PZ-S	9.8	69.2	Buried Soil Horizon	20.4		30	15	15	0.36		
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1					107.7	52.5
BTNB-R7A-PZ-S	19.8	59.2	Sandy Clay	23.6		30	14	16	0.60		
BTNB-R7A-PZ-S	23.1	55.9	Colma Sand	19.9	133.6					111.5	17.6
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand	20.9	132.1					109.3	18.2
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	23	15	8	0.23	115.1	
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	30	28	2	-6.60	122.2	
BTSB-R1-PZ	13.3	87.8	Fill	15.0	121.7					105.8	3.3
BTSB-R1-PZ	22.8	78.3	Fill	26.4	127.0					100.5	2.1
BTSB-R1-PZ	22.8	78.3	Fill	25.3	126.2					100.7	
BTSB-R1-PZ	22.8	78.3	Fill	30.8	125.4					95.9	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTSB-R1-PZ	27.5	73.5	Sandy Clay	22.0	129.9					106.5	
BTSB-R1-PZ	28.8	72.3	Sandy Clay	22.8	123.5					100.6	
BTSB-R1-PZ	28.8	72.3	Sandy Clay			37	16	21			
BTSB-R1-PZ	28.8	72.3	Sandy Clay			39	18	21			
BTSB-R1-PZ	36.3	64.8	Sandstone		164.6						
BTSB-R1-PZ	36.6	64.4	Sandstone		165.3						
BTSB-R1-PZ	45.2	55.9	Sandstone, Shale		166.4						
BTSB-R2	3.3	88.9	Fill	5.3	118.8					112.9	
BTSB-R2	12.8	79.3	Sandy Clay	22.5	128.2	38	18	20	0.23	104.6	
BTSB-R2	17.8	74.3	Colma Sand	19.1	135.8					114.0	48.3
BTSB-R2	28.3	63.9	Colma Sand	21.8	130.1					106.8	11.4
BTSB-R2	28.3	63.9	Colma Sand	20.7	129.9					107.6	
BTSB-R2	28.3	63.9	Colma Sand	20.6	130.0					107.8	
BTSB-R2	33.6	58.6	Colma Sand	21.2	128.5					106.0	13.0
BTSB-R2	37.8	54.3	Sandy Clay	20.7	130.4	30	17	13	0.28	108.1	
BTSB-R2	38.3	53.8	Sandy Clay	22.3	127.6	45	21	24	0.05	104.3	
BTSB-R2	42.8	49.3	Sandy Clay	19.4	132.4	40	20	20	-0.03	110.9	
BTSB-R3A-PZ-S	3.1	95.0	Fill	6.7	115.6					108.4	1.8
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.2	109.1					99.9	1.4
BTSB-R3A-PZ-S	9.3	88.8	Fill	10.4	112.9					102.3	
BTSB-R3A-PZ-S	9.3	88.8	Fill	9.3	109.7					100.4	

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
BTSB-R3A-PZ-S	12.8	85.2	Buried Soil Horizon	18.6	131.8	23	16	7	0.37	111.2	
BTSB-R3A-PZ-S	17.8	80.2	Sandstone	10.5	142.2					128.7	33.1
BTSB-R3-PZ-D	24.8	73.1	Sandstone								
BTSB-R3-PZ-D	25.1	72.8	Sandstone		158.2						
BTSB-R3-PZ-D	25.5	72.5	Sandstone								
BTSB-R3-PZ-D	30.2	67.7	Sandstone		159.5						
BTSB-R3-PZ-D	44.5	53.5	Sandstone		161.3						
BTSB-R3-PZ-D	44.9	53.1	Sandstone		166.7						
BTSB-R3-PZ-D	50.4	47.5	Sandstone		164.9						
BTSB-R3-PZ-D	81.7	16.3	Sandstone		166.2						
RW5-R1	3.3	89.8	Colma Sand	13.8	134.0					117.7	49.9
RW6-R1-PZ	3.1	105.5	Fill	15.4	124.3					107.7	49.5
RW6-R1-PZ	7.9	100.7	Sandy Clay	15.7		28	15	13	0.05		75.6
RW6-R1-PZ	12.9	95.7	Colma Sand	16.6	128.7					110.4	21.5
RW6-R1-PZ	12.9	95.7	Colma Sand	16.8	127.2					108.9	
RW6-R1-PZ	12.9	95.7	Colma Sand	16.3	129.1					111.0	
RW6-R1-PZ	17.3	91.3	Colma Sand	21.2	131.1					108.2	27.4
RW6-R1-PZ	17.3	91.3	Colma Sand	22.1	131.0					107.3	
RW6-R1-PZ	17.3	91.3	Colma Sand	18.7	134.1					113.0	
RW6-R1-PZ	26.6	81.9	Sandstone								
RW6-R1-PZ	26.9	81.6	Sandstone		152.6						

TABLE B-1

SUMMARY OF INDEX TEST RESULTS

Borehole ID	Depth	Elevation, (NAVD88)	Soil Unit	Moisture Content, w_o	Total Unit Weight, γ_t	Liquid Limit, w_l	Plastic Limit, w_p	Plasticity Index, I_p	Liquidity Index, LI	Dry Unit Weight, γ_d	Percent Fines
RW6-R1-PZ	45.3	63.2	Sandstone		163.4						
RW6-R1-PZ	49.9	58.7	Sandstone		166.5						
RW6-R2A-PZ-S	3.8	104.6	Fill	4.5	104.2					99.7	4.5
RW6-R2A-PZ-S	8.1	100.3	Fill	24.3	126.3					101.6	2.7
RW6-R2A-PZ-S	8.1	100.3	Fill	21.7	131.2					107.8	
RW6-R2A-PZ-S	8.1	100.3	Fill	18.2	124.7					105.5	
RW6-R2A-PZ-S	18.6	89.8	Colma Sand	13.2	129.6					114.5	16.4
RW6-R2-PZ-D	31.0	77.7	Sandstone		160.5						
RW8-R1-PZ	8.8	81.9	Fill	9.6	109.0					99.5	
RW8-R1-PZ	13.3	77.4	Sandy Clay	22.4	127.3	24	17	7	0.77	104.0	83.4
RW8-R1-PZ	18.8	71.9	Sandy Clay	19.0	131.3	29	19	10	-0.004	110.4	
RW8-R1-PZ	23.1	67.5	Sandy Clay	19.6	126.4	25	13	12	0.55	105.7	60.1
RW8-R1-PZ	24.4	66.2	Colma Sand	18.2	131.0	23	16	7	0.31	110.8	47.2
RW8-R1-PZ	29.8	60.9	Colma Sand	15.3							20.4
RW8-R1-PZ	33.3	57.4	Colma Sand	19.6	130.3					108.9	21.3
RW8-R1-PZ	33.3	57.4	Colma Sand	20.0	130.3					108.6	
RW8-R1-PZ	33.3	57.4	Colma Sand	19.5	133.2					111.5	
RW8-R1-PZ	43.3	47.4	Sandy Clay	23.1	126.9	29	16	13	0.55	103.1	
RW8-R1-PZ	43.8	46.9	Sandy Clay	21.1	124.0	29	18	11	0.28	102.4	
RW8-R1-PZ	76.5	14.1	Serpentinite	7.7							
RW8-R1-PZ	121.9	-31.3	Serpentinite		150.5						

TABLE B-2
SUMMARY OF THE RESULTS OF INCREMENTAL LOADING (IL) CONSOLIDATION TESTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Initial Moisture Content, w_i (%)	Initial Total Unit Weight, γ_t (pcf)	In-Situ Effective Vertical Stress, σ'_{vo} (psf)	Maximum Past Pressure, σ'_p (psf)	Over Consolidation Ratio, OCR	Compression Ratio, CR	Recompression Ratio, RR	Swelling Ratio, SR
BTSB-R1-PZ	28.75	72.3	Sandy Clay	22.8	123.5	1,850	7,500	4.1	0.124	0.006	0.017
RW8-R1-PZ	23.125	67.5	Sandy Clay	19.8	124.5	2,850	13,500	4.7	0.126	0.008	0.008
RW8-R1-PZ	43.75	46.9	Sandy Clay	21.1	124.0	5,580	4,400	0.8	0.094	0.007	0.007

TABLE B-3
SUMMARY OF DIRECT SHEAR TEST RESULTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Normal Consolidation Stress, σ'_{vc} (psf)	Peak Shear Stress, τ_{max} (psf)	Residual Shear Stress, τ_{res} (psf)	Peak Strength	
									Peak Friction Angle, ϕ' (degrees)	Cohesion Intercept, c' (psf)
BTSB-R1-PZ	22.8	78.3	Buried Soil Horizon (SP)	26.4	127.0	2,650	2,208	1,680	38	0
				25.3	126.2	3,300	2,508	1,932		
				30.8	125.4	4,000	3,012	2,304		
BTNB-R4-PZ	23.5	47.0	Colma Sand (SP-SM)	19.5	131.9	2,700	2,640	1,788	45	0
				19.4	129.0	3,300	3,336	2,220		
				18.8	127.8	4,000	4,020	2,628		
BTSB-R2	28.3	63.9	Colma Sand (SP-SM)	21.8	130.1	3,200	3,120	2,064	43	0
				20.7	129.9	4,000	3,744	2,532		
				20.6	130.0	4,800	4,404	3,156		
RW6-R1-PZ	12.9	95.7	Colma Sand (SP-SM)	16.6	128.7	1,000	1,236	852	50	0
				16.8	127.2	1,200	1,320	912		
				16.3	129.1	1,400	1,764	1,116		
RW6-R1-PZ	17.3	91.3	Colma Sand (SP-SM)	21.2	131.1	2,000	1,884	1,464	41	0
				22.1	131.0	2,500	2,100	1,668		
				18.7	134.1	3,000	2,652	1,980		
BTSB-R3A-PZ-S	9.3	88.8	Fill (SP)	9.2	109.1	1,000	936	804	42	0
				10.4	112.9	1,300	1,044	864		
				9.3	109.7	1,600	1,500	1,176		
RW6-R2A-PZ-S	8.1	100.3	Fill (SP)	24.3	126.3	1,000	972	780	42	0
				21.7	131.2	1,200	1,092	888		
				18.2	124.7	1,400	1,200	996		
RW8-R1-PZ	33.3	57.4	Colma Sand (SC)	19.6	130.3	4,150	3,852	2,856	31	1,350
				20.0	130.3	5,200	4,476	3,192		
				19.5	133.2	6,225	5,124	4,116		

TABLE B-4

SUMMARY OF ORGANIC CONTENT TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Soil Unit	Moisture Content, w_o (%)	Organic Content (%)	Remarks
RW8-R1-PZ	13.3	77.4	Buried Soil Horizon	22.4	3.5	

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TABLE B-5

SUMMARY OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Unit	Water Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Effective Vertical Stress, $\sigma'_{v,o}$ (ksf)	Total Confining Stress, σ_c (ksf)	Deviator Stress, σ_1-σ_3 (ksf)	Undrained Shear Strength, s_u (ksf)	$s_u/\sigma'_{v,o}$	Axial Strain at Failure, σ_f (%)	Undrained Young's Modulus at 50% Strain, $E_{u,50}$ (ksf)	$E_{u,50}/s_u$	Material Description (From Lab Records)	Remarks
BTNB-R1	51.9	39.5	Mélange Matrix	10.3	149.7	4.8	9.5	1.9	0.935	0.19	8.1	125	133	Very dark gray silty clayey gravel	
BTNB-R4-PZ	60.3	10.1	Serpentinite	16.5	139.4	6.0	10.5	1.5	0.729	0.12	19.6	178	245	Bluish gray clayey sand	
BTNB-R4-PZ	87.6	-17.2	Serpentinite	16.8	138.5	8.2	16.0	1.7	0.832	0.10	20.0	1157	1390	Bluish gray clayey sand	
BTNB-R6A-PZ-S	28.3	55.2	Serpentinite	48.8	108.8	3.5	4.9	3.0	1.487	0.42	1.9	218	147	Olive brown clayey sand	
BTNB-R6-PZ-D	13.0	70.6	Sandy Clay	20.5	129.3	1.6	2.3	4.9	2.442	1.56	9.4	86	35	Brown clay	
BTNB-R6-PZ-D	90.7	-7.1	Serpentinite	14.9	140.4	8.6	17.0	1.8	0.875	0.10	1.8	2097	2397	Dark bluish gray silt	
BTNB-R7A-PZ-S	18.3	60.7	Sandy Clay	20.8	130.1	2.2	3.1	2.5	1.240	0.56	10.3	50	40	Reddish brown sandy clay	
BTNB-R7-PZ-D	13.3	66.1	Sandy Clay	16.8	134.5	1.6	2.3	3.5	1.740	1.10	9.6	58	33	Brown sandy clay	
BTNB-R7-PZ-D	86.4	-7.0	Gabbro	14.8	140.3	8.1	16.0	1.1	0.570	0.07	1.0	1615	2836	Bluish gray gravelly silt	
BTSB-R1-PZ	27.5	73.5	Sandy Clay	22.0	129.9	2.6	5.2	3.0	1.480	0.57	4.0	81	55	Olive brown clay with sand	
BTSB-R2	12.8	79.3	Sandy Clay	22.5	128.2	1.6	2.3	3.7	1.854	1.18	15.1	74	40	Reddish brown clay	
BTSB-R2	17.8	74.3	Colma Sand	19.1	135.8	2.2	3.1	3.7	1.854	0.84	10.9	44	24	Reddish brown clayey sand	
BTSB-R2	37.8	54.3	Sandy Clay	20.7	130.4	4.8	6.6	4.6	2.296	0.48	13.9	105	46	Reddish brown clay	
BTSB-R2	38.3	53.8	Sandy Clay	22.3	127.6	4.8	6.6	7.4	3.675	0.76	20.0	288	78	Yellowish brown clay	
BTSB-R2	42.8	49.3	Sandy Clay	19.4	132.4	5.3	7.4	12.5	6.274	1.19	9.6	269	43	Yellowish brown clay	
BTSB-R3A-PZ-S	12.8	85.2	Buried Soil Horizon	18.6	131.8	1.6	2.3	1.5	0.775	0.50	12.8	24	30	Dark brown sandy clay	
BTSB-R3A-PZ-S	17.8	80.2	Sandstone	10.5	142.2	2.2	3.1	5.1	2.561	1.16	2.3	220	86	Yellowish brown clayey sand	
RW8-R1-PZ	22.5	68.1	Sandy Clay	19.6	126.4	2.9	4.2	2.9	1.457	0.51	6.6	45	31	Brown sandy clay	
RW8-R1-PZ	43.3	47.4	Sandy Clay	23.1	126.9	5.5	8.2	2.6	1.282	0.24	15.3	51	40	Brown clay with gravel	

TABLE B-6
SUMMARY OF ISOTROPICALLY CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TESTS

Borehole ID	Depth (ft)	Elevation (ft)	Soil Type	Moisture Content, w_o (%)	Total Unit Weight, γ_t (pcf)	Effective Confining Stress, σ'_c (psf)	Parameters at 10% Strain			Parameters at Max Obliquity			
							p' (psf)	q' (psf)	ϕ' [1] (degrees)	ε_a (%)	p' (psf)	q' (psf)	ϕ' [1] (degrees)
BTNB-R6-PZ-D	27.6	56.0	Colma Sand (SP-SC)	14.9	124.4	4,650	39,641	24,973	39.0	5.4	33,703	21,382	39.4
BTNB-R7A-PZ-S	33.3	45.7	Colma Sand (SP)	20.9	132.1	5,800	10,460	6,492	38.4	5.4	6,033	3,732	38.2
BTSB-R2	33.6	58.6	Colma Sand (SP-SC)	21.2	128.5	5,700	6,268	3,562	34.6	11.1	6,343	3,596	34.5
RW8-R1-PZ	24.4	66.2	Colma Sand (SC-SM)	18.2	131.0	4,650	6,271	3,562	34.6	4.6	5,181	2,991	35.3
								Average	**36.7**			**Average**	**36.8**

[1] ϕ' calculated assuming c = 0

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TABLE B-7
SUMMARY OF THE RESULTS OF UNIAXIAL COMPRESSION TESTS ON ROCK

Borehole ID	Depth (ft)	Elevation (NAVD88) (ft)	Rock Type	Diameter, D (in)	Length, L (in)	L/D	Mass (g)	Wet Density (pcf)	Failure Load (lb)	Failure Type		Compressive Strength (psi)	Young's Modulus (psi)	Poisson's Ratio
BTNB-R4-PZ	96.5	-26.1	Serpentinite	2.401	5.036	2.1	852.00	142.4	5,800	F/S		1,280	7.20E+05	0.171
BTNB-R5-PZ-D	88.4	-8.7	Sandstone	2.389	5.011	2.1	965.60	163.8	39,500	F		8,810	1.33E+06	0.089
BTNB-R5A-PZ-S	25.5	53.9	Sandstone	2.405	5.193	2.2	1025.70	165.6	44,500	F		9,800	4.92E+06	0.108
BTNB-R6-PZ-D	83.8	-0.2	Gabbro	2.398	5.326	2.2	954.10	151.1	16,500	F/S		3,650	1.10E+06	0.177
BTNB-R6-PZ-D	47.7	35.9	Serpentinite	2.399	5.076	2.1	795.40	132.1	1,800	F		400	1.50E+05	0.095
BTSB-R1-PZ	36.3	64.8	Sandstone	2.400	5.227	2.2	1021.60	164.6	49,050	S/F		10,840	4.23E+06	0.184
BTSB-R1-PZ	45.2	55.9	Sandstone	2.399	5.326	2.2	1051.40	166.4	57,000	F/S		12,610	6.63E+06	0.202
BTSB-R3-PZ-D	25.1	72.8	Sandstone	2.398	4.850	2.0	909.50	158.2	22,000	F		4,870	1.35E+06	0.086
BTSB-R3-PZ-D	30.2	67.7	Sandstone	2.401	3.880	1.6	735.50	159.5	15,600	F	*	3,350	1.78E+06	0.197
BTSB-R3-PZ-D	44.5	53.5	Sandstone	2.395	5.437	2.3	1037.00	161.3	42,500	F		9,430	4.96E+06	0.109
BTSB-R3-PZ-D	50.4	47.5	Sandstone	2.408	5.220	2.2	1029.00	164.9	76,500	S/F		16,800	5.45E+06	0.136
BTSB-R3-PZ-D	81.7	16.3	Sandstone	2.410	5.053	2.1	1005.70	166.2	16,000	F		3,510	3.30E+06	0.193
RW6-R1-PZ	26.9	81.6	Sandstone	2.403	5.816	2.4	1056.60	152.6	14,000	F/S		3,090	4.60E+05	0.131
RW6-R1-PZ	45.3	63.2	Sandstone	2.394	5.891	2.5	751.40	163.4	67,000	S/F	*	14,480	4.17E+06	0.114
RW6-R2-PZ-D	31.0	77.7	Sandstone	2.396	5.330	2.2	1012.50	160.5	17,000	F		3,770	1.25E+06	0.121
RW8-R1-PZ	121.9	-31.3	Serpentinite	2.398	5.219	2.2	931.10	150.5	8,000	F		1,770	7.60E+05	0.200

Failure Types - S: Shear Failure, M: Matrix Failure, F: Failure through Fracture/Bedding, V: Void Collapse, C: Combination

* Strength values were corrected to account for short sample (L/D < 2.0)

** Not Testable, short sample L/D < 1.5

*** Due to pre-existing conditions of the sample, meaningful measurements for the calculation of Young's modulus and Poisson's ratio were not possible

TABLE B-8
SUMMARY OF DIAMETRAL POINT LOADS INDEX TESTS

Borehole ID	Test No.	Test Depth (ft)	Test Elevation, (NAVD88) (ft)	Rock Type	Test Type	D_c (mm)	D' (mm)	Max. Pressure (bars)	Max. Pressure (psi)	Load, P (lbf)	D_e (mm)	$(D_e)^2$ (in2)	I_s (psi)	I_s (tsf)	F	$I_{s(50)}$ (psi)	$I_{s(50)}$ (tsf)	σ_a (psi)	Average σ_a from Valid Tests (psi)	Remarks
BTNB-R5-PZ-D		10.95	68.7	Sandstone	Diametral	71.0	67.5	72.4	1,050	1,574	69.2	7.43	211.9	15.3	1.158	245.3	17.7	6,010	6,010	
BTNB-R5-PZ-D		29.85	49.8	Sandstone	Diametral	71.0	67.0	168.2	2,440	3,657	69.0	7.37	496.0	35.7	1.156	573.2	41.3	14,044	14,044	
BTNB-R5-PZ-D		32.55	47.1	Sandstone	Diametral	71.0	67.0	110.8	1,607	2,409	69.0	7.37	326.7	23.5	1.156	377.6	27.2	9,251	-	Invalid test-- broke through pre-existing fracture
BTNB-R5-PZ-D		87.53	-7.9	Sandstone	Diametral	71.0	60.0	88.4	1,282	1,922	65.3	6.60	291.1	21.0	1.127	328.2	23.6	8,040	8,040	
BTNB-R5A-PZ-S		4.56	74.8	Sandstone	Diametral	71.0	68.5	114.8	1,665	2,496	69.7	7.54	331.1	23.8	1.162	384.6	27.7	9,422	9,422	
BTNB-R5A-PZ-S		12.71	66.7	Sandstone	Diametral	71.0	66.0	152.2	2,208	3,309	68.5	7.26	455.6	32.8	1.152	524.8	37.8	12,857	12,857	
BTNB-R5A-PZ-S		22.65	56.7	Sandstone	Diametral	71.0	67.0	146.6	2,126	3,187	69.0	7.37	432.3	31.1	1.156	499.6	36.0	12,240	12,240	
BTNB-R5-PZ-D		88.00	-8.4	Sandstone	Axial	61.0	44.2	33.3	484	725	51.9	4.18	173.5	12.5	1.017	176.5	12.7	4,323	-	*Test performed axially*
BTNB-R6-PZ-D		68.73	14.9	Sandstone	Diametral	71.0	71.0	55.6	806	1,209	71.0	7.81	154.7	11.1	1.171	181.2	13.0	4,438	-	Invalid test-- broke through pre-existing fracture
BTSB-R1-PZ		35.43	65.6	Sandstone	Diametral	71.0	64.0	202.6	2,939	4,405	67.4	7.04	625.4	45.0	1.144	715.4	51.5	17,527	17,527	
BTSB-R1-PZ		38.80	62.2	Sandstone	Diametral	71.0	59.0	230.6	3,345	5,014	64.7	6.49	772.2	55.6	1.123	867.3	62.4	21,248	21,248	
BTSB-R1-PZ		45.98	55.1	Sandstone	Diametral	71.0	54.0	230.6	3,345	5,014	61.9	5.94	843.7	60.7	1.101	928.9	66.9	22,757	22,757	
BTSB-R3-PZ-D		25.78	72.1	Sandstone	Diametral	71.0	49.0	109.0	1,581	2,370	59.0	5.39	439.5	31.6	1.077	473.4	34.1	11,598	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		32.38	65.5	Sandstone	Diametral	71.0	66.0	20.2	293	439	68.5	7.26	60.5	4.4	1.152	69.6	5.0	1,706	1,706	
BTSB-R3-PZ-D		37.37	60.5	Sandstone	Diametral	70.5	60.0	85.4	1,239	1,857	65.0	6.56	283.2	20.4	1.126	318.8	23.0	7,810	7,810	
BTSB-R3-PZ-D		49.70	48.2	Sandstone	Diametral	71.0	59.5	194.8	2,825	4,235	65.0	6.55	646.8	46.6	1.125	727.8	52.4	17,832	17,832	
BTSB-R3-PZ-D		53.35	44.6	Sandstone	Diametral	71.0	56.0	231.8	3,362	5,040	63.1	6.16	817.8	58.9	1.110	907.7	65.4	22,240	22,240	
BTSB-R3-PZ-D		55.55	42.4	Sandstone	Diametral	71.0	63.0	261.2	3,788	5,679	66.9	6.93	819.1	59.0	1.140	933.6	67.2	22,874	22,874	
BTSB-R3-PZ-D		57.78	40.1	Sandstone	Diametral	71.0	64.0	287.8	4,174	6,257	67.4	7.04	888.4	64.0	1.144	1016.2	73.2	24,898	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		59.93	38.0	Sandstone	Diametral	71.0	64.0	190.8	2,767	4,148	67.4	7.04	589.0	42.4	1.144	673.7	48.5	16,506	16,506	
BTSB-R3-PZ-D		62.43	35.5	Sandstone	Diametral	71.0	64.5	145.2	2,106	3,157	67.7	7.10	444.7	32.0	1.146	509.6	36.7	12,486	12,486	
BTSB-R3-PZ-D		64.75	33.2	Sandstone	Diametral	71.0	68.5	33.2	482	722	69.7	7.54	95.8	6.9	1.162	111.2	8.0	2,725	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		67.41	30.5	Sandstone	Diametral	70.5	62.0	258.6	3,751	5,622	66.1	6.78	829.9	59.8	1.134	941.0	67.8	23,055	23,055	
BTSB-R3-PZ-D		91.80	6.1	Sandstone	Diametral	70.0	68.0	1.6	23	35	69.0	7.38	4.7	0.3	1.156	5.4	0.4	134	-	Invalid test-- broke through pre-existing fracture
BTSB-R3-PZ-D		98.85	-0.9	Sandstone	Diametral	71.0	69.0	5.4	78	117	70.0	7.59	15.5	1.1	1.163	18.0	1.3	441	-	Invalid test-- broke through pre-existing fracture
RW5-R1		10.20	82.9	Sandstone	Diametral	71.0	65.0	31.8	461	691	67.9	7.15	96.7	7.0	1.148	110.9	8.0	2,718	2,718	
RW5-R1		15.50	77.6	Sandstone	Diametral	71.0	67.0	79.8	1,157	1,735	69.0	7.37	235.3	16.9	1.156	272.0	19.6	6,663	6,663	
RW5-R1		27.18	65.9	Sandstone	Diametral	71.0	68.0	44.0	638	957	69.5	7.48	127.8	9.2	1.160	148.2	10.7	3,632	-	Invalid test-- broke through pre-existing fracture
RW6-R1-PZ		34.48	74.0	Sandstone	Diametral	70.0	64.0	87.0	1,262	1,892	66.9	6.94	272.4	19.6	1.140	310.6	22.4	7,610	7,610	

TABLE B-8
SUMMARY OF DIAMETRAL POINT LOADS INDEX TESTS

Borehole ID	Test No.	Test Depth (ft)	Test Elevation, (NAVD88) (ft)	Rock Type	Test Type	D_c (mm)	D' (mm)	Max. Pressure (bars)	Max. Pressure (psi)	Load, P (lbf)	D_e (mm)	$(D_e)^2$ (in2)	I_s (psi)	I_s (tsf)	F	$I_{s(50)}$ (psi)	$I_{s(50)}$ (tsf)	σ_a (psi)	Average σ_a from Valid Tests (psi)	Remarks
RW6-R1-PZ		37.21	71.3	Sandstone	Diametral	70.5	64.0	95.0	1,378	2,065	67.2	6.99	295.3	21.3	1.142	337.3	24.3	8,264	8,264	
RW6-R1-PZ		40.13	68.4	Sandstone	Diametral	70.0	60.0	250.0	3,626	5,435	64.8	6.51	834.9	60.1	1.124	938.3	67.6	22,988	22,988	
RW6-R1-PZ		49.68	58.8	Sandstone	Diametral	60.2	60.2	194.7	2,824	4,233	60.2	5.62	753.6	54.3	1.087	819.2	59.0	20,071	20,071	
RW6-R1-PZ		53.03	55.5	Sandstone	Diametral	70.0	64.0	74.0	1,073	1,609	66.9	6.94	231.7	16.7	1.140	264.2	19.0	6,473	-	Invalid test-- broke through pre-existing fracture
RW6-R1-PZ		61.03	47.5	Sandstone	Diametral	71.0	65.0	202.0	2,930	4,392	67.9	7.15	614.0	44.2	1.148	704.8	50.7	17,267	-	Invalid test-- broke through pre-existing fracture
RW6-R2-PZ-D		30.15	78.5	Sandstone	Diametral	71.0	70.5	33.6	487	731	70.7	7.76	94.2	6.8	1.169	110.1	7.9	2,697	2,697	
RW6-R2-PZ-D		32.05	76.6	Sandstone	Diametral	71.0	67.0	101.4	1,471	2,205	69.0	7.37	299.0	21.5	1.156	345.6	24.9	8,466	8,466	
RW6-R2-PZ-D		37.50	71.2	Sandstone	Diametral	71.0	67.5	71.6	1,038	1,557	69.2	7.43	209.6	15.1	1.158	242.6	17.5	5,944	5,944	
RW6-R2-PZ-D		72.50	36.2	Sandstone	Diametral	71.0	54.0	157.2	2,280	3,418	61.9	5.94	575.1	41.4	1.101	633.2	45.6	15,513	-	Invalid test-- broke through pre-existing fracture
RW6-R2-PZ-D		79.43	29.2	Sandstone	Diametral	71.0	68.5	53.6	777	1,165	69.7	7.54	154.6	11.1	1.162	179.6	12.9	4,399	4,399	
RW6-R2-PZ-D		82.33	26.3	Sandstone	Diametral	71.0	68.0	94.8	1,375	2,061	69.5	7.48	275.4	19.8	1.160	319.4	23.0	7,825	7,825	
RW6-R2-PZ-D		99.15	9.5	Sandstone	Diametral	71.0	55.5	232.8	3,377	5,061	62.8	6.11	828.7	59.7	1.108	918.0	66.1	22,491	22,491	
RW8-R1-PZ		54.70	35.9	Sandstone	Diametral	70.5	69.0	3.0	44	65	69.7	7.54	8.7	0.6	1.162	10.0	0.7	246	-	Invalid test
RW8-R1-PZ		68.18	22.4	Sandstone	Diametral	70.5	64.0	54.0	783	1,174	67.2	6.99	167.9	12.1	1.142	191.7	13.8	4,697	-	Invalid test-- broke through pre-existing fracture
RW8-R1-PZ		122.25	-31.6	Serpentinite	Diametral	60.1	60.0	8.2	119	178	60.0	5.59	31.8	2.3	1.086	34.6	2.5	847	1,643	
BTNB-R7-PZ-D		73.25	6.1	Greenstone	Diametral	69.0	60.0	42.6	618	926	64.3	6.42	144.3	10.4	1.120	161.7	11.6	3,961	3,961	
BTNB-R7-PZ-D		98.70	-19.3	Serpentinite	Diametral	70.0	66.0	1.4	20	30	68.0	7.16	4.3	0.3	1.148	4.9	0.4	120	1,643	

TABLE B-9
SUMMARY OF BRAZILIAN (INDIRECT TENSILE STRENGTH) TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Diameter, D (in)	Length, L (in)	Mass (g)	Wet Density, γ_t (pcf)	Failure Load (lb)	Failure Type	Splitting Tensile Strength (psi)
BTSB-R1-PZ	36.6	64.4	Sandstone	2.385	1.209	234.40	165.3	2,753	S	610
BTSB-R3-PZ-D	44.9	53.1	Sandstone	2.388	1.379	270.30	166.7	4,071	S	790
BTNB-R5A-PZ-S	25.1	54.3	Sandstone	2.389	1.215	239.50	167.5	3,165	S	690
RW6-R1-PZ	49.9	58.7	Sandstone	2.369	1.126	216.90	166.5	4,584	S	1,090

Failure Types - S: Single Failure Plane, M: Multiple Failure Planes

TABLE B-10
SUMMARY OF PUNCH PENETRATION TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Peak Slope (kips/in)
BTSB-R3-PZ-D	25.5	72.5	Sedimentary	61

TABLE B-11
SUMMARY OF CERCHAR ABRASIVITY TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Abrasivity Index
BTSB-R3-PZ-D	24.8	73.1	Sedimentary	1.0
BTNB-R5A-PZ-S	25.1	54.3	Sedimentary	1.2
RW6-R1-PZ	26.6	81.9	Sedimentary	0.4

TABLE B-12
SUMMARY OF SLAKE DURABILITY TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Moisture Content (%)	First Cycle Slake Durability Index, $I_{d(2)}$ (%)	Second Cycle Slake Durability Index, $I_{d(2)}$ (%)	Slake Durability Index, $I_{d(2)}$ (%)	Type
BTNB-R4-PZ	70.2	0.2	Serpentinite	7.20	94.2	91.8	94.2	I
BTNB-R4-PZ	75.6	-5.2	Serpentinite	6.03	67.4	64.7	65.2	II
RW8-R1-PZ	76.5	14.1	Serpentinite	7.69	32.6	23.9	61.8	III

TABLE B-13
SUMMARY OF PETROGRAPHIC ANALYSIS (THIN SECTION MICROSCOPY) TEST RESULTS

Borehole ID	Depth (ft)	Elevation, (NAVD88) (ft)	Rock Type	Mineral Composition							
				Quartz	Feldspar (albite)	Chlorite	Muscovite/ Illite	Kaolinite	Clinochrysotile	Lizardite	Hydotalcite
BTSB-R3-PZ-D	44.2	97.9	ss	63%	21%	5%	4%	7%	0%	0%	0%
BTNB-R4-PZ	96.4	70.4	sp	0%	0%	0%	0%	0%	56%	0%	44%
BTNB-R6-PZ-D	84.1	83.6	ga	0%	0%	0%	0%	0%	87%	13%	0%
RW6-R1-PZ	27.3	108.5	ss	63%	30%	5%	2%	0%	0%	0%	0%

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ARUP BATTERY TUNNEL FOUNDATION BORING GEOPHYSICS BORINGS BTNB-R4, BTNB-R5, BTNB-R5A BTNB-R7, BTSB-R2, BTSB-R3, RW6-R1, RW6-R2, RW8-R1 AND RW8-R5 SUSPENSION PS VELOCITY AND ACOUSTIC TELEVIEWER SURVEYS

July 11, 2008

Report 7589-05 rev 1

ARUP BATTERY TUNNEL FOUNDATION BORING GEOPHYSICS BORINGS BTNB-R4, BTNB-R5, BTNB-R5A BTNB-R7, BTSB-R2, BTSB-R3, RW6-R1, RW6-R2, RW8-R1 AND RW8-R5 SUSPENSION PS VELOCITY AND ACOUSTIC TELEVIEWER SURVEYS

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APPENDICES

APPENDIX A SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

APPENDIX B TELEVIEWER BASED CALIPER LOGS

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APPENDIX E TELEVIEWER ROSE DIAGRAMS

APPENDIX F GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION PROCEDURES AND CALIBRATION RECORDS

INTRODUCTION

Suspension PS velocity measurements were collected in nine uncased borings located along the alignment of Doyle Drive, in San Francisco. Acoustic Televiewer measurements were collected in seven of the nine borings. Geophysical data acquisition was performed between January 9 and April 22, 2008 by Robert Steller, John Diehl and Charles Carter of **GEO***Vision*. Data analysis and report preparation was performed by Robert Steller and reviewed by John Diehl of GEOVision. The work was performed under subcontract with ARUP, with Terrence Carroll as the point of contact for ARUP.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of suspension PS velocity measurements collected between January 9 and April 22, 2008 as detailed in Table 1. The purpose of these studies was to supplement stratigraphic information obtained during ARUP's soil and rock sampling program and to acquire shear wave velocities and compressional wave velocities as a function of depth, as a component of the Doyle Drive retrofit program.

The OYO/Robertson Suspension PS Logging System (Suspension System) was used to obtain in-situ horizontal shear (S_H) and compressional (P) wave velocity measurements in all nine borings at 1.6 foot intervals. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the velocity measurement techniques used in this study is:

> Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

The Robertson High Resolution Acoustic Televiewer (HIRAT) was used to collect data at 0.008 foot intervals in seven of the nine 3.86 inch diameter borings, as detailed in Table 1. The purpose of these studies was to supplement lithologic information obtained during ARUP's rock coring program and to acquire fracture and bedding depths, azimuths and dips.

INSTRUMENTATION

Suspension Instrumentation

Suspension soil velocity measurements were performed in nine borings using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3 foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.3 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is 19 feet, with the center point of the receiver pair 12.1 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate

through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 7.0 foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver. In faster soils or rock, the isolation cylinder is extended to allow greater separation of the P- and S_H-wave signals.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.
5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (meter versus centimeter scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing. Up to 8 sampling sequences can be summed to improve the signal to noise ratio of the signals.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), sample rate, and summing number to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as outlined in Appendix F.

Acoustic Televiewer Instrumentation

Acoustic Televiewer data were collected using a Robertson High Resolution Acoustic Televiewer probe (HiRAT), serial number 5174, controlled by Robertson's HiRAT program, version 13. The total length of the probe as used in this survey is 5.2 feet, with the sensor head located 0.5 feet above the bottom end of the probe, as illustrated in Figure 2.

The probe receives control signals from, and sends the digitized measurement values to a Robertson Micrologger II on the surface via an armored 4 conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data, using a 3.28 foot circumference sheave fitted with a digital rotary encoder. The probe and depth data are transmitted by USB link from the Micrologger unit to a laptop computer where it is displayed and stored on hard disk.

The probe contains a fluxgate magnetometer to monitor magnetic north, and all raw televiewer data is referenced to magnetic north. The processed data is referenced to true north, using a declination of 14.5 degrees east for this site and dates, obtained from the NOAA declination web

site (http://www.ngdc.noaa.gov/seg/geomag/jsp/struts/calcDeclination). Also, a three axis accelerometer is enclosed in the probe, and boring deviation data is recorded during the logging runs, to permit correction of structure dip angle from apparent dip, (referenced to boring axis), to true dip (referenced to a vertical axis) in non-vertical borings. The probe is centered in the boring by two sets of flat spring centralizers.

The data are presented on a computer screen for operator review during the logging run, and stored on hard disk for later processing.

MEASUREMENT PROCEDURES

Suspension Measurement Procedures

All nine borings were logged uncased, filled with bentonite or polymer based drilling mud. Measurements followed the **GEO***Vision* Procedure for P-S Suspension Seismic Velocity Logging, revision 1.31. In each boring, the probe was positioned with the top of the probe at the top of the casing, and the electronic depth counter was set to 8.2 feet, the distance between the mid-point of the receiver and the top of the probe, minus the height of the casing stick-up, as verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, and then returned to the surface, stopping at 1.6 foot intervals to collect data, as summarized in Table 3.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded on disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

Acoustic Televiewer Measurement Procedures

Seven of the nine borings were logged uncased, filled with polymer based drilling mud or clear water. In accordance with the manufacturer's recommended procedures, the probe was inspected and tested prior to entering the boring, including comparison of probe heading with a Brunton compass, and comparison of probe tilt with a Brunton compass inclinometer as well as comparison with vertical while hanging free.

The probe was positioned with the collar of the probe positioned at grade, and the electronic depth counter was set to 4.72 feet, corresponding to the offset between collar and imaging window. The probe was then lowered to the bottom of the boring. Data acquisition was started on the laptop computer and the probe was raised at a rate of approximately 3 feet per minute to the surface, with an acquisition rate of 125 samples/foot, giving an equivalent vertical pixel size of 0.008 feet (approximately 0.1 inches). The rotational scan resolution was set to 360 samples per revolution, giving a horizontal pixel size of 0.033 inches.

Upon completion of the measurements, the probe zero depth indication at grade was verified prior to removal from the boring.

DATA ANALYSIS

Suspension Analysis

Using the proprietary OYO program PSLOG.EXE version 1.0, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 3.3 foot segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into an EXCEL template (EXCEL version 2003 SP2) to complete the velocity calculations based upon the arrival time picks made in PSLOG. The EXCEL analysis files are included in the boring specific directories on the data disk (CD-R) labeled Report 7589-06 that accompanies this report.

The P-wave velocity over the 7.0 foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in EXCEL, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 5.2 feet to correspond to the mid-point of the 7.0 foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, the recorded digital waveforms were analyzed to locate clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital Fast Fourier Transform – Inverse Fast Fourier Transform (FFT – IFFT) lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves

at different depths, ranging from 600 Hz in the slowest zones to 4000 Hz in the regions of highest velocity. At each depth, the filter frequency was selected to be at least twice the fundamental frequency of the S_H-wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 7.0 foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 5.2 foot to correspond to the mid-point of the 7.0 foot S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 0.3 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

These data and analysis were reviewed by John Diehl as a component of **GEO***Vision*'s in-house QA-QC program.

Figure 3 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 3, the time difference over the 3.3 foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H-wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 4 displays the same record before filtering of the S_H-waveform record with a 1400 Hz FFT - IFFT digital lowpass filter,

illustrating the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H-wave by residual P-wave signal.

Acoustic Televiewer Analysis

The acoustic televiewer data were processed using Robertson's RGLDIP software, version 6.2. Sinusoidal projections of open and hairline fractures in the boring walls were interactively picked on the un-wrapped televiewer image, and are presented on the logs as red sinusoids superimposed over the televiewer image. Bedding projections, where identifiable, were picked on the same images, and are presented on the logs as green sinusoids. The sinusoidal projections were processed using the standard boring gauge of 3.86 inches to calculate apparent dip angle. True dip was calculated, correcting for the plunge of the borings using the recorded data from the accelerometers located in the probes, and presented in arrow format, with true dip indicated by the arrow position across the plot. Azimuth of dip (not strike), is indicated by the direction of the arrow tail, with true north being "up". These values are presented with the comments to the right of the arrow plots, as dip azimuth followed by dip angle. In the case of veins or open fractures, the thickness of the feature is presented as well.

The televiewer images were also processed to create a simulated core image of the borings. It must be noted that the simulated core image represents a core that would have the full 3.86 inch diameter of the boring, not the 2.5 inch diameter of the cores removed during drilling, so that direct comparison between the two is not possible. Also, the unwrapped image is viewed from the perspective of an observer in the center of the boring looking outward. The simulated core image is viewed form the "outside" of the boring looking inward, so there is a reversal of the position of east and west relative to north between the two images.

The televiewer data were also processed to extract the deviation data and produce an ASCII file and plots of boring deviation.

In borings with enough features to warrant it, stereonet analysis of the identified features was performed with Robertson's RGLDIP software, version 6.2 to assist in identifying dominant joining in the borings. High concentrations of similarly oriented features were enclosed in three to five small circles on the stereonet image, and the vector mean dip and azimuth for each small circle was calculated.

RESULTS

Suspension Results

Suspension R1-R2 P- and S_H-wave velocities are plotted in Figures 5, 7, 11, 13, 14, 17, 20, 23, and 25. The suspension velocity data presented in these figures are presented in Tables 5, 7, 9, 11, 12, 14, 16, 18 and 20. The PSLOG and EXCEL analysis files for each boring are included in the boring specific directories on the data disk (CD-R) labeled Report 7589-06 that accompanies this report, along with the raw and filtered waveforms.

P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figures A-1 through A-9 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.3 foot segment of the soil column; S-R1 data are an average over 7.0 feet, creating a significant smoothing relative to the R1-R2 plots. S-R1 data are presented in Tables A-1 through A-9, and included in the EXCEL analysis files for each boring on the data disk (CD-R) labeled Report 7589-06 that accompanies this report.

Calibration procedures and records for the suspension PS measurement system are presented in Appendix F.

Acoustic Televiewer Results

Acoustic Televiewer based Caliper logs are presented in Appendix B. Acoustic Televiewer images and dip data are presented in Appendix C. Both are provided in .PDF format on the data disk (CD-R) labeled Report 7589-06 that accompanies this report. Fracture and bedding depth, dip and azimuth of dip data are provided on the multi-page log sheets in Appendix C, in Tables 6, 8, 10, 13, 15, 17, and 19, as well as in ASCII format on the data disk (CD-R) labeled Report 7589-06 that accompanies this report.

Boring deviation data are presented graphically in Figures 6, 9, 10, 12, 16, 19, 22 and 24, and summarized in Table 4. Deviation data plots in Acrobat format and deviation data at 1.0 foot stations are presented in ASCII format in the boring specific sub-directories on the data disk.

Stereonet plots for borings BTNB-R5, BTSB-R3, RW-6-R1 and RW6-R2 are presented in Figures 8, 15, 18 and 21, as well as in PDF format on the data disk. These borings did not exhibit different zones of feature orientation; the feature orientations appeared to be fairly evenly distributed over the boring depths, so all four borings were processed as single zone models.

The mean dip for each of the stereonet small circles is presented on Figures 8, 15, 18 and 21, and in ASCII format on the data disk (CD-R) labeled Report 7589-06 that accompanies this report. Fracture distribution histograms are presented in Appendix D, and Rose diagrams are presented in Appendix E. Both are available in .PDF format on the data disk.

SUMMARY

Discussion of Suspension Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boring, drilled with rotary mud (rotary wash) methods. The borings at this site were well suited for collection of suspension PS velocity data, though there were some regions prone to washouts, and several borings (BTNB-R5A and RW8-R5) were affected by vibration from adjacent traffic.

Suspension PS velocity data quality is judged based upon 5 criteria:

1. Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.
2. Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)
3. Consistency between data from adjacent depth intervals.
4. Clarity of P-wave and S_H-wave onset, as well as damping of later oscillations.
5. Consistency of profile between adjacent borings, if available.

All of these data show excellent correlation between R1 – R2 and S – R1 data, as well as excellent correlation between P-wave and S_H-wave velocities. P-wave and S_H-wave onsets are very clear, and later oscillations are well damped.

Discussion of Acoustic Televiewer Results

The borings in harder material (i.e. sandstone) produced very good quality images, but the boring sections in Melange were typically eroded and did not produce satisfactory images due to the irregular wall surface and low acoustic reflectance of the soft material

The deviation data collected showed the borings held very nearly constant inclination and azimuth for their entire depths, with inclinations near the target of 5 degrees for the borings where oriented coring was performed.

Quality Assurance

These boring geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEO***Vision* quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation;
- Use of standard field data logs;
- Log records were collected going down the boring as well as coming up for QA/QC purposes and compared for consistency of image and depth of structures when possible.
- Use of independent verification of orientation and plunge by comparison of measured values to as built information and reference structures, such as casing shoe or water surface.

Suspension Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.3 foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Depth indications are very reliable with estimated precision of +/- 0.2 feet. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

Acoustic Televiewer Data Reliability

Depth indications are very reliable with estimated precision of +/- 0.2 feet. Estimated precision of boring deviation dip and azimuth is +/- 1 degree. Estimated precision of feature dip and azimuth of feature dip is +/- 5 degrees. Standardized field procedures and quality assurance checks add to the reliability of these data.

BORING DESIGNATION	DATES LOGGED	COORDINATES (FEET) [1]		ELEVATION [1] (FEET)
		NORTHING	EASTING	
BTNB-R4	2/20/08	2120367.0	5994998.3	70.422
BTNB-R5	4/9-10/08	2120581.3	5994178.2	79.635
BTNB-R7	4/2/08	2120459.9	5994825.7	79.353
BTSB-R2	2/29/08	2120218.3	5994858.3	92.121
BTSB-R3	4/22/08	2120226.0	5994556.1	97.900
RW6-R1	2/28/08	2120380.7	5994104.9	108.507
RW6-R2	4/16/08	2120270.1	5993967.8	108.659
RW8-R1	1/16/08	2120199.7	5995008.5	90.616
RW8-R5	1/9/08	2120487.5	5995958.5	42.437

[1] Survey data provided by ARUP

Table 1. Boring locations and logging dates

Winch GEOVision 4-conductor
Sheave - Measuring wheel GEOVision S/N 102
Robertson Suspension PS telemetry unit M/N 3403 S/N 160023, 160024
Robertson Micrologger II S/N 5772
OYO Suspension PS Logger Borehole Probe, includes:
Receiver/Sensor S/N 30086, S/N 12008, S/N 20042
Isolation tube, 1m M/N 3387B S/N 24053, S/N 28072, S/N 28068, S/N 300083
Source M/N 3304 S/N 19043, S/N 21050
Driver M/N 3386A S/N 27073, S/N 490157
Weight M/N 3302W S/N 12007, S/N 470150

Table 2. Suspension PS Logging Equipment

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	OPEN HOLE (FEET)	BORING TOTAL DEPTH (FEET)	SAMPLE INTERVAL (FEET)	DATE LOGGED
BTNB-R4	SUSPENSION PS 01	53.3 - 109.9	-	114.0	1.6	2/20/08
BTNB-R4	SUSPENSION PS 02	0 – 59.1	-		1.6	2/20/08
BTNB-R4	TELEVIEWER 01	123.1 – 52.5	123.1		.008	2/20/08
BTNB-R5	SUSPENSION PS 01	0 – 77.0	-	115.0	1.6	4/9/08
BTNB-R5	TELEVIEWER 01	106.2 – 57.8	106.2		.008	4/9/08
BTNB-R5	SUSPENSION PS 02	6.6 – 21.7	-		1.6	4/9/08
BTNB-R5	TELEVIEWER 02	46.0 – 2.2	46.0		.008	4/9/08
BTNB-R5A	SUSPENSION PS 03	6.6 – 60.7	72.8		1.6	4/10/08
BTNB-R5A	TELEVIEWER 03	65.0 – 1.3	-		.008	4/10/08
BTNB-R7	SUSPENSION PS 01	2.0- 100.0	112.1	113	1.6	4/3/08
BTNB-R7	SUSPENSION PS 02	14.4 – 49.2	-		1.6	4/3/08
BTNB-R7	TELEVIEWER 01	112.0 - 41.0	-		.008	4/3/08
BTNB-R7	TELEVIEWER 02	55.0 – 9.0	-		.008	4/3/08
BTSB-R2	SUSPENSION PS 01	6.9 – 101.7	113.8	115	1.6	3/3/08
BTSB-R3	SUSPENSION PS 01	3.3 – 97.7	109.8	113.0	1.6	4/22/08
BTSB-R3	TELEVIEWER 01	108.4 – 19.1	-		.008	4/22/08
RW6-R1	SUSPENSION PS 01	8.2 -47.6	59.7	64.0	1.6	2/28/08
RW6-R1	TELEVIEWER 01	57.3 – 3.0	-		.008	2/28/08
RW6-R2	SUSPENSION PS 01	31.2 – 101.7	113.8	115.0	1.6	4/16/08
RW6-R2	TELEVIEWER 01	113.0 – 28.5	-		.008	4/16/08
RW6-R2	TELEVIEWER 02	40.0 - 0	-		.008	4/16/08
RW8-R1	SUSPENSION PS 01	82.0 – 131.2	143.3	145.5	1.6	1/16/08
RW8-R1	SUSPENSION PS 01	14.8 – 83.6	-		1.6	1/16/08
RW8-R1	TELEVIEWER 01	140.0 – 78.0	-		.008	1/16/08
RW8-R1	TELEVIEWER 02	86.0 – 81.7	-		.008	1/16/08
RW8-R1	TELEVIEWER 03	87.0 – 13.0	-		.008	1/16/08
RW8-R1	TELEVIEWER 04	87.0 – 13.0	-		.008	1/16/08
RW8-R5	SUSPENSION PS 01	9.8 – 131.9	144.0	147.5	1.6	1/9/08

Table 3. Logging dates and depth ranges

BORING NUMBER	MEAN DEVIATION AND AZIMUTH (DEGREES TN)	SURVEY DEPTH (FEET)	VERTICAL DEPTH (FEET)	HORIZONTAL OFFSET (FEET)
BTNB-R4	0.2 – N67.0	123.1	123.0	0.4
BTNB-R5	5.7 – N80.3	106.2	105.6	10.6
BTNB-R5A	0.2 – N57.9	64.9	64.9	0.2
BTNB-R7	5.0 – N233.8	112.0	111.6	9.7
BTSB-R3	2.9 – N109.8	108.4	108.2	5.5
RW6-R1	0.4 – N47.5	57.2	57.2	0.4
RW6-R2	4.1 – N56.8	113.0	112.7	8.0
RW8-R1	0.4 – N305.1	140.1	140.1	1.0

Table 4. Televiewer Deviation Data Summary

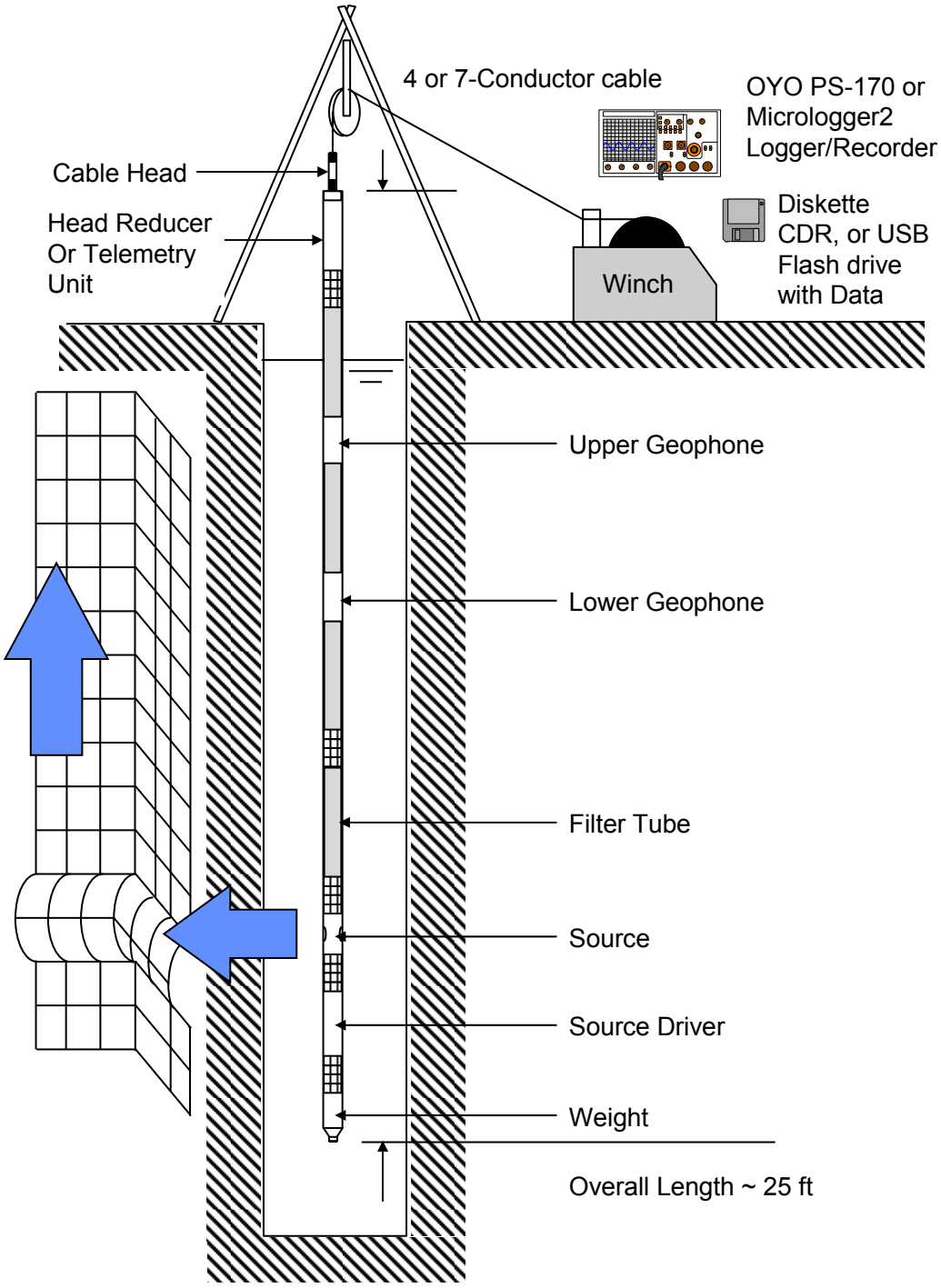


Figure 1: Concept illustration of P-S logging system

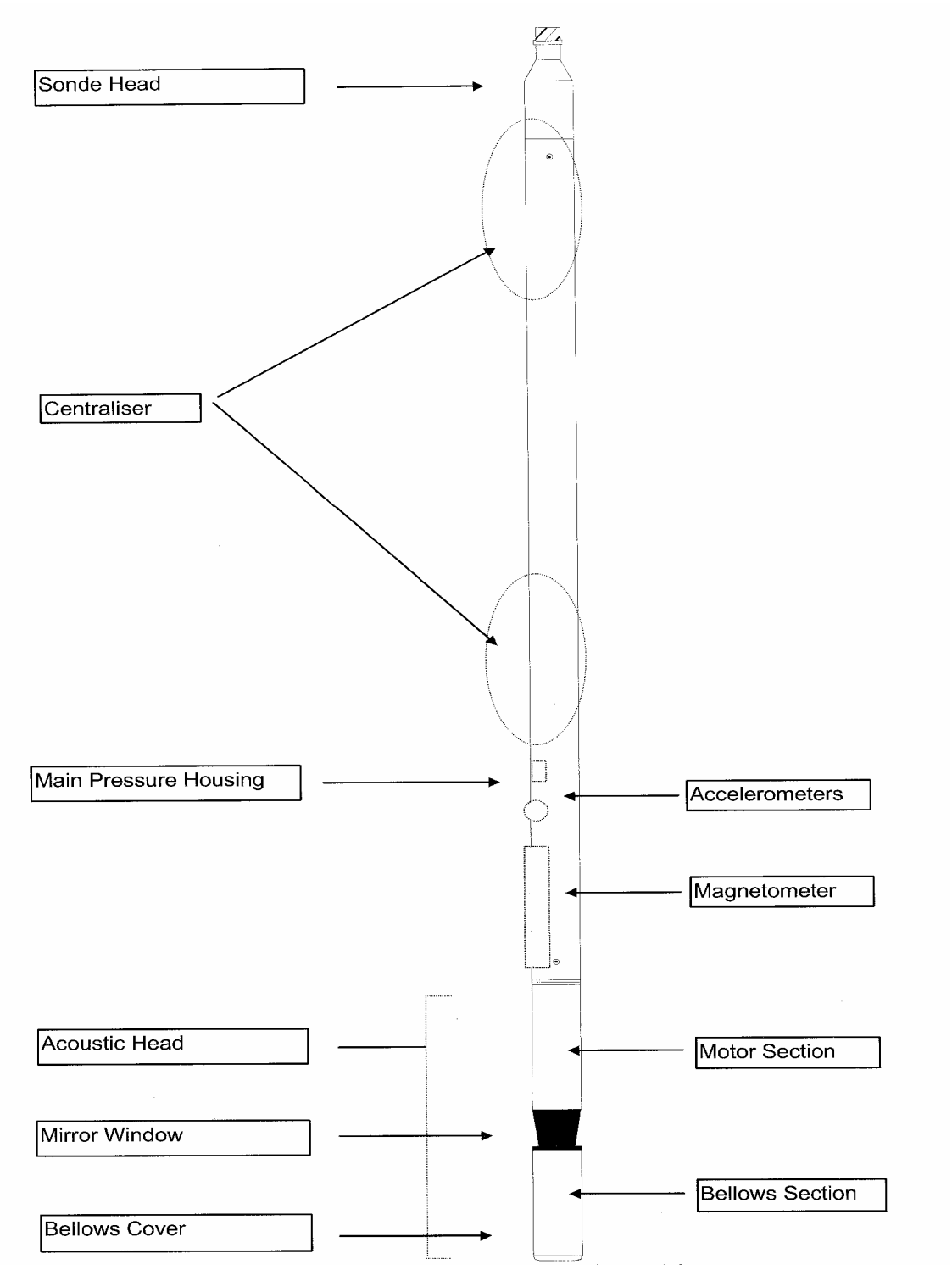


Figure 2: Concept illustration of televiewer probe

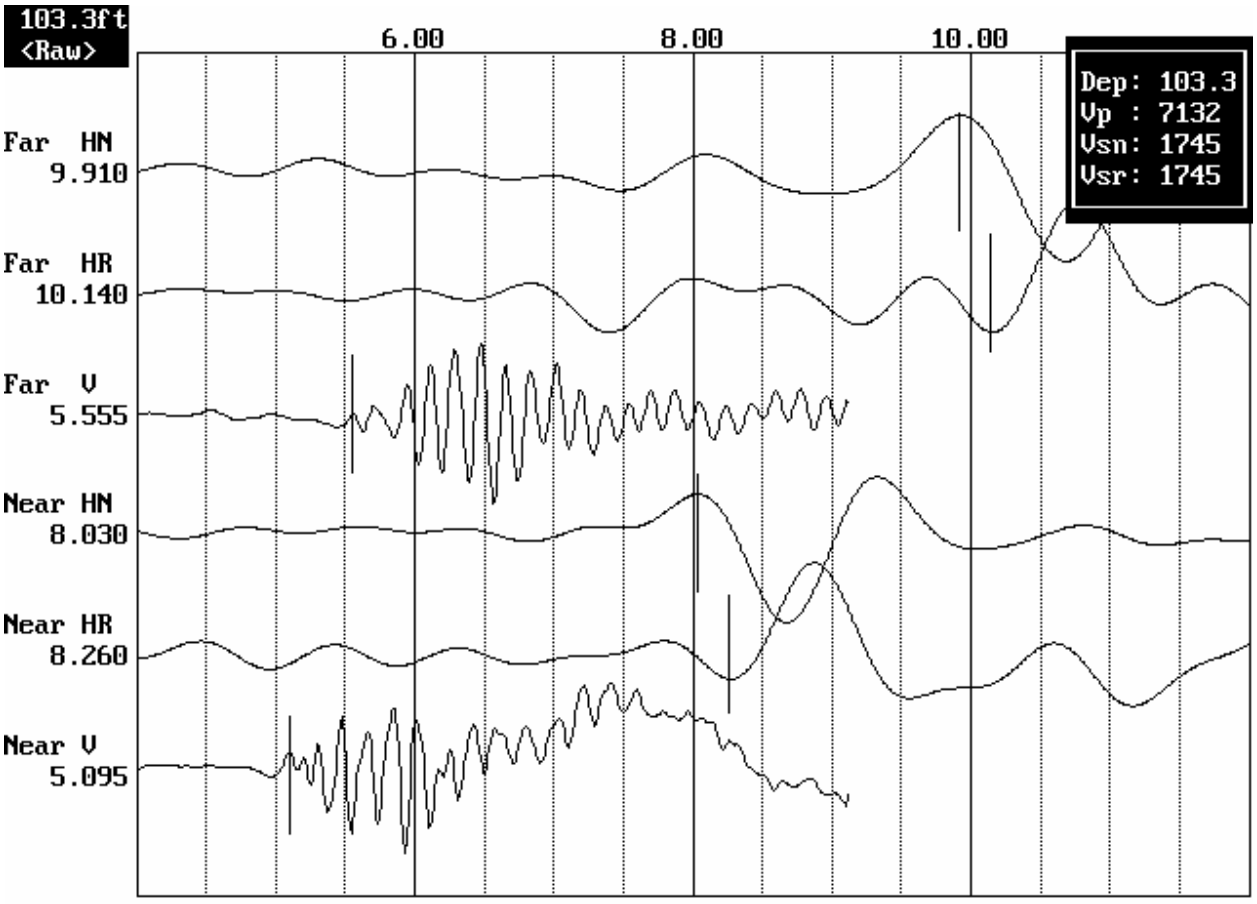


Figure 3: Example of filtered (1400 Hz lowpass) record

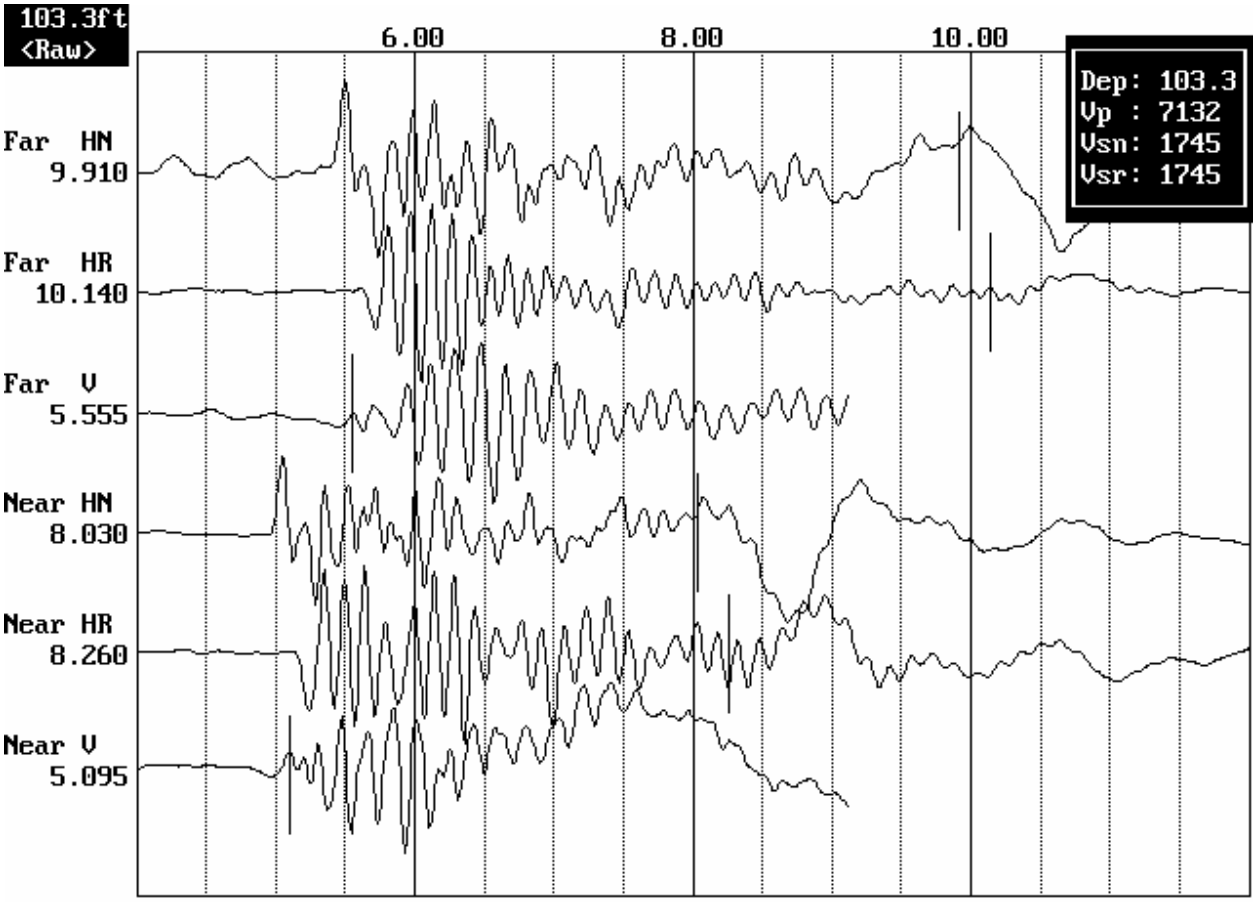


Figure 4. Example of unfiltered record

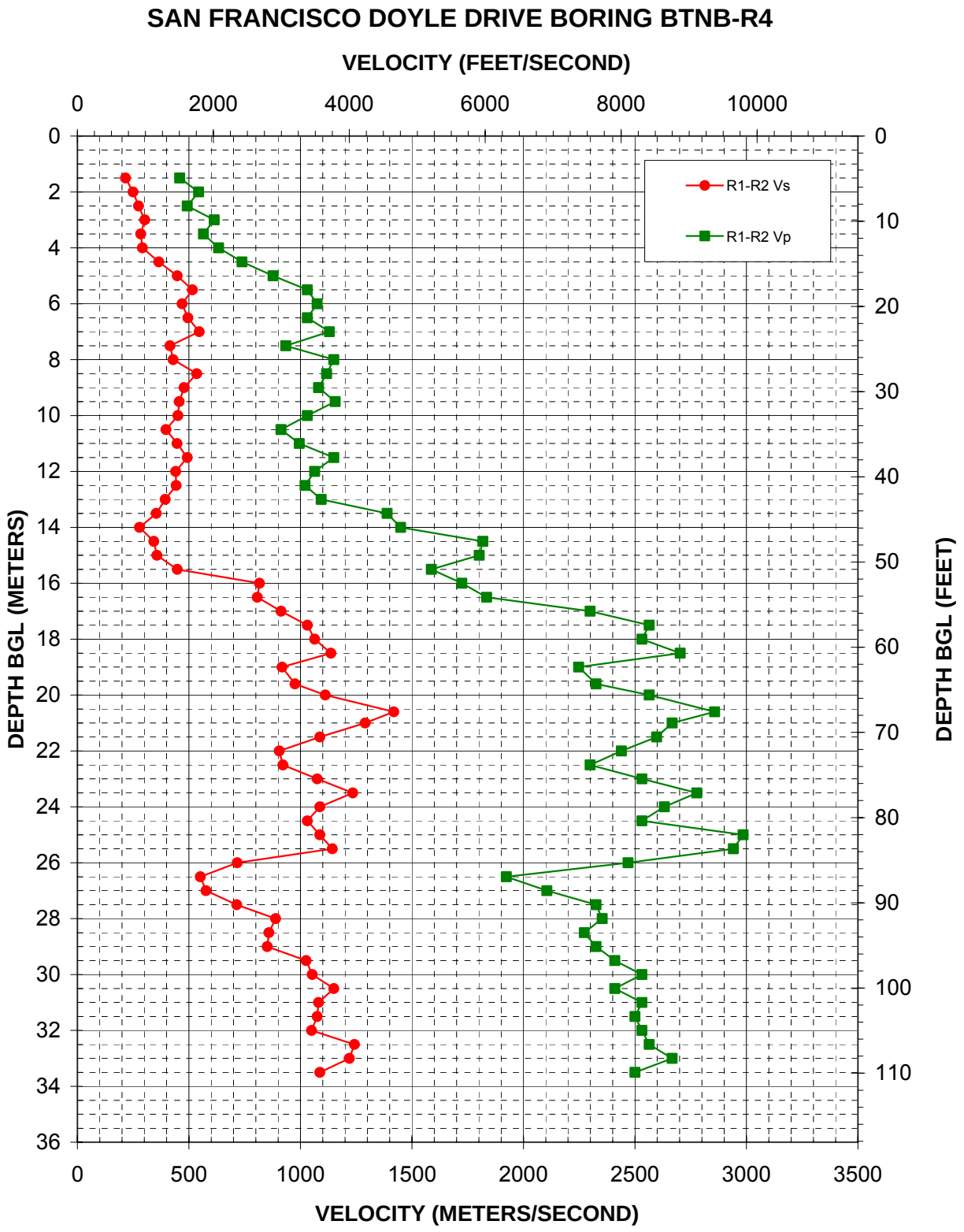


Figure 5: Boring BTNB-R4, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
4.92	707	1505
6.56	818	1783
8.20	899	1616
9.84	991	2013
11.48	932	1854
13.12	957	2076
14.76	1197	2421
16.40	1468	2878
18.04	1691	3382
19.69	1540	3528
21.33	1624	3382
22.97	1793	3707
24.61	1361	3066
26.25	1408	3771
27.89	1754	3666
29.53	1570	3547
31.17	1498	3793
32.81	1478	3382
34.45	1302	2996
36.09	1465	3265
37.73	1616	3771
39.37	1445	3490
41.01	1452	3348
42.65	1292	3586
44.29	1159	4557
45.93	914	4755
47.57	1124	5965
49.21	1170	5911
50.85	1468	5208
52.49	2678	5657
54.13	2646	6020
55.77	2996	7542
57.41	3382	8412
59.06	3490	8306
60.70	3728	8867
62.34	3010	7373
64.30	3201	7630
65.62	3645	8412
67.59	4654	9374
68.90	4233	8749
70.54	3566	8522
72.18	2969	8002
73.82	3024	7542
75.46	3528	8306
77.10	4050	9113
78.74	3566	8634
80.38	3382	8306
82.02	3566	9794
83.66	3750	9650
85.30	2352	8101
86.94	1808	6309
88.58	1891	6907
90.22	2343	7630
91.86	2916	7720
93.50	2816	7456
95.14	2792	7630
96.78	3365	7906
98.43	3454	8306
100.07	3771	7906
101.71	3547	8306
103.35	3528	8202
104.99	3444	8306
106.63	4076	8412
108.27	4001	8749
109.91	3566	8202

Table 5. Boring BTNB-R4, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
67.872	N276	14.9	Primary-structure Planar Bedding
71.232	N104	48.1	Fracture Planar Healed Fracture
84.277	N221	47.9	Primary-structure Planar Bedding
95.804	N257	17.6	Primary-structure Planar Bedding
96.905	N220	13.8	Primary-structure Planar Bedding
116.438	N225	53.7	Fracture Planar Healed Fracture

Table 6. Boring BTNB-R4, Structure depth, dip azimuth, dip and structure description

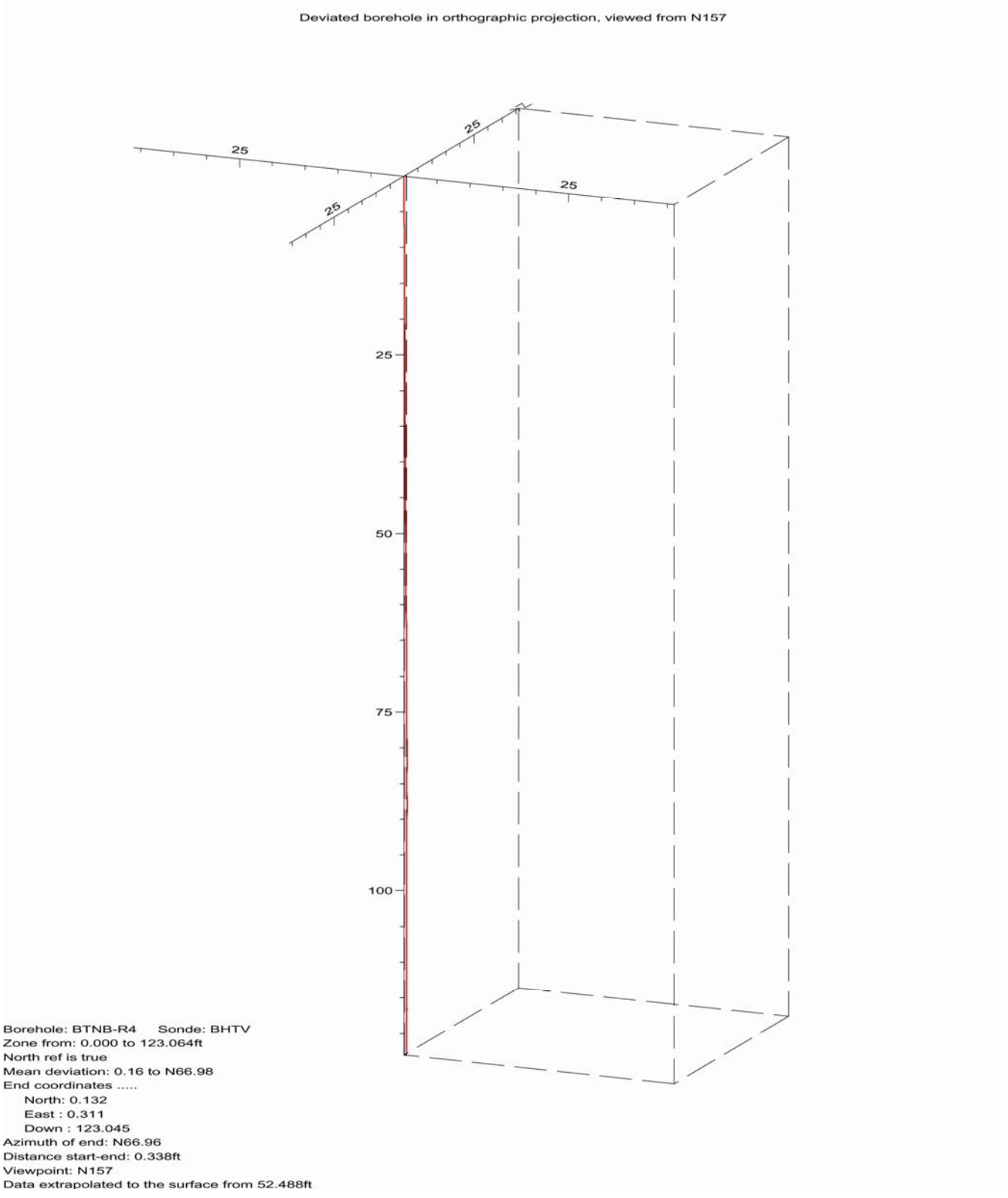


Figure 6. Boring BTNB-R4, Deviation Projection (dimensions in feet)

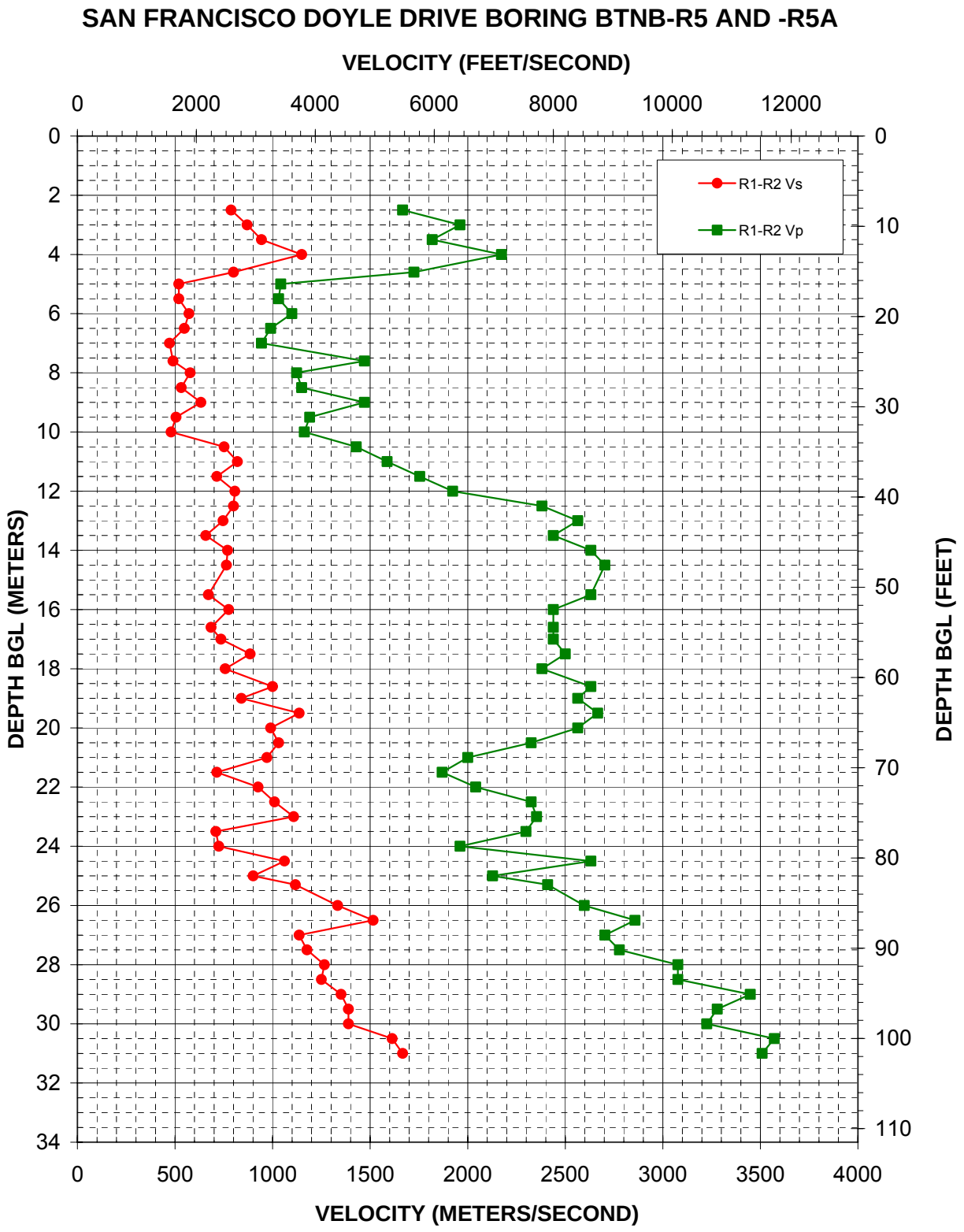


Figure 7: Borings BTNB-R5 and -R5A, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.20	2583	5468
9.84	2853	6433
11.48	3095	5965
13.12	3771	7132
15.09	2625	5657
16.40	1704	3418
18.04	1704	3382
19.69	1875	3605
21.33	1798	3248
22.97	1548	3095
24.93	1608	4825
26.25	1896	3686
27.89	1745	3771
29.53	2076	4825
31.17	1657	3906
32.81	1574	3815
34.45	2467	4687
36.09	2689	5208
37.73	2343	5756
39.37	2646	6309
41.01	2625	7811
42.65	2448	8412
44.29	2158	8002
45.93	2524	8634
47.57	2504	8867
50.85	2202	8634
52.49	2543	8002
54.46	2247	8002
55.77	2412	8002
57.41	2903	8202
59.06	2485	7812
61.02	3281	8634
62.34	2757	8412
63.98	3728	8749
65.62	3248	8412
67.26	3382	7630
68.90	3185	6562
70.54	2343	6132
72.18	3038	6696
73.82	3314	7630
75.46	3635	7720
77.10	2327	7542
78.74	2377	6433
80.38	3481	8634
82.02	2956	6981
83.01	3666	7906
85.30	4374	8522
86.94	4971	9374
88.58	3728	8867
90.22	3860	9113

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
91.86	4153	10095
93.50	4101	10095
95.14	4434	11313
96.78	4557	10757
98.43	4557	10583
100.07	5292	11717
101.71	5468	11512

Table 7. Borings BTNB-R5 AND -R5A, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
2.507	N252	73	Fracture Planar Open-fracture
3.351	N116	40.5	Fracture Planar Healed fracture
4.083	N007	22.6	Fracture Planar Open-fracture
4.989	N074	33.8	Fracture Planar Healed fracture
5.336	N281	53.2	Fracture Planar Hairline-fracture
5.368	N165	58.5	Fracture Planar Healed fracture
6.148	N061	46.7	Fracture Planar Open-fracture
6.607	N131	41	Fracture Planar Healed fracture
6.994	N297	80.8	Fracture Planar Hairline-fracture
8.669	N064	68.5	Fracture Planar Healed fracture
8.737	N308	65	Fracture Planar Healed fracture
9.189	N153	54.6	Fracture Planar Healed fracture
9.572	N144	50.7	Fracture Planar Hairline-fracture
9.741	N139	48.6	Fracture Planar Hairline-fracture
10.209	N156	61.2	Fracture Planar Hairline-fracture
11.332	N051	38.2	Fracture Planar Open-fracture
12.357	N086	47.1	Fracture Planar Open-fracture
12.616	N227	45.1	Fracture Planar Hairline-fracture
12.776	N137	41.7	Fracture Planar Hairline-fracture
13.231	N347	34.2	Fracture Planar Healed fracture
13.377	N158	41.7	Fracture Planar Healed fracture
13.925	N197	49.2	Fracture Planar Healed fracture
14.363	N185	23.2	Fracture Planar Healed fracture
14.572	N292	52.1	Fracture Planar Hairline-fracture
14.723	N154	52.7	Fracture Planar Hairline-fracture
14.993	N171	50.1	Fracture Planar Hairline-fracture
15.131	N210	80.2	Fracture Planar Hairline-fracture
15.674	N141	43.8	Fracture Planar Hairline-fracture
16.047	N142	75.3	Fracture Planar Hairline-fracture
17.141	N079	70.1	Fracture Planar Open-fracture
24.462	N153	45.8	Fracture Planar Open-fracture
24.636	N158	48.2	Fracture Planar Open-fracture
25.533	N150	60.3	Fracture Planar Open-fracture
28.278	N152	25.5	Fracture Planar Hairline-fracture
33.948	N103	84.1	Fracture Planar Open-fracture
36.472	N127	84.1	Fracture Planar Open-fracture
72.171	N277	61.9	Primary-structure Planar Bedding
73.589	N173	74.2	Fracture Planar Hairline-fracture
83.311	N342	73	Fracture Planar Hairline-fracture
84.563	N155	51.8	Fracture Planar Hairline-fracture
87.065	N297	35.9	Primary-structure Planar Bedding
89.151	N259	28.6	Fracture Planar Hairline-fracture
89.288	N199	30.7	Fracture Planar Hairline-fracture
89.442	N249	43.6	Fracture Planar Hairline-fracture
90.191	N240	52.2	Fracture Planar Hairline-fracture
90.553	N274	20.1	Fracture Planar Hairline-fracture
90.907	N230	69.2	Fracture Planar Hairline-fracture
92.185	N295	56.2	Fracture Planar Hairline-fracture
94.366	N133	64.4	Fracture Planar Hairline-fracture
95.941	N138	50.8	Fracture Planar Hairline-fracture

Table 8. Borings BTNB-R5 and -R5A, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
96.004	N088	67.8	Fracture Planar Hairline-fracture
96.226	N142	81.6	Fracture Planar Hairline-fracture
98.271	N315	61.9	Fracture Planar Hairline-fracture
98.943	N247	51.1	Fracture Planar Hairline-fracture
99.181	N141	63.9	Fracture Planar Hairline-fracture
99.742	N079	70.2	Fracture Planar Healed fracture
100.221	N268	59.4	Fracture Planar Healed fracture
100.263	N046	57.4	Fracture Planar Hairline-fracture
100.849	N031	57.3	Fracture Planar Healed fracture
100.914	N145	54.6	Fracture Planar Healed fracture
102.12	N356	73.9	Fracture Planar Healed fracture
102.823	N197	54.7	Fracture Planar Hairline-fracture
103.17	N207	30.8	Fracture Planar Hairline-fracture
103.818	N303	41.4	Fracture Planar Hairline-fracture
105.199	N225	33.9	Fracture Planar Hairline-fracture

Table 8, continued. Borings BTNB-R5 and -R5A, Structure depth, dip azimuth, dip and structure description

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

16 Jun 2008

ARUP

Borehole: BTNB-R5

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 105.699 to 2.007ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

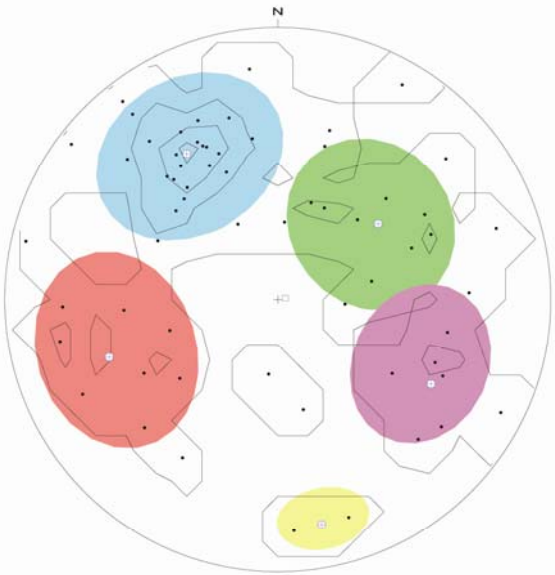
BTNB-R5
Zone 0. 2.007 - 105.689ft
Deviation 2.30 N 79.60

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Fresh Open-fracture

	mean dip	n	f
N148 53	N148 53	20	0.32
N071 55	N071 55	9	(0.16)
N233 38	N233 38	8	(0.09)
N299 54	N299 54	6	(0.09)
N349 73	N349 73	2	(0.07)

intersections

	N148 53	N071 55	N233 38	N299 54	N349 73
N148 53		47 N112	35 N206	19 N223	19 N073
N071 55	47 N112		09 N155	30 N005	54 N054
N233 38	35 N206	09 N155		38 N243	32 N270
N299 54	19 N223	30 N005	38 N243		53 N283
N349 73	19 N073	54 N054	32 N270	53 N283	



equal-area lower-hemisphere 0-90
contour-levels 1,3,6,10,

BTNB-R5, Interpretation 1 105.689 to 2.007fl 1

Figure 8. Borings BTNB-R5 and -R5A, Stereonet Diagram

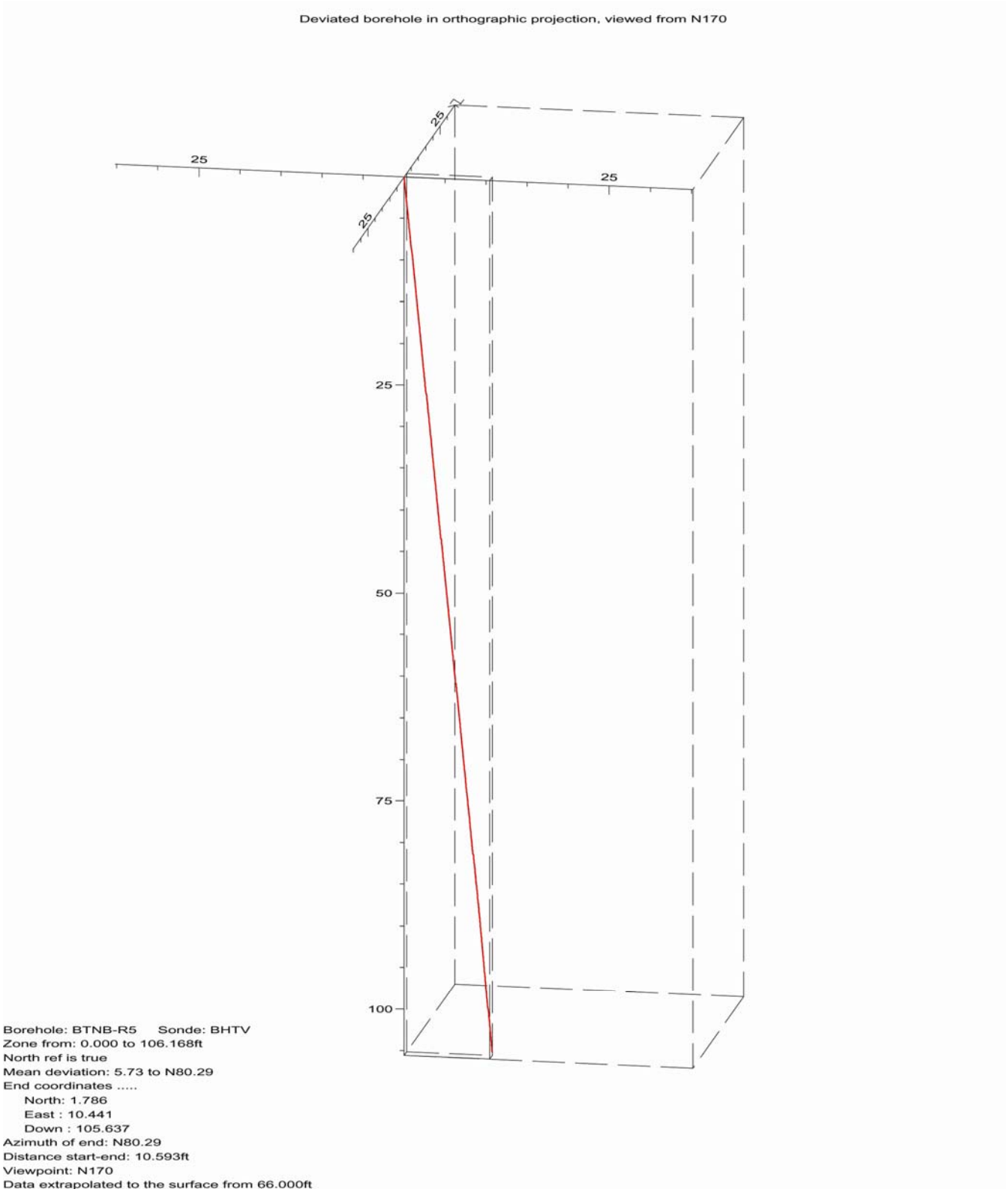


Figure 9. Boring BTNB-R5, Deviation Projection (dimensions in feet)

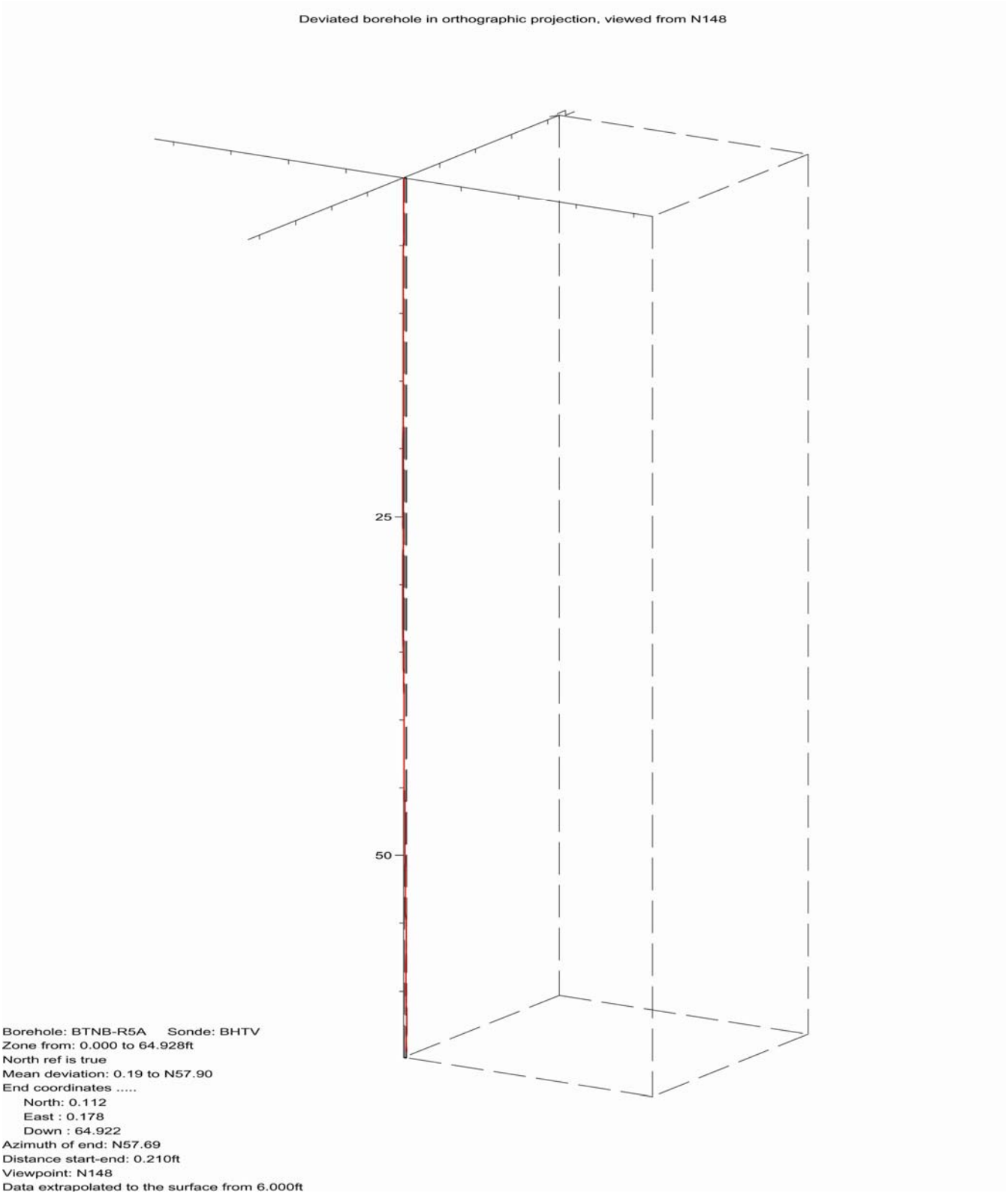


Figure 10. Boring BTNB-R5A, Deviation Projection (dimensions in feet)

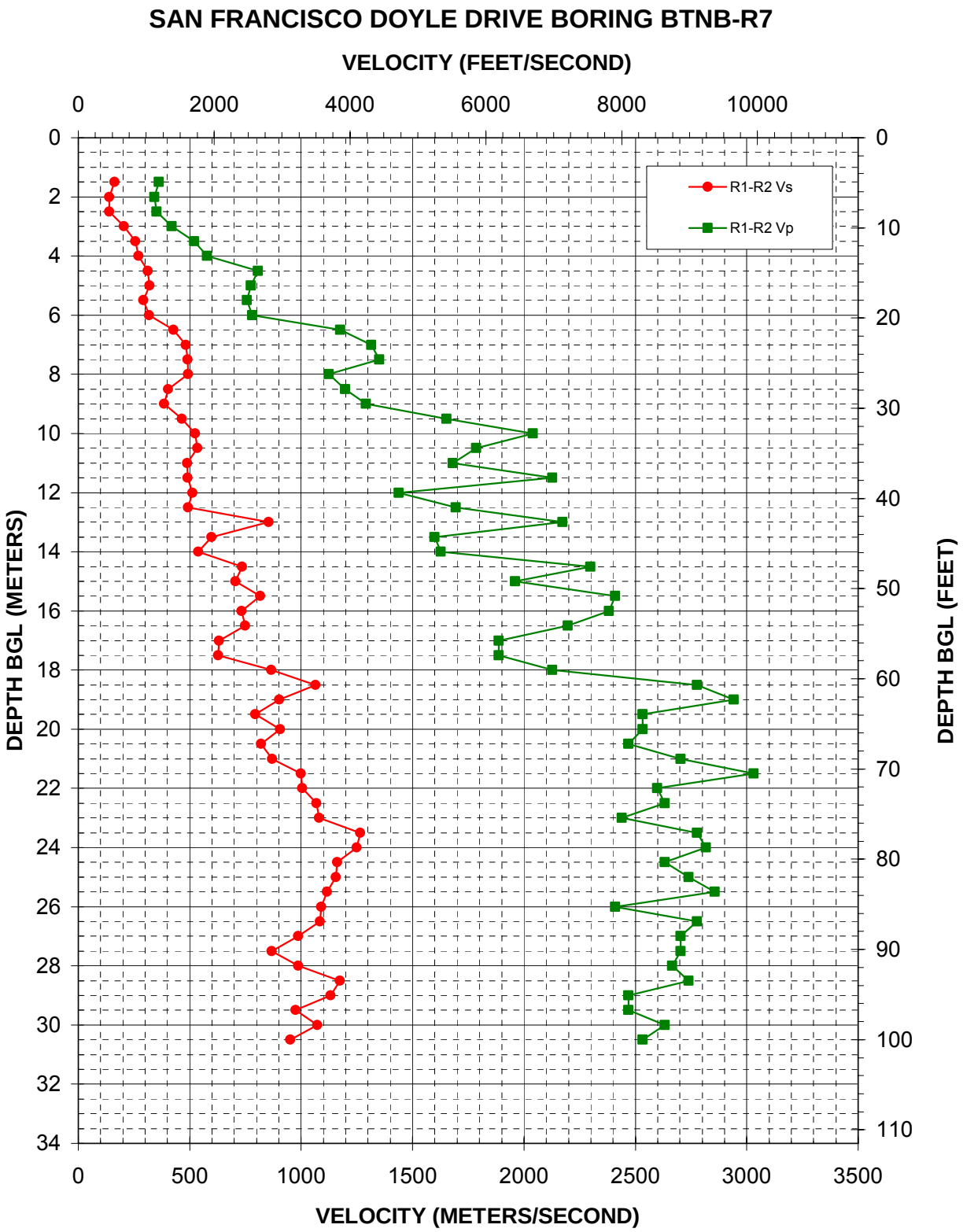


Figure 11: Boring BTNB-R7, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
4.92	533	1189
6.56	454	1124
8.20	459	1155
9.84	670	1373
11.48	843	1709
13.12	887	1896
14.76	1022	2646
16.40	1052	2543
18.04	959	2485
19.69	1045	2563
21.33	1402	3860
22.97	1585	4317
24.61	1608	4434
26.25	1616	3686
27.89	1326	3929
29.53	1262	4233
31.17	1526	5423
32.81	1718	6696
34.45	1754	5859
36.09	1604	5514
37.73	1612	6981
39.37	1678	4721
41.01	1616	5561
42.65	2804	7132
44.29	1959	5249
45.93	1769	5335
47.57	2412	7542
49.21	2310	6433
50.85	2678	7906
52.49	2404	7812
54.13	2458	7211
55.77	2070	6190
57.41	2057	6190
59.06	2841	6981
60.70	3490	9113
62.34	2956	9650
63.98	2604	8306
65.62	2969	8306
67.26	2689	8101
68.90	2853	8867
70.54	3281	9942
72.18	3297	8522
73.82	3509	8634
75.46	3547	8002
77.10	4153	9113
78.74	4101	9242
80.38	3815	8634
82.02	3793	8989
83.66	3666	9374
85.30	3576	7906
86.94	3556	9113
88.58	3240	8867
90.22	2847	8867
91.86	3240	8749
93.50	3848	8989
95.14	3718	8101
96.78	3201	8101
98.43	3518	8634
100.07	3125	8306

Table 9. Boring BTNB-R7, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
43.102	N189	45.3	Primary-structure Planar Bedding
47.934	N282	16.4	Primary-structure Planar Bedding
53.669	N245	11.7	Primary-structure Planar Bedding
59.416	N202	27.7	Primary-structure Planar Bedding
61.542	N230	59.2	Fracture Planar Healed fracture
63.499	N232	19.1	Primary-structure Planar Bedding
64.611	N184	61.5	Primary-structure Planar Bedding
66.93	N037	53.4	Primary-structure Planar Bedding
68.801	N338	49.3	Fracture Planar Hairline-fracture
69.894	N111	31.2	Fracture Planar Hairline-fracture
70.325	N173	62	Fracture Planar Hairline-fracture
73.209	N020	33.3	Primary-structure Planar Bedding
79.975	N065	14	Primary-structure Planar Bedding
103.354	N025	29.5	Primary-structure Planar Bedding
108.31	N231	40	Primary-structure Planar Bedding

Table 10. Boring BTNB-R7, Structure depth, dip azimuth, dip and structure description

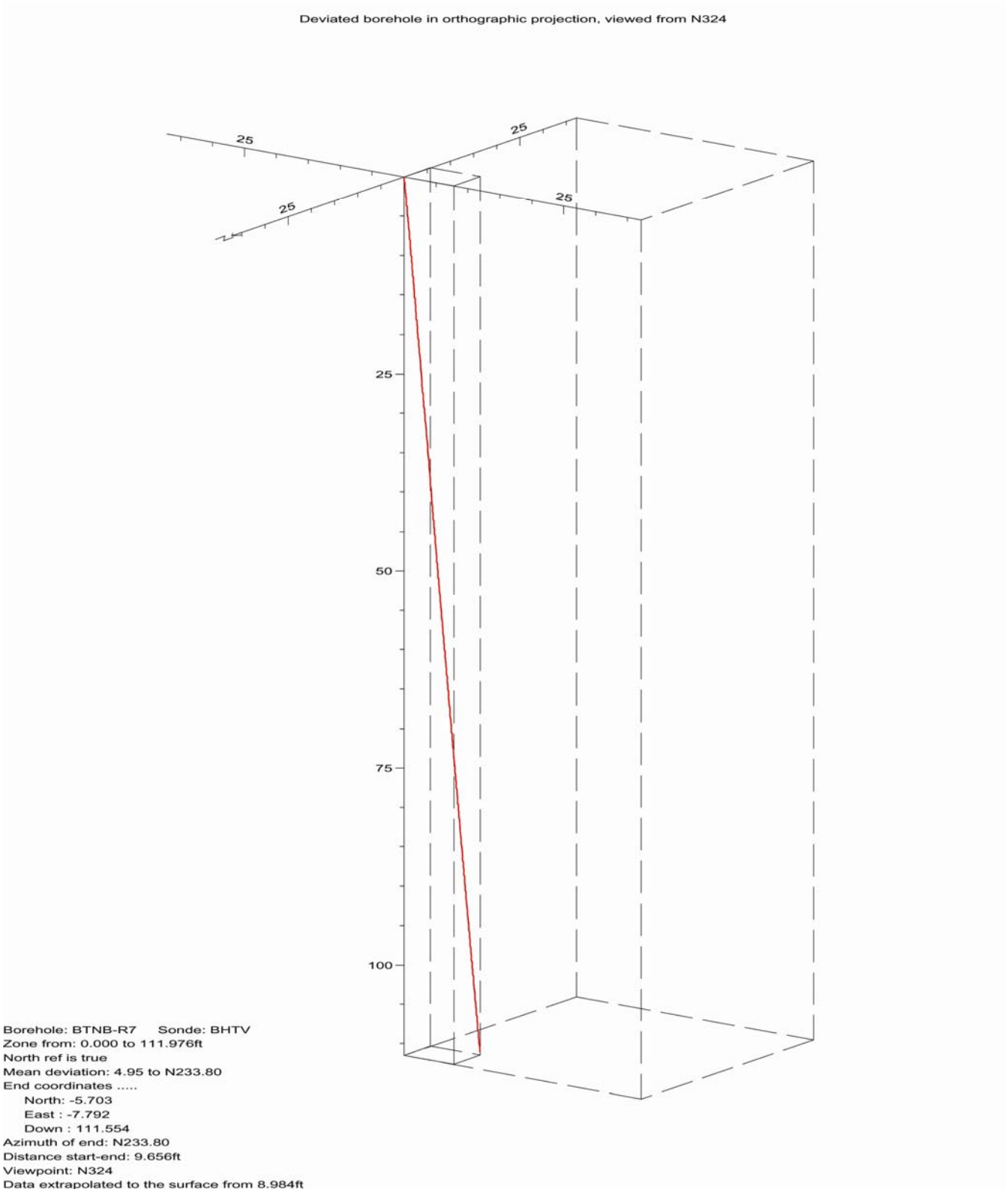


Figure 12. Boring BTNB-R7, Deviation Projection (dimensions in feet)

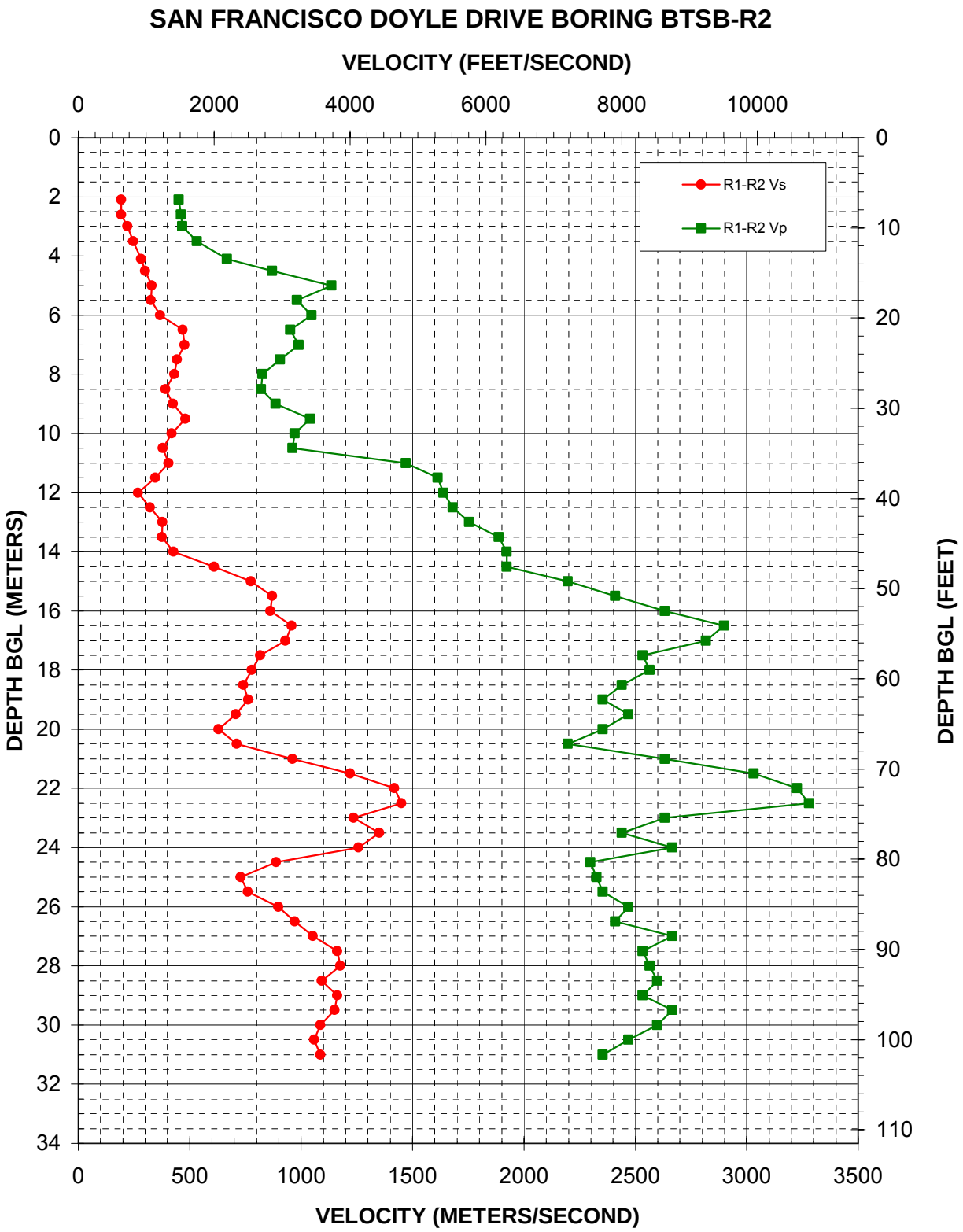


Figure 13: Boring BTSB-R2, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
6.89	634	1478
8.53	634	1512
9.84	721	1533
11.48	805	1745
13.45	924	2187
14.76	987	2853
16.40	1085	3728
18.04	1067	3217
19.69	1206	3435
21.33	1540	3125
22.97	1562	3248
24.61	1452	2969
26.25	1414	2711
27.89	1282	2689
29.53	1396	2903
31.17	1577	3418
32.81	1373	3185
34.45	1243	3155
36.09	1328	4825
37.73	1131	5292
39.37	882	5378
41.01	1055	5514
42.65	1238	5756
44.29	1233	6190
45.93	1402	6309
47.57	2001	6309
49.21	2543	7211
50.85	2853	7906
52.49	2828	8634
54.13	3140	9510
55.77	3052	9242
57.41	2678	8306
59.06	2553	8412
60.70	2430	8002
62.34	2504	7720
63.98	2319	8101
65.62	2063	7720
67.26	2335	7211
68.90	3155	8634
70.54	4001	9942
72.18	4654	10583
73.82	4755	10757
75.46	4050	8634
77.10	4434	8002
78.74	4127	8749
80.38	2916	7542
82.02	2395	7630
83.66	2495	7720
85.30	2942	8101
86.94	3185	7906
88.58	3454	8749
90.22	3815	8306
91.86	3860	8412
93.50	3586	8522
95.14	3815	8306
96.78	3771	8749
98.43	3566	8522
100.07	3472	8101
101.71	3566	7720

Table 11. Boring BTSB-R2, Suspension R1-R2 depths and P- and S_H-wave velocities

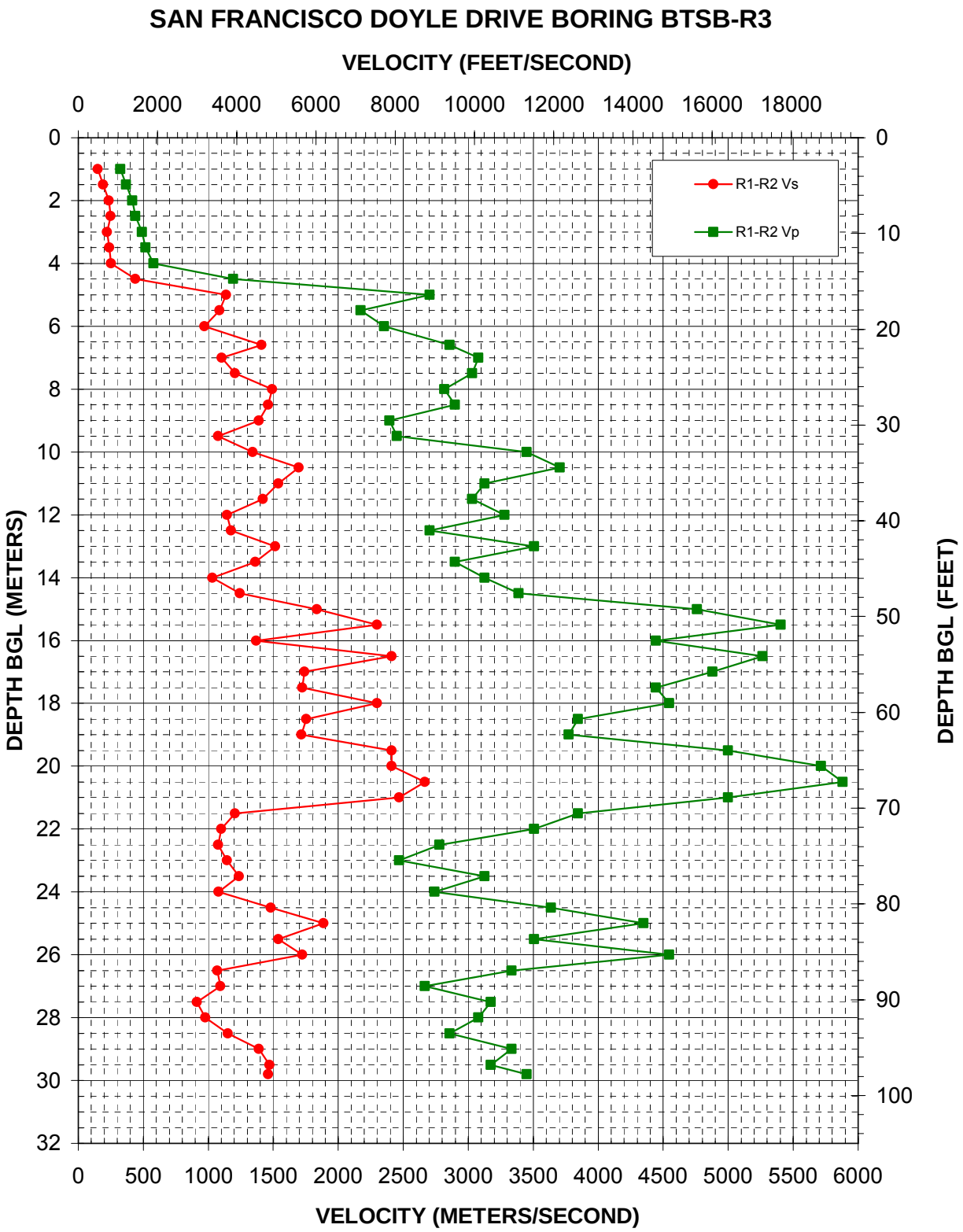


Figure 14: Boring BTSB-R3, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
3.28	492	1058
4.92	628	1206
6.56	767	1367
8.20	820	1439
9.84	729	1608
11.48	787	1700
13.12	822	1896
14.76	1445	3906
16.40	3728	8867
18.04	3566	7132
19.69	3185	7720
21.65	4621	9374
22.97	3625	10095
24.61	3953	9942
26.25	4897	9242
27.89	4790	9510
29.53	4557	7849
31.17	3528	8041
32.81	4404	11313
34.45	5561	12151
36.09	5047	10253
37.73	4654	9942
39.37	3750	10757
41.01	3860	8867
42.65	4971	11512
44.29	4464	9510
45.93	3382	10253
47.57	4076	11121
49.21	6020	15623
50.85	7542	17734
52.49	4494	14582
54.13	7906	17268
55.77	5706	16004
57.41	5657	14581
59.06	7542	14913
60.70	5756	12619
62.34	5632	12381
63.98	7906	16404
65.62	7906	18748
67.26	8749	19299
68.90	8101	16404
70.54	3953	12619
72.18	3605	11512
73.82	3528	9113
75.46	3750	8101
77.10	4050	10253
78.74	3547	8989
80.38	4861	11930
82.02	6190	14265
83.66	5047	11512
85.30	5657	14913
86.94	3509	10936
88.58	3586	8749
90.22	2996	10415
91.86	3201	10095
93.50	3771	9374
95.14	4557	10936
96.78	4825	10415
97.77	4790	11313

Table 12. Boring BTSB-R3, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
25.4	N094	29	Fracture Planar Healed fracture
25.871	N129	38	Fracture Planar Healed fracture
26.473	N046	44.7	Fracture Planar Healed fracture
26.848	N020	41.9	Fracture Planar Hairline-fracture
27.491	N107	46.2	Fracture Planar Healed fracture
27.927	N183	53.7	Fracture Planar Healed fracture
28.016	N333	37.4	Fracture Planar Healed fracture
28.101	N350	25.6	Fracture Planar Healed fracture
28.566	N342	35.8	Fracture Planar Healed fracture
28.579	N091	62.9	Fracture Planar Healed fracture
29.432	N096	34.3	Fracture Planar Healed fracture
29.858	N093	10.2	Fracture Planar Healed fracture
30.323	N311	41.7	Fracture Planar Healed fracture
30.727	N108	73.1	Fracture Planar Healed fracture
31.149	N303	37.6	Fracture Planar Healed fracture
31.338	N082	61.7	Fracture Planar Healed fracture
31.797	N111	59.4	Fracture Planar Healed fracture
31.9	N204	38.4	Fracture Planar Healed fracture
32.526	N103	39.9	Fracture Planar Hairline-fracture
33.024	N101	40	Fracture Planar Healed fracture
33.458	N097	62.1	Fracture Planar Hairline-fracture
33.666	N348	84.3	Fracture Planar Healed fracture
34.659	N200	35.4	Fracture Planar Healed fracture
34.844	N201	39.7	Fracture Planar Healed fracture
35.368	N314	85.8	Fracture Planar Healed fracture
35.852	N040	23	Fracture Planar Healed fracture
36.131	N120	70.5	Fracture Planar Healed fracture
36.225	N072	35.1	Fracture Planar Healed fracture
36.697	N198	36.1	Fracture Planar Healed fracture
37.188	N319	26.8	Fracture Planar Hairline-fracture
37.981	N037	69.2	Fracture Planar Hairline-fracture
38.46	N058	43.9	Fracture Planar Hairline-fracture
38.92	N279	84.1	Fracture Planar Hairline-fracture
39.135	N181	83.2	Fracture Planar Healed fracture
39.421	N316	31.5	Fracture Planar Healed fracture
40.013	N337	31.9	Fracture Planar Hairline-fracture
40.116	N346	50.2	Fracture Planar Hairline-fracture
41.637	N135	36.7	Fracture Planar Hairline-fracture
42.511	N013	63.2	Fracture Planar Hairline-fracture
43.127	N212	42.5	Fracture Planar Hairline-fracture
44.652	N043	32.4	Fracture Planar Healed fracture
45.724	N327	72.7	Fracture Planar Open-fracture
46.037	N355	68.8	Fracture Planar Open-fracture
46.769	N050	62.4	Fracture Planar Hairline-fracture
47.213	N107	67.5	Fracture Planar Healed fracture
47.262	N200	31.8	Fracture Planar Healed fracture
47.558	N068	55	Fracture Planar Healed fracture
47.959	N222	38.1	Fracture Planar Healed fracture
48.452	N212	42.8	Fracture Planar Healed fracture
48.566	N214	46.3	Fracture Planar Healed fracture

Table 13. Boring BTSB-R3, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
48.614	N298	84	Fracture Planar Healed fracture
49.091	N122	58.2	Fracture Planar Healed fracture
50.669	N075	51.2	Fracture Planar Healed fracture
50.88	N101	41.3	Fracture Planar Healed fracture
50.904	N120	50.7	Fracture Planar Healed fracture
50.924	N017	63	Fracture Planar Healed fracture
51.312	N048	29.7	Fracture Planar Healed fracture
52.769	N318	63	Fracture Planar Healed fracture
53.311	N214	45.5	Fracture Planar Healed fracture
54.611	N112	60.4	Fracture Planar Healed fracture
54.72	N091	40.8	Fracture Planar Healed fracture
54.782	N001	57	Fracture Planar Hairline-fracture
54.837	N112	19.4	Fracture Planar Healed fracture
57.941	N102	41.4	Fracture Planar Healed fracture
58.071	N167	49.4	Fracture Planar Healed fracture
58.482	N359	74.2	Fracture Planar Healed fracture
59.106	N241	66.8	Fracture Planar Healed fracture
59.127	N007	44.1	Fracture Planar Open-fracture
59.344	N011	31.6	Fracture Planar Healed fracture
60.013	N078	57.4	Fracture Planar Healed fracture
60.112	N002	66.5	Fracture Planar Healed fracture
61.07	N329	63.1	Fracture Planar Hairline-fracture
61.298	N297	49.9	Fracture Planar Hairline-fracture
69.273	N068	58.4	Fracture Planar Healed fracture
71.186	N148	67.8	Primary-structure Planar Bedding
77.194	N139	39.7	Primary-structure Planar Bedding
79.304	N300	65.3	Fracture Planar Healed fracture
80.637	N134	59.6	Fracture Planar Healed fracture
82.933	N137	47.1	Fracture Planar Healed fracture
83.159	N066	30.8	Fracture Planar Healed fracture
83.626	N057	48.9	Fracture Planar Healed fracture
84.288	N012	52.6	Fracture Planar Healed fracture
84.451	N079	36.4	Fracture Planar Healed fracture
84.916	N335	21	Fracture Planar Healed fracture
85.233	N039	37.3	Fracture Planar Healed fracture
85.614	N329	61.2	Fracture Planar Healed fracture
85.818	N228	30.6	Primary-structure Planar Bedding
91.524	N147	44.9	Primary-structure Planar Bedding
93.472	N163	72.9	Fracture Planar Open-fracture
95.353	N162	75.9	Fracture Planar Healed fracture
95.81	N079	44.7	Fracture Planar Healed fracture
96.794	N152	63.5	Fracture Planar Hairline-fracture
97.242	N144	58.1	Fracture Planar Healed fracture
97.948	N106	65.9	Fracture Planar Healed fracture
98.789	N060	71.9	Fracture Planar Open-fracture
98.935	N061	72.1	Fracture Planar Open-fracture
99.593	N284	27.8	Fracture Planar Healed fracture
100.823	N095	79.9	Fracture Planar Healed fracture
100.928	N040	39.5	Fracture Planar Healed fracture
101.842	N274	63.1	Fracture Planar Hairline-fracture

Table 13, continued. Boring BTSB-R3, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
103.744	N319	60.4	Fracture Planar Hairline-fracture
104.761	N063	44.6	Fracture Planar Hairline-fracture
104.928	N293	83.3	Fracture Planar Open-fracture
105.945	N185	58.6	Fracture Planar Hairline-fracture
106.607	N194	30.4	Fracture Planar Healed fracture
106.814	N357	67	Fracture Planar Healed fracture

Table 13, continued. Boring BTSB-R3, Structure depth, dip azimuth, dip and structure description

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

14 Jun 2008

ARUP

Borehole: BTSB-R3

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 107.314 to 24.900ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

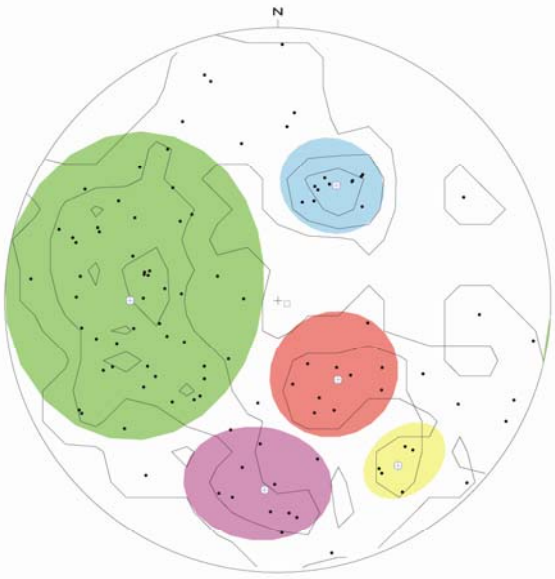
BTSB-R3
Zone 0. 24.900 - 107.304ft
Deviation 2.90 N109.30

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Fresh Open-fracture

	mean dip	n	f
N207 39	N207 39	11	0.17
N323 30	N323 30	10	0.14
N090 45	N090 45	47	0.85
N004 59	N004 59	11	0.25
N324 64	N324 64	5	(0.13)

intersections

	N207 39	N323 30	N090 45	N004 59	N324 64
N207 39		20 N271	25 N152	12 N281	30 N251
N323 30	20 N271		18 N019	26 N291	01 N234
N090 45	25 N152	18 N019		41 N062	31 N037
N004 59	12 N281	26 N291	41 N062		59 N360
N324 64	30 N251	01 N234	31 N037	59 N360	



equal-area lower-hemisphere 0-90
contour-levels 1,3,6,

BTSB-R3, Interpretation 1 107.304 to 24.900ft 1

Figure 15. Boring BTSB-R3, Stereonet Diagram

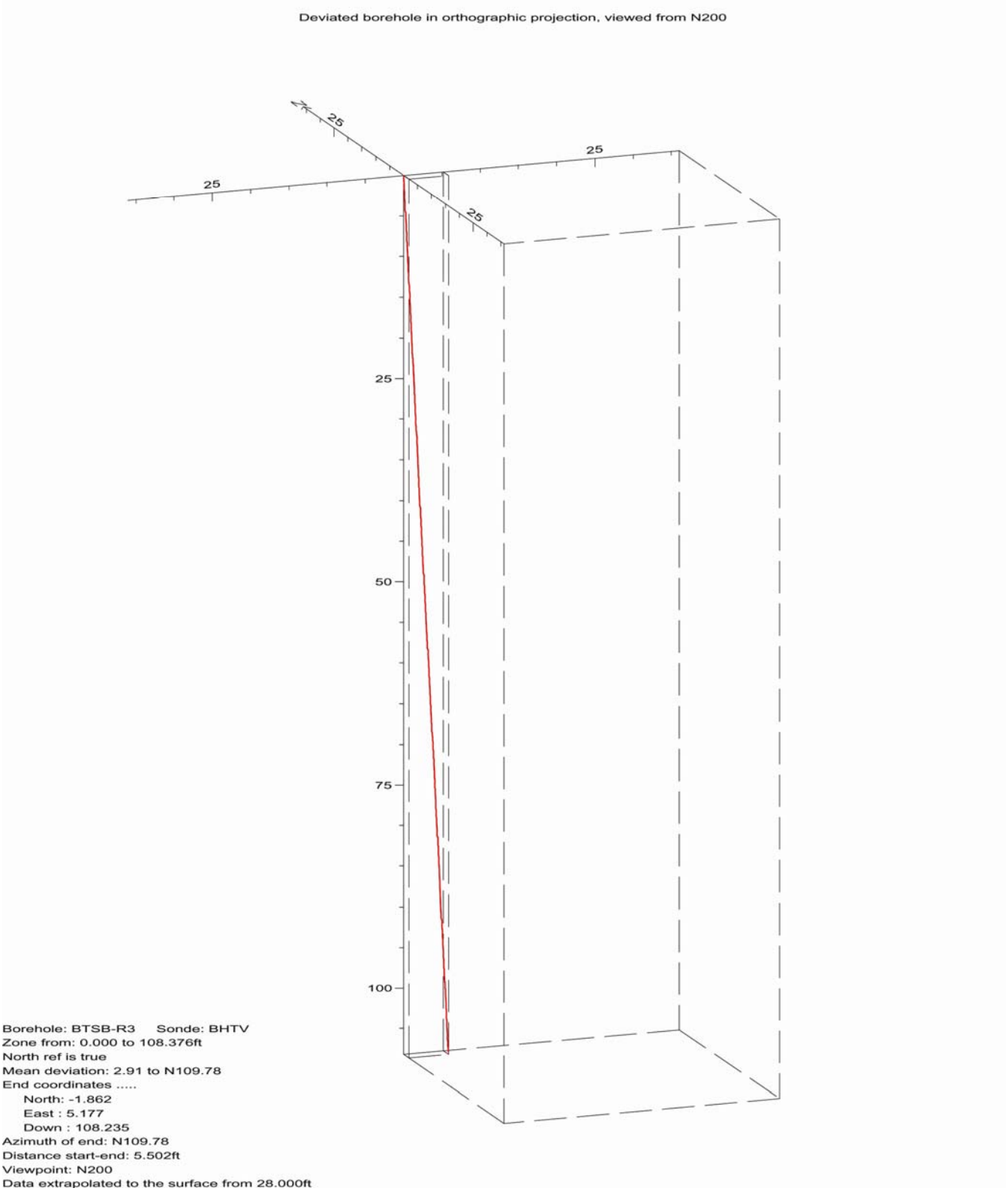


Figure 16. Boring BTSB-R3, Deviation Projection (dimensions in feet)

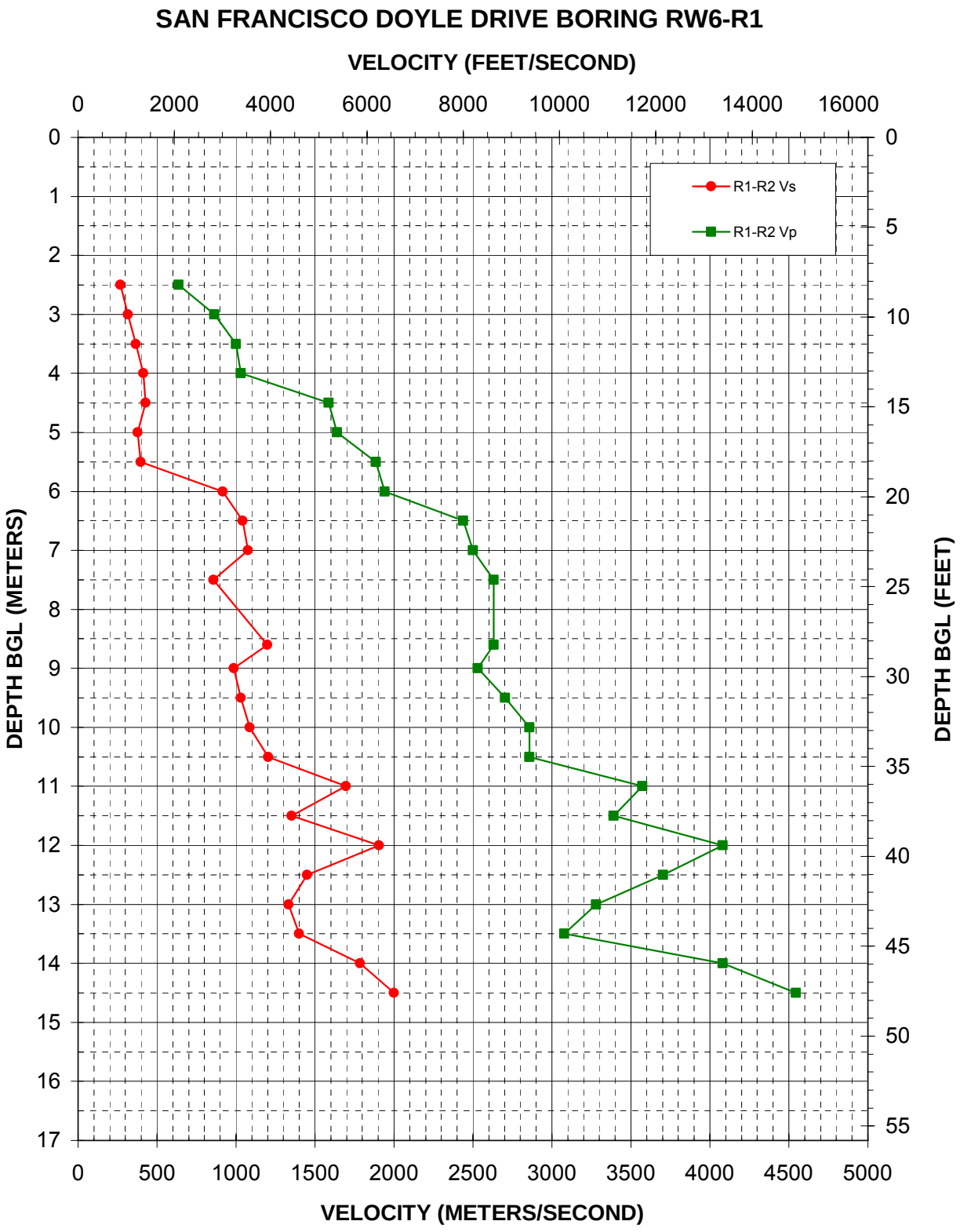


Figure 17: Boring RW6-R1, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.20	881	2090
9.84	1033	2828
11.48	1204	3281
13.12	1353	3382
14.76	1402	5208
16.40	1233	5378
18.04	1297	6190
19.69	3010	6371
21.33	3418	8002
22.97	3528	8202
24.61	2816	8634
28.22	3929	8634
29.53	3232	8306
31.17	3382	8867
32.81	3566	9374
34.45	3953	9374
36.09	5561	11717
37.73	4434	11121
39.37	6249	13391
41.01	4755	12151
42.65	4374	10757
44.29	4589	10095
45.93	5859	13391
47.57	6562	14913

Table 14. Boring RW6-R1, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
17.177	N026	30.8	Primary-structure Planar Bedding
18.509	N086	54.1	Fracture Planar Hairline-fracture
18.649	N087	44	Fracture Planar Hairline-fracture
18.925	N175	74.6	Fracture Planar Hairline-fracture
20.851	N063	59.7	Fracture Planar Healed fracture
21	N070	50.2	Fracture Planar Healed fracture
21.213	N163	67.8	Fracture Planar Healed fracture
21.266	N324	72.3	Fracture Planar Healed fracture
22.006	N172	68.2	Fracture Planar Hairline-fracture
22.868	N100	46	Fracture Planar Healed fracture
23.81	N104	33.6	Fracture Planar Open-fracture
25.135	N036	56.1	Fracture Planar Open-fracture
25.347	N164	75.7	Fracture Planar Healed fracture
26.342	N143	45.7	Fracture Planar Healed fracture
26.474	N134	46.5	Fracture Planar Healed fracture
26.97	N041	65.2	Fracture Planar Hairline-fracture
27.493	N319	64.1	Fracture Planar Hairline-fracture
27.852	N146	44.2	Fracture Planar Hairline-fracture
28.145	N128	41.2	Fracture Planar Hairline-fracture
28.598	N140	41.8	Primary-structure Planar Bedding
28.874	N141	25.1	Primary-structure Planar Bedding
30.423	N151	67.3	Fracture Planar Open-fracture
31.096	N169	58.8	Fracture Planar Open-fracture
32.175	N155	72.3	Fracture Planar Open-fracture
32.784	N167	49	Primary-structure Planar Bedding
33.733	N289	61.2	Fracture Planar Hairline-fracture
33.786	N160	66.5	Fracture Planar Healed fracture
34.018	N145	73.3	Fracture Planar Healed fracture
34.609	N323	76.4	Fracture Planar Healed fracture
35.105	N147	73	Fracture Planar Healed fracture
35.893	N136	67.9	Fracture Planar Healed fracture
37.386	N160	55.8	Fracture Planar Healed fracture
39.437	N090	43.7	Fracture Planar Open-fracture
40.076	N064	69.6	Fracture Planar Healed fracture
40.614	N047	73	Fracture Planar Healed fracture
41.985	N333	85.6	Fracture Planar Healed fracture
42.098	N360	56.8	Fracture Planar Healed fracture
42.141	N072	52	Fracture Planar Healed fracture
42.533	N099	62.6	Fracture Planar Healed fracture
42.904	N099	54.3	Fracture Planar Healed fracture
43.061	N101	58	Fracture Planar Healed fracture
44.129	N077	46.9	Fracture Planar Open-fracture
45.087	N126	57.9	Fracture Planar Hairline-fracture
45.458	N127	21.6	Fracture Planar Open-fracture
45.715	N158	51	Fracture Planar Hairline-fracture
46.756	N154	81.7	Fracture Planar Hairline-fracture
47.058	N156	83.8	Fracture Planar Hairline-fracture
47.659	N113	37.5	Fracture Planar Open-fracture
48.28	N286	72.9	Fracture Planar Hairline-fracture
49.25	N088	48.3	Fracture Planar Hairline-fracture

Table 15. Boring RW6-R1, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
49.481	N097	46.7	Fracture Planar Open-fracture
49.514	N237	49.4	Fracture Planar Hairline-fracture
49.696	N099	52.2	Fracture Planar Hairline-fracture
50.213	N096	39.3	Fracture Planar Open-fracture
51.534	N093	40.3	Fracture Planar Hairline-fracture
51.785	N224	26.5	Fracture Planar Hairline-fracture
51.914	N121	32.7	Fracture Planar Hairline-fracture
52.272	N319	40.6	Fracture Planar Hairline-fracture
52.499	N282	63.4	Fracture Planar Hairline-fracture
52.856	N094	54.1	Fracture Planar Hairline-fracture
54.524	N157	76.6	Fracture Planar Open-fracture
55.086	N154	78	Fracture Planar Open-fracture
56.372	N133	30.6	Primary-structure Planar Bedding

Table 15, continued. Boring RW6-R1, Structure depth, dip azimuth, dip and structure description

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

15 Jun 2008

ARUP

Borehole: RW6-R1

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 55.586 to 18.009ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

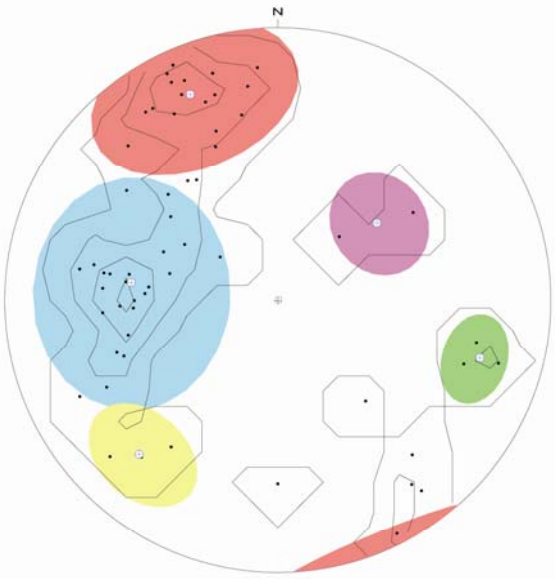
RW6-R1
Zone 0. 18.009 - 55.585ft
Deviation 0.30 N 41.20

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Fresh Open-fracture

	mean dip	n	f
N097 45	N097 45	24	0.91
N157 71	N157 71	18	1.48
N286 66	N286 66	3	(0.19)
N232 38	N232 38	2	(0.07)
N042 65	N042 65	3	(0.19)

intersections

	N097 45	N157 71	N286 66	N232 38	N042 65
N097 45		45 N087	06 N013	19 N167	45 N104
N157 71	45 N087		47 N225	38 N231	53 N094
N286 66	06 N013	47 N225		37 N215	49 N345
N232 38	19 N167	38 N231	37 N215		06 N315
N042 65	45 N104	53 N094	49 N345	06 N315	



mean dip
well axis

equal-area lower-hemisphere 0-90
contour-levels 1,3,6,10,

RW6-R1, Interpretation 1 55.585 to 18.009ft 1

Figure 18. Boring RW6-R1, Stereonet Diagram

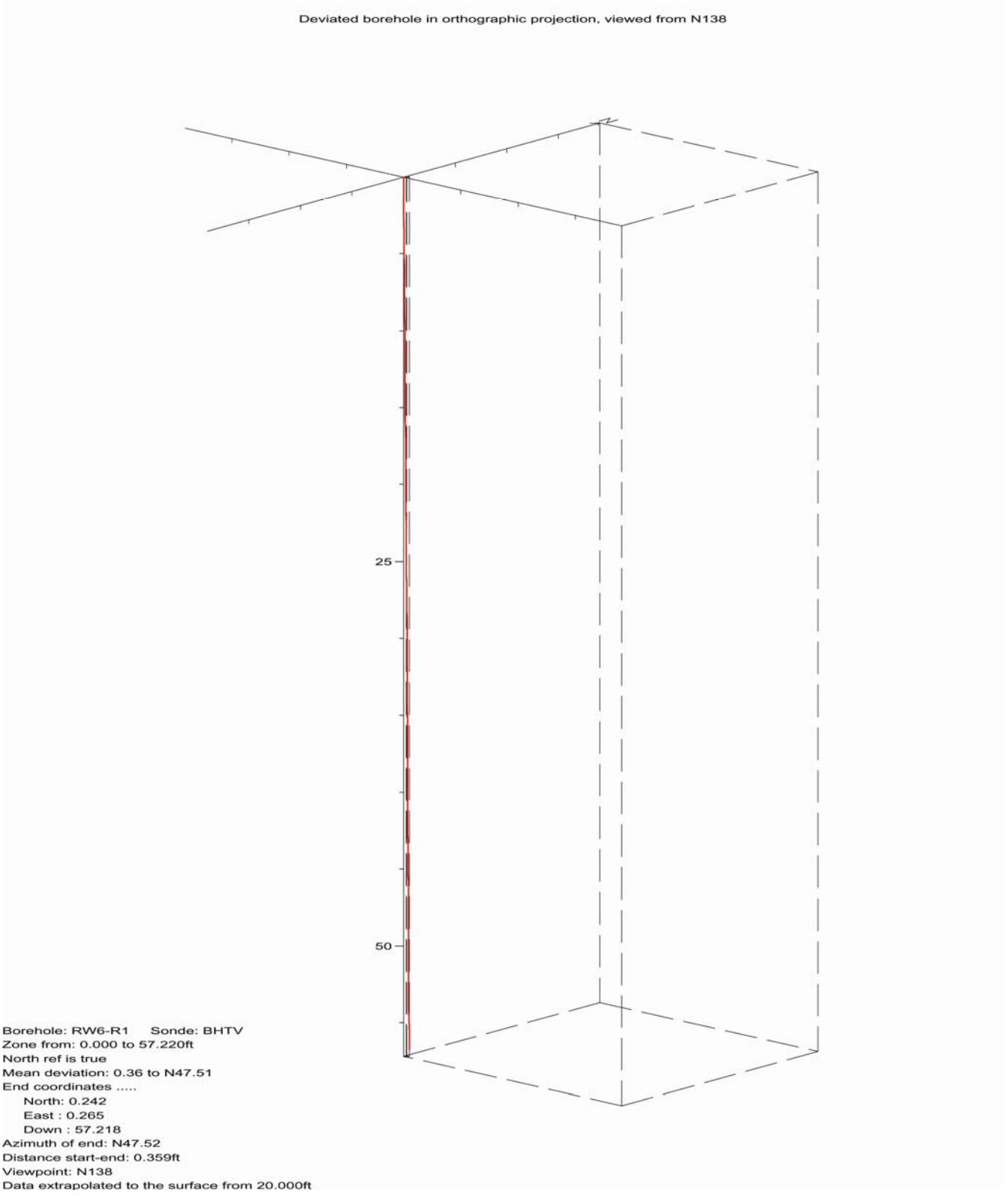


Figure 19. Boring RW6-R1, Deviation Projection (dimensions in feet)

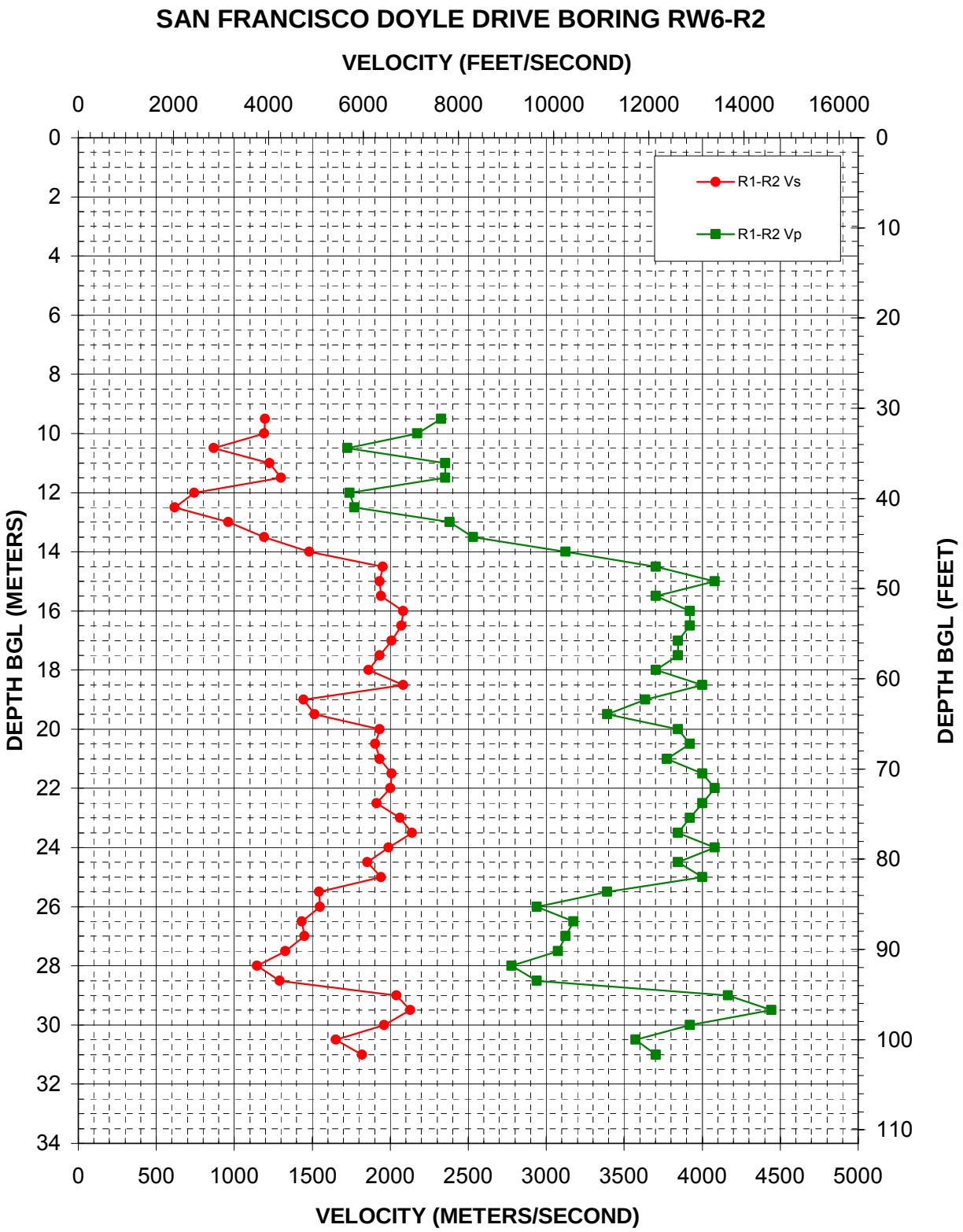


Figure 20: Boring RW6-R2, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
31.17	3929	7630
32.81	3906	7132
34.45	2853	5657
36.09	4026	7720
37.73	4261	7720
39.37	2439	5706
41.01	2031	5807
42.65	3155	7812
44.29	3906	8306
45.93	4861	10253
47.57	6402	12151
49.21	6340	13391
50.85	6371	12151
52.49	6835	12866
54.13	6800	12866
55.77	6595	12619
57.41	6340	12619
59.06	6104	12151
60.70	6835	13123
62.34	4738	11930
63.98	4971	11121
65.62	6340	12619
67.26	6249	12866
68.90	6340	12381
70.54	6595	13123
72.18	6562	13391
73.82	6279	13123
75.46	6765	12866
77.10	7018	12619
78.74	6529	13391
80.38	6076	12619
82.02	6371	13123
83.66	5067	11121
85.30	5087	9650
86.94	4704	10415
88.58	4755	10253
90.22	4360	10095
91.86	3760	9113
93.50	4233	9650
95.14	6696	13670
96.78	6981	14582
98.43	6433	12866
100.07	5423	11717
101.71	5965	12151

Table 16. Boring RW6-R2, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
18.261	N118	32	Primary-structure Planar Bedding
29.242	N308	7	Primary-structure Planar Bedding
29.637	N277	60.4	Fracture Planar Healed fracture
29.864	N264	68.4	Fracture Planar Healed fracture
30.03	N133	42.7	Fracture Planar Healed fracture
30.032	N224	54.3	Fracture Planar Healed fracture
30.784	N134	25.7	Fracture Planar Healed fracture
31.126	N061	73.6	Fracture Planar Healed fracture
31.612	N119	33.8	Fracture Planar Healed fracture
31.942	N348	40.3	Fracture Planar Healed fracture
32.042	N143	29.5	Fracture Planar Healed fracture
32.518	N251	76	Fracture Planar Hairline-fracture
33.273	N084	74.5	Fracture Planar Healed fracture
33.368	N262	34.9	Fracture Planar Healed fracture
33.492	N222	62.1	Fracture Planar Healed fracture
34.771	N206	55.8	Fracture Planar Healed fracture
35.204	N081	58.5	Fracture Planar Hairline-fracture
36.174	N266	66	Fracture Planar Healed fracture
36.941	N253	40.5	Fracture Planar Healed fracture
37.231	N243	34.9	Fracture Planar Healed fracture
37.798	N022	17.1	Primary-structure Planar Bedding
38.534	N008	28.1	Primary-structure Planar Bedding
38.802	N180	50.2	Fracture Planar Healed fracture
39.1	N320	67.4	Fracture Planar Healed fracture
39.508	N313	81.3	Fracture Planar Healed fracture
39.568	N318	61.7	Fracture Planar Healed fracture
39.673	N337	75.5	Fracture Planar Healed fracture
39.805	N303	47.1	Fracture Planar Healed fracture
40.103	N233	89.2	Fracture Planar Hairline-fracture
40.738	N155	76.8	Fracture Planar Healed fracture
40.845	N043	62.5	Fracture Planar Hairline-fracture
40.905	N184	44.5	Fracture Planar Healed fracture
42.645	N334	16.1	Primary-structure Planar Bedding
43.104	N006	21.3	Primary-structure Planar Bedding
44.568	N207	49.5	Primary-structure Planar Bedding
45.922	N253	63.9	Primary-structure Planar Bedding
48.129	N004	21.8	Fracture Planar Healed fracture
49.104	N010	38.7	Fracture Planar Healed fracture
49.601	N352	49.5	Fracture Planar Hairline-fracture
50.104	N046	52.7	Fracture Planar Healed fracture
50.259	N122	83	Fracture Planar Healed fracture
50.775	N169	72.1	Fracture Planar Healed fracture
50.83	N196	43.1	Fracture Planar Healed fracture
50.847	N028	48.9	Fracture Planar Healed fracture
51.608	N022	56.8	Fracture Planar Healed fracture
51.73	N133	83.1	Fracture Planar Healed fracture
52.095	N109	81.1	Fracture Planar Healed fracture
52.947	N197	59.8	Fracture Planar Healed fracture
53.639	N063	53.6	Fracture Planar Healed fracture
55.01	N120	53.7	Fracture Planar Healed fracture

Table 17. Boring RW6-R2, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
55.066	N326	46	Fracture Planar Healed fracture
55.355	N055	58.7	Fracture Planar Healed fracture
55.75	N218	68.8	Fracture Planar Healed fracture
56.071	N342	35.2	Fracture Planar Healed fracture
56.366	N353	46.8	Fracture Planar Healed fracture
56.878	N123	51.4	Fracture Planar Healed fracture
57.004	N216	78.5	Fracture Planar Healed fracture
57.658	N072	57.3	Fracture Planar Healed fracture
58.503	N093	58.2	Fracture Planar Healed fracture
59.069	N321	61	Fracture Planar Healed fracture
59.479	N353	42.6	Fracture Planar Healed fracture
59.58	N225	85.3	Fracture Planar Healed fracture
59.86	N015	65.3	Fracture Planar Healed fracture
59.951	N087	58.9	Fracture Planar Healed fracture
60.177	N275	58.5	Fracture Planar Healed fracture
60.197	N149	54.9	Fracture Planar Healed fracture
60.366	N228	79.9	Fracture Planar Healed fracture
61.052	N083	49.5	Fracture Planar Healed fracture
61.315	N314	64.3	Fracture Planar Healed fracture
61.581	N130	71.3	Fracture Planar Healed fracture
61.691	N332	76.1	Fracture Planar Healed fracture
62.128	N144	70.7	Fracture Planar Healed fracture
62.175	N220	71.1	Fracture Planar Healed fracture
62.684	N217	72.5	Fracture Planar Healed fracture
62.843	N115	45.5	Fracture Planar Healed fracture
63.021	N139	60.7	Fracture Planar Healed fracture
63.357	N050	37.3	Fracture Planar Healed fracture
63.931	N229	76.8	Fracture Planar Healed fracture
64.17	N108	67.5	Fracture Planar Open-fracture
64.408	N242	67.6	Fracture Planar Healed fracture
64.557	N080	63	Fracture Planar Healed fracture
65.316	N071	62.4	Fracture Planar Healed fracture
65.934	N164	68.7	Fracture Planar Healed fracture
66.437	N278	76.1	Fracture Planar Healed fracture
67.538	N093	79.4	Fracture Planar Healed fracture
68.354	N288	52.8	Fracture Planar Healed fracture
68.866	N121	54.6	Fracture Planar Healed fracture
70.974	N079	74.9	Fracture Planar Healed fracture
72.292	N281	29.1	Fracture Planar Healed fracture
72.783	N310	13.4	Fracture Planar Healed fracture
73.695	N320	73.5	Fracture Planar Healed fracture
73.724	N103	57.8	Fracture Planar Healed fracture
73.734	N105	55.4	Fracture Planar Healed fracture
73.994	N103	58	Fracture Planar Healed fracture
74.048	N112	48.8	Fracture Planar Healed fracture
74.684	N166	75	Fracture Planar Healed fracture
74.727	N074	48.8	Fracture Planar Hairline-fracture
74.775	N125	22.4	Fracture Planar Hairline-fracture
75.143	N079	57.1	Fracture Planar Healed fracture
76.379	N062	71.8	Fracture Planar Healed fracture

Table 17, continued. Boring RW6-R2, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
76.469	N094	45.9	Fracture Planar Healed fracture
77.183	N090	58.2	Fracture Planar Healed fracture
77.341	N095	60	Fracture Planar Healed fracture
77.63	N127	64.1	Fracture Planar Healed fracture
77.944	N294	52.8	Fracture Planar Healed fracture
77.961	N042	45.7	Fracture Planar Healed fracture
78.883	N357	27.1	Fracture Planar Healed fracture
78.955	N084	61.3	Fracture Planar Healed fracture
79.084	N094	74.6	Fracture Planar Healed fracture
79.349	N272	50.5	Fracture Planar Healed fracture
79.849	N292	28.9	Fracture Planar Healed fracture
80.174	N251	78.3	Fracture Planar Healed fracture
80.288	N105	63.9	Fracture Planar Healed fracture
80.839	N253	85	Fracture Planar Healed fracture
80.858	N088	52.4	Fracture Planar Healed fracture
81.355	N007	24.4	Fracture Planar Healed fracture
81.749	N001	35.9	Fracture Planar Healed fracture
82.297	N218	36.9	Fracture Planar Healed fracture
82.844	N036	39	Fracture Planar Healed fracture
84.66	N206	46.1	Fracture Planar Healed fracture
84.692	N209	37.4	Fracture Planar Healed fracture
85.802	N329	30.5	Fracture Planar Hairline-fracture
86.079	N219	44.9	Fracture Planar Healed fracture
86.641	N123	32.6	Fracture Planar Healed fracture
87.154	N147	37.8	Fracture Planar Open-fracture
87.289	N336	70.4	Fracture Planar Healed fracture
87.971	N061	61	Fracture Planar Healed fracture
88.152	N062	76.9	Fracture Planar Healed fracture
89.614	N084	51	Fracture Planar Healed fracture
89.726	N108	45.7	Fracture Planar Healed fracture
89.859	N045	27	Fracture Planar Open-fracture
90.125	N351	29.5	Fracture Planar Open-fracture
90.32	N114	51.4	Fracture Planar Open-fracture
90.334	N057	25.4	Fracture Planar Open-fracture
90.902	N129	71.8	Fracture Planar Healed fracture
90.952	N284	32.2	Fracture Planar Healed fracture
91.501	N298	42.7	Fracture Planar Healed fracture
91.655	N034	43.9	Fracture Planar Healed fracture
91.8	N311	46.8	Fracture Planar Healed fracture
91.925	N348	14	Fracture Planar Hairline-fracture
92.193	N356	53.7	Fracture Planar Hairline-fracture
92.662	N252	20.5	Fracture Planar Open-fracture
92.841	N065	36.9	Fracture Planar Open-fracture
93.345	N018	29.3	Fracture Planar Open-fracture
93.511	N014	32.3	Fracture Planar Open-fracture
93.905	N136	72.3	Fracture Planar Healed fracture
94.365	N308	77.6	Fracture Planar Healed fracture
94.755	N147	74	Fracture Planar Healed fracture
95.334	N312	80.1	Fracture Planar Healed fracture
95.918	N090	31.2	Fracture Planar Healed fracture

Table 17, continued. Boring RW6-R2, Structure depth, dip azimuth, dip and structure description

Depth (feet)	Dip azimuth	Dip	Structure description
96.051	N113	36.9	Fracture Planar Healed fracture
96.636	N119	44.6	Fracture Planar Healed fracture
96.938	N142	41.1	Fracture Planar Healed fracture
96.957	N115	61.6	Fracture Planar Healed fracture
97.143	N117	69.1	Fracture Planar Healed fracture
97.393	N215	74.4	Fracture Planar Healed fracture
97.849	N168	74.2	Fracture Planar Healed fracture
97.895	N255	53.1	Fracture Planar Healed fracture
98.15	N149	45.6	Fracture Planar Healed fracture
98.679	N274	71.1	Fracture Planar Healed fracture
98.937	N121	37.5	Fracture Planar Healed fracture
98.966	N222	48.2	Fracture Planar Healed fracture
100.164	N248	64.5	Fracture Planar Healed fracture
100.199	N271	38.8	Fracture Planar Healed fracture
100.589	N244	75.5	Fracture Planar Healed fracture
100.718	N250	81.1	Fracture Planar Healed fracture
101.476	N272	73.5	Fracture Planar Healed fracture
101.633	N278	40.1	Fracture Planar Healed fracture
101.711	N066	66.2	Fracture Planar Healed fracture
101.721	N332	9.6	Fracture Planar Healed fracture
102.281	N102	20.4	Fracture Planar Healed fracture
102.65	N281	45.8	Fracture Planar Healed fracture
103.116	N349	42.9	Fracture Planar Healed fracture
103.612	N084	36.2	Fracture Planar Healed fracture
103.711	N314	74.3	Fracture Planar Healed fracture
103.942	N110	73.9	Fracture Planar Healed fracture
104.025	N114	59.9	Fracture Planar Healed fracture
104.233	N141	78.8	Fracture Planar Healed fracture
105.719	N146	69.4	Fracture Planar Hairline-fracture
106.182	N313	81.9	Fracture Planar Hairline-fracture
107.134	N320	70	Fracture Planar Healed fracture
107.283	N287	45.2	Fracture Planar Healed fracture
107.789	N123	49	Fracture Planar Healed fracture
108	N024	65.2	Fracture Planar Healed fracture
108.122	N332	43.3	Fracture Planar Healed fracture
108.507	N324	80.6	Fracture Planar Healed fracture
108.655	N291	35.5	Fracture Planar Healed fracture
109.651	N276	32.9	Fracture Planar Healed fracture
110.278	N304	61.6	Fracture Planar Healed fracture
110.844	N314	84.7	Fracture Planar Healed fracture
110.862	N298	88.3	Fracture Planar Healed fracture
110.97	N064	62.2	Fracture Planar Hairline-fracture
111.088	N113	80.2	Fracture Planar Healed fracture
111.836	N184	71.3	Fracture Planar Hairline-fracture

Table 17, continued. Boring RW6-R2, Structure depth, dip azimuth, dip and structure description

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS STEREOGRAMS

16 Jun 2008

ARUP

Borehole: RW6-R2

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

North ref: true
Depth units are feet

Zone from 112.336 to 29.137ft
Mean dip format: dip-azimuth and dip

Interpretation 1

Dip data sets .....
BHTV dips

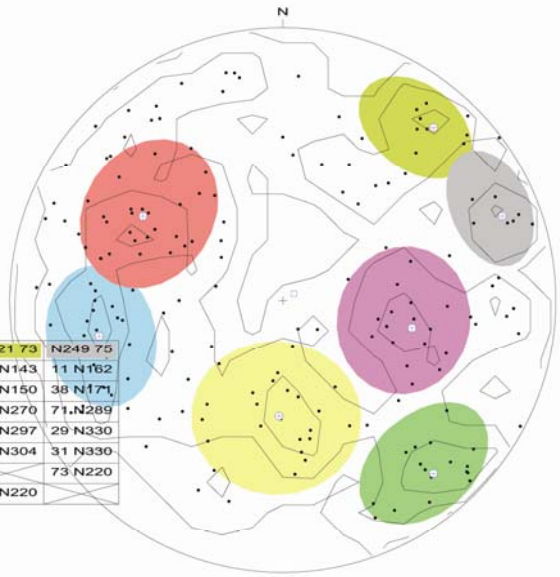
RW6-R2
Zone 0. 29.137 - 112.326ft
Deviation 3.90 N 58.60

dipdata sets.....
BHTV dips
• Highlighted dips: Fracture Planar Fresh Open-fracture

	mean dip	n	f
N079 58	N079 58	21	0.54
N121 50	N121 50	27	0.52
N319 73	N319 73	17	0.67
N282 40	N282 40	16	0.24
N002 35	N002 35	22	0.33
N221 73	N221 73	8	0.27
N249 75	N249 75	7	0.27

intersections

	N079 58	N121 50	N319 73	N282 40	N002 35	N221 73	N249 75
N079 58		50 N121	47 N030	12 N357	34 N014	35 N143	11 N162
N121 50	50 N121		15 N044	09 N203	24 N053	46 N150	38 N171
N319 73	47 N030	15 N044		32 N240	29 N039	65 N270	71 N289
N282 40	12 N357	09 N203	32 N240		30 N328	39 N297	29 N330
N002 35	34 N014	24 N053	29 N039	30 N328		21 N304	31 N330
N221 73	35 N143	46 N150	65 N270	39 N297	21 N304		73 N220
N249 75	11 N162	38 N171	71 N289	29 N330	31 N330	73 N220	



mean dip
well axis

equal-area lower-hemisphere 0-90
contour-levels 1,3,6,10,

RW6-R2, Interpretation 1 112.326 to 29.137ft 1

Figure 21. Boring RW6-R2, Stereonet Diagram

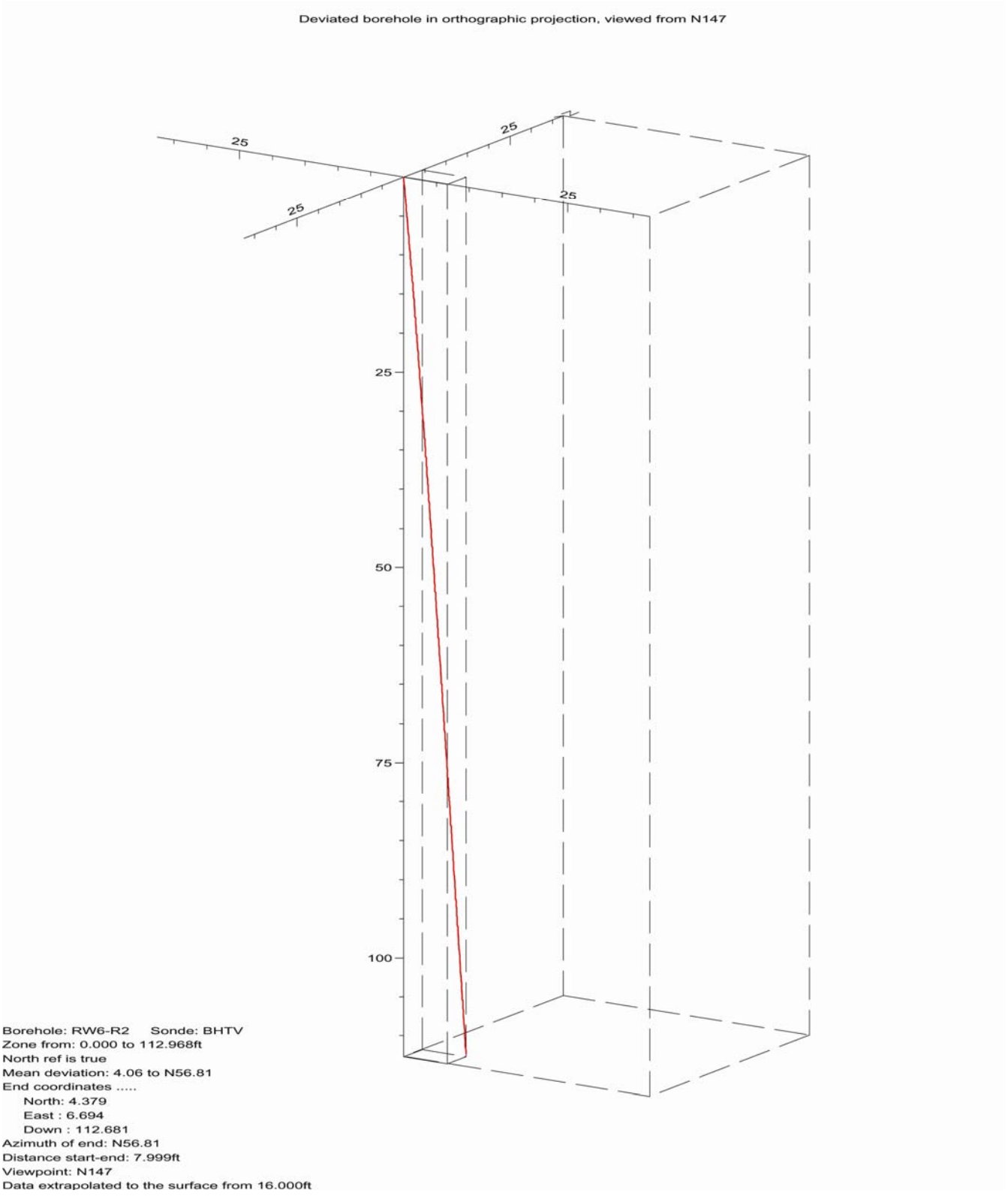


Figure 22. Boring RW6-R2, Deviation Projection (dimensions in feet)

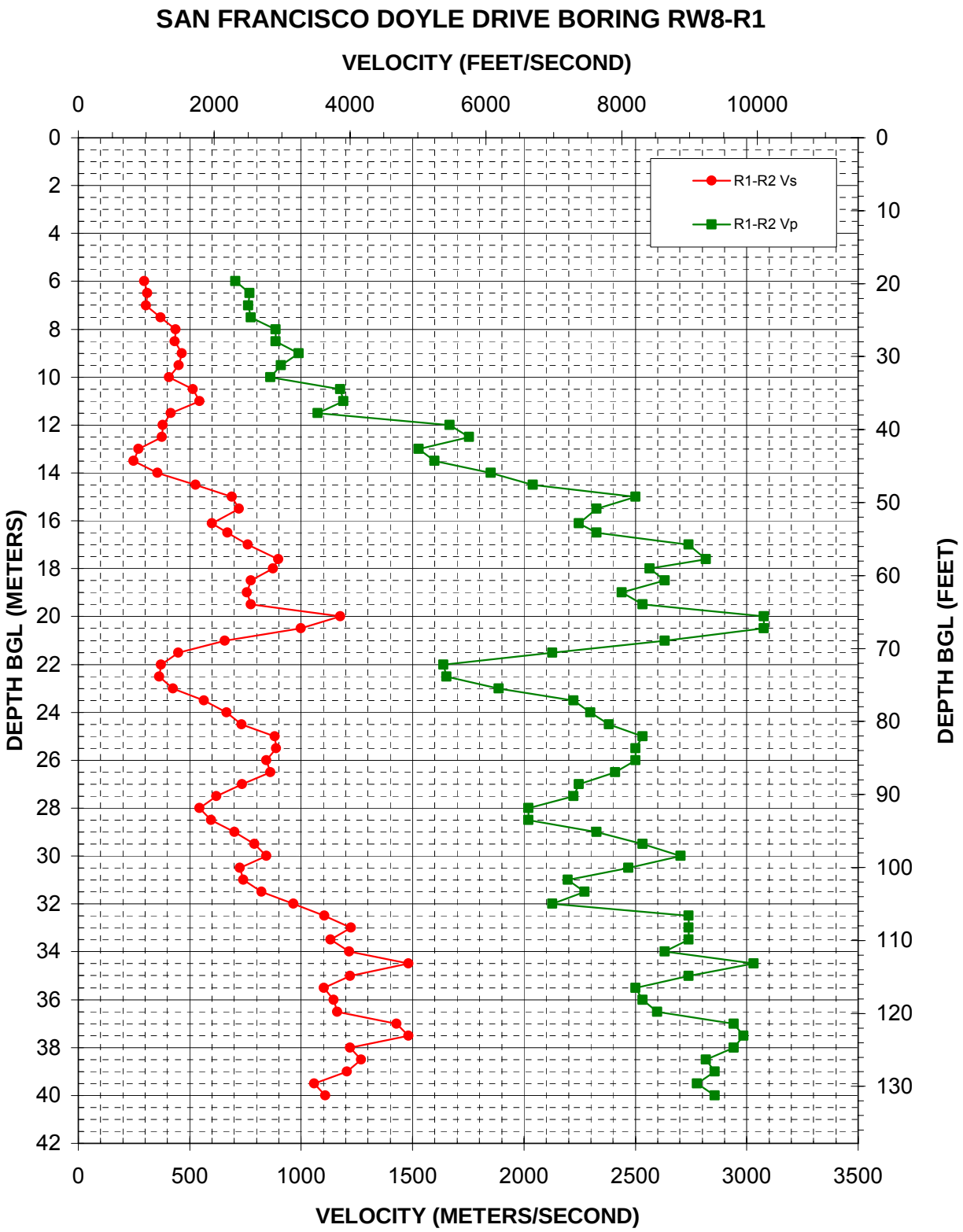


Figure 23: Boring RW8-R1, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
19.69	974	2310
21.33	1016	2524
22.97	1000	2504
24.61	1211	2543
26.25	1433	2903
27.89	1420	2903
29.53	1526	3248
31.17	1478	2983
32.81	1339	2828
34.45	1691	3860
36.09	1783	3906
37.73	1361	3528
39.37	1247	5468
41.01	1229	5756
42.65	887	5009
44.29	816	5249
45.93	1163	6076
47.57	1727	6696
49.21	2263	8202
50.85	2369	7630
52.82	1970	7373
54.13	2195	7630
55.77	2495	8989
57.74	2942	9242
59.06	2865	8412
60.70	2543	8634
62.34	2485	8002
63.98	2543	8306
65.62	3860	10095
67.26	3281	10095
68.90	2158	8634
70.54	1471	6981
72.18	1220	5378
73.82	1193	5423
75.46	1396	6190
77.10	1848	7291
78.74	2180	7542
80.38	2404	7812
82.02	2891	8306
83.66	2916	8202
85.30	2769	8202
86.94	2828	7906
88.58	2412	7373
90.22	2031	7291
91.86	1783	6628
93.50	1953	6628
95.14	2302	7630
96.78	2594	8306
98.43	2769	8867
100.07	2377	8101
101.71	2430	7211
103.35	2700	7456
104.99	3170	6981
106.63	3625	8989
108.27	4013	8989
109.91	3718	8989
111.55	3989	8634
113.19	4861	9942
114.83	4001	8989
116.47	3615	8202
118.11	3760	8306
119.75	3815	8522
121.39	4687	9650
123.03	4861	9794
124.67	4001	9650
126.31	4166	9242
127.95	3953	9374
129.59	3472	9113
131.23	3635	9374

Table 18. Boring RW8-R1, Suspension R1-R2 depths and P- and S_H-wave velocities

Depth (feet)	Dip azimuth	Dip	Structure description
45.322	N156	32.1	Primary-structure Planar Bedding
46.209	N204	61.9	Fracture Planar Hairline-fracture
47.125	N338	67.4	Fracture Planar Hairline-fracture
47.905	N208	50.8	Fracture Planar Hairline-fracture
49.639	N330	73.1	Fracture Planar Hairline-fracture
50.895	N019	78.1	Fracture Planar Hairline-fracture
51.119	N100	83	Fracture Planar Hairline-fracture
51.132	N204	59.7	Fracture Planar Hairline-fracture
55.16	N104	72.2	Fracture Planar Hairline-fracture
55.458	N320	83.5	Fracture Planar Hairline-fracture
57.353	N269	63.1	Fracture Planar Hairline-fracture
57.923	N329	78.9	Fracture Planar Open-fracture
58.266	N276	36.6	Fracture Planar Open-fracture
58.827	N307	50.5	Fracture Planar Open-fracture
60.96	N298	69	Fracture Planar Open-fracture
65.455	N164	51.3	Primary-structure Planar Bedding
70.077	N223	66.4	Fracture Planar Hairline-fracture
70.46	N314	24.7	Primary-structure Planar Bedding
79.235	N001	5.6	Primary-structure Planar Bedding
96.593	N254	41	Fracture Planar Hairline-fracture
97.307	N000	67.7	Fracture Planar Open-fracture
105.6	N185	54.8	Fracture Planar Healed fracture
105.73	N050	66.3	Fracture Planar Healed fracture
107.457	N329	50.7	Fracture Planar Open-fracture
107.824	N119	49.9	Fracture Planar Open-fracture
108.329	N134	44.4	Fracture Planar Open-fracture
108.813	N243	68.6	Fracture Planar Hairline-fracture
112.012	N267	36.2	Fracture Planar Hairline-fracture
112.843	N132	68	Fracture Planar Healed fracture
113.354	N053	67.8	Fracture Planar Healed fracture
113.765	N173	35.4	Fracture Planar Hairline-fracture
113.899	N101	66.8	Fracture Planar Healed fracture
115.454	N207	41.5	Fracture Planar Healed fracture
115.69	N093	27.4	Primary-structure Planar Bedding
116.857	N318	2.4	Primary-structure Planar Bedding
117.587	N205	18.8	Fracture Planar Healed fracture
118.707	N230	30.5	Fracture Planar Healed fracture
120.772	N049	21.8	Fracture Planar Healed fracture
121.267	N038	37.3	Fracture Planar Open-fracture
121.921	N028	27.5	Fracture Planar Open-fracture
122.352	N106	35.5	Fracture Planar Healed fracture
122.803	N098	39.6	Fracture Planar Healed fracture
123.85	N104	41.8	Fracture Planar Hairline-fracture
124.518	N221	15.7	Fracture Planar Hairline-fracture
125.016	N136	15.3	Fracture Planar Hairline-fracture
125.328	N225	14.2	Primary-structure Planar Bedding

Table 19. Boring RW8-R1, Structure depth, dip azimuth, dip and structure description

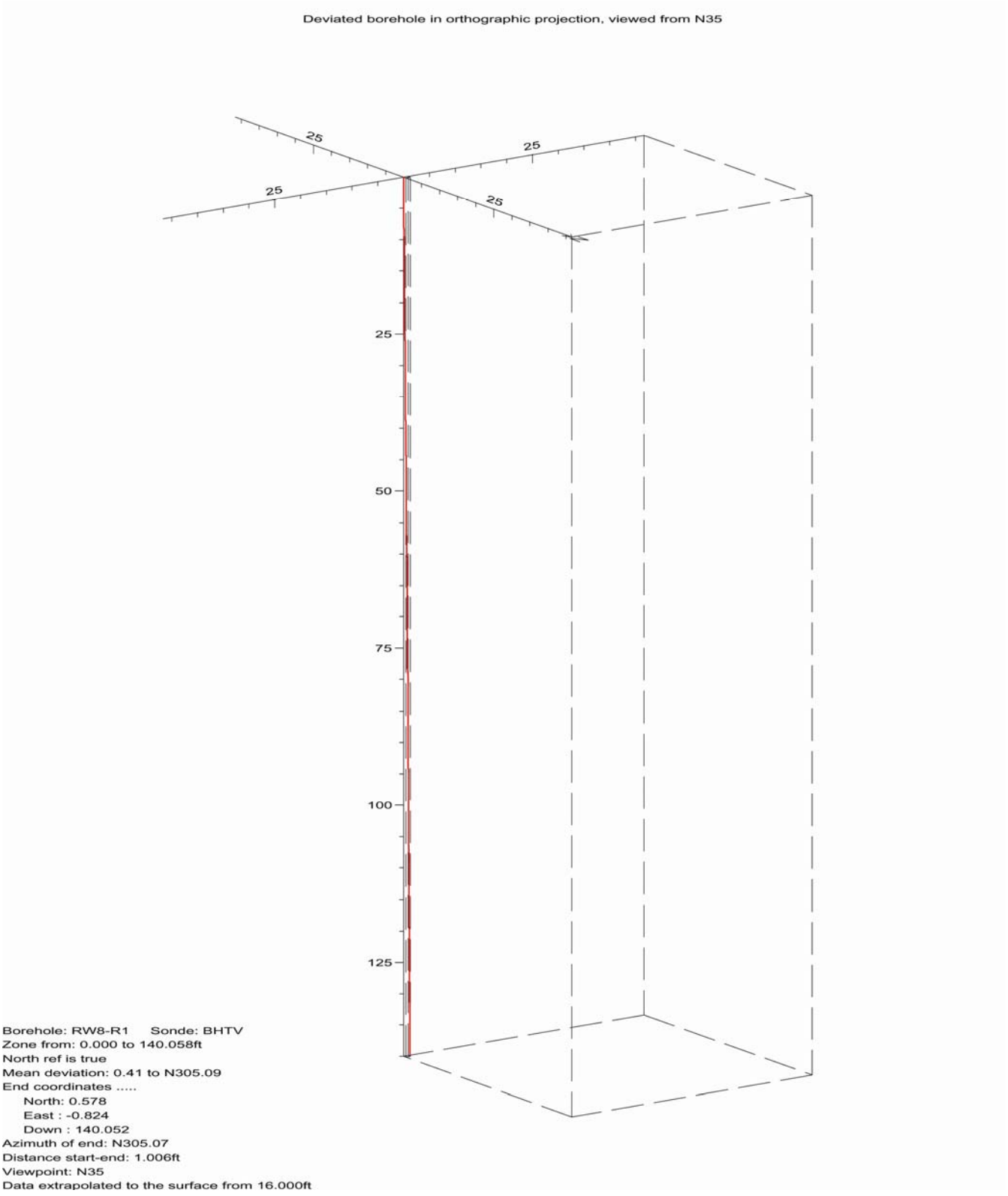


Figure 24. Boring RW8-R1, Deviation Projection (dimensions in feet)

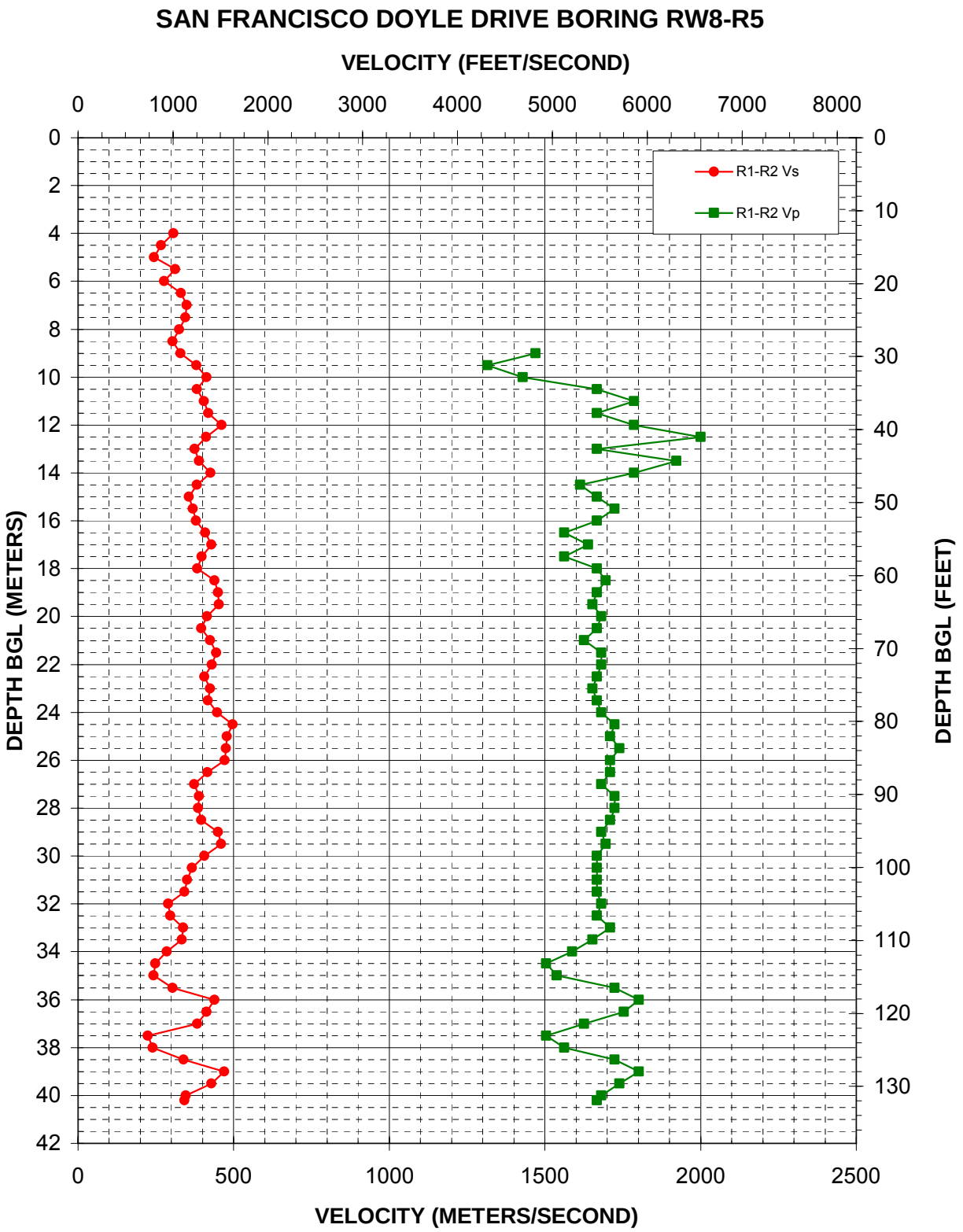


Figure 25: Boring RW8-R5, Suspension R1-R2 P- and S_H-wave velocities

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.12	1006	-
14.76	875	-
16.40	800	-
18.04	1022	--
19.68	909	-
21.33	1083	-
22.97	1147	-
24.61	1131	-
26.25	1065	-
27.89	994	-
29.53	1079	4825
31.17	1248	4317
32.81	1356	4687
34.45	1252	5468
36.09	1328	5859
37.73	1373	5468
39.37	1512	5859
41.01	1350	6562
42.65	1229	5468
44.29	1277	6309
45.93	1397	5859
47.57	1252	5292
49.21	1168	5468
50.85	1211	5657
52.49	1243	5468
54.13	1339	5126
55.77	1408	5378
57.41	1302	5126
59.05	1257	5468
60.69	1439	5561
62.34	1475	5468
63.98	1483	5423
65.62	1359	5514
67.26	1297	5468
68.90	1390	5335
70.54	1458	5514
72.18	1411	5514
73.82	1331	5468
75.46	1393	5423
77.10	1370	5468
78.74	1465	5514
80.38	1628	5657
82.02	1570	5608
83.66	1559	5706
85.30	1544	5608
86.94	1364	5608
88.58	1224	5514
90.22	1274	5657
91.86	1264	5657
93.50	1299	5608
95.14	1475	5514
96.78	1509	5561
98.42	1331	5468
100.06	1202	5468
101.70	1151	5468
103.35	1124	5468
104.99	948	5514
106.63	971	5468
108.27	1108	5608
109.91	1094	5423
111.55	937	5208
113.19	814	4934
114.83	796	5047
116.47	997	5657
118.11	1440	5911
119.75	1356	5756
121.39	1257	5335
123.03	736	4934
124.67	785	5126
126.31	1112	5657
127.95	1540	5911
129.59	1408	5706
131.23	1137	5514
131.89	1120	5468

Table 20. Boring RW8-R5, Suspension R1-R2 depths and P- and S_H-wave velocities

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

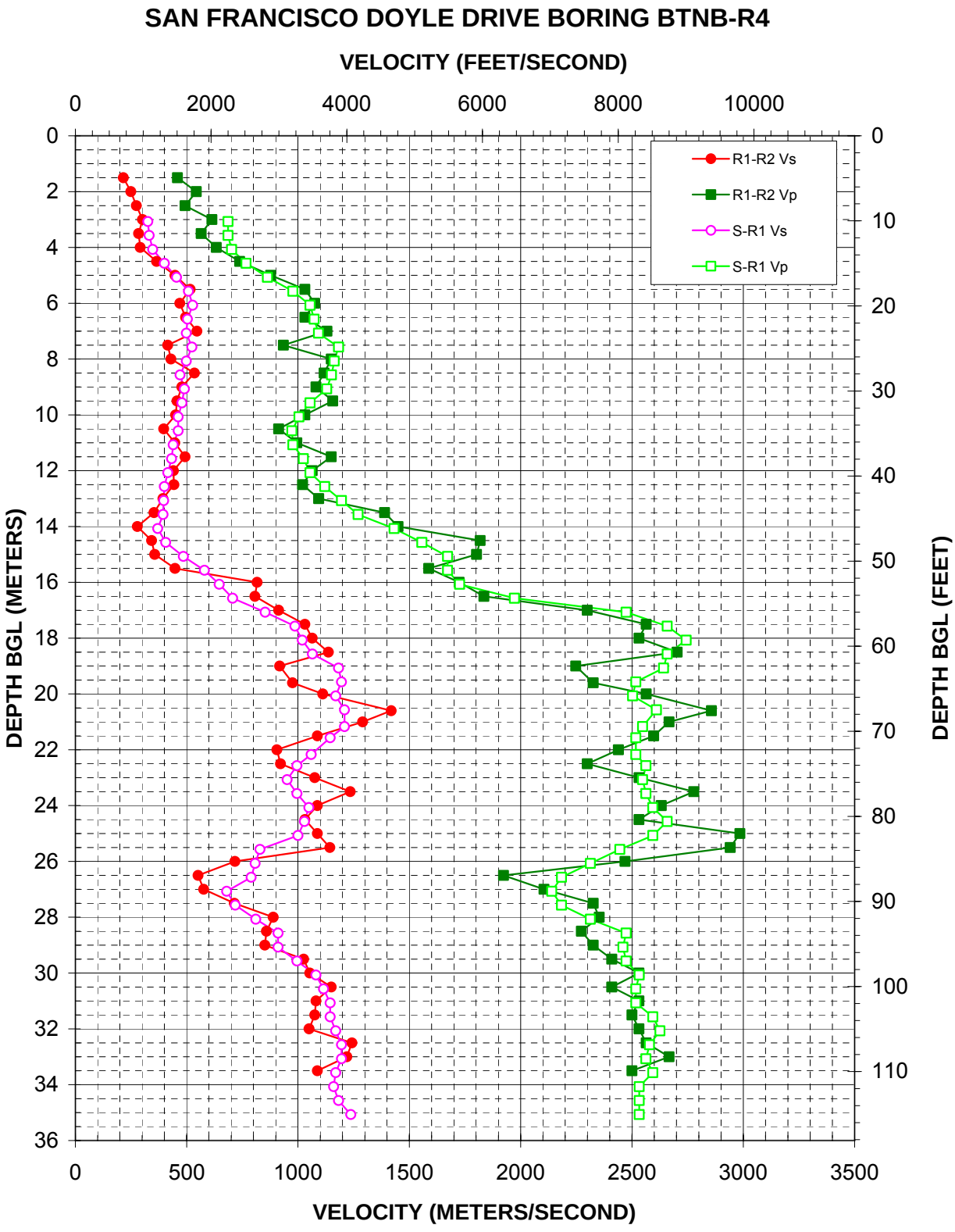


Figure A-1. Boring BTNB-R4, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
10.07	1069	2250
11.71	1089	2250
13.35	1140	2302
14.99	1312	2516
16.63	1491	2831
18.27	1668	3206
19.91	1729	3459
21.56	1652	3519
23.20	1637	3582
24.84	1717	3879
26.48	1637	3816
28.12	1543	3775
29.76	1607	3705
31.40	1571	3459
33.04	1516	3296
34.68	1516	3191
36.32	1442	3206
37.96	1418	3359
39.60	1363	3459
41.24	1312	3676
42.88	1303	3922
44.52	1293	4167
46.16	1213	4696
47.80	1332	5106
49.44	1592	5485
51.08	1903	5485
52.72	2121	5662
54.36	2317	6471
56.00	2797	8117
57.64	3235	8722
59.28	3343	9001
60.93	3493	8722
62.57	3879	8668
64.21	3922	8260
65.85	3837	8212
67.49	3967	8562
69.46	3967	8358
70.77	3755	8260
72.74	3476	8260
74.05	3266	8408
75.69	3120	8358
77.33	3266	8408
78.97	3442	8510
80.61	3375	8722
82.25	3281	8510
83.89	2721	8024
85.53	2649	7590
87.17	2591	7164
88.81	2229	7021
90.45	2356	7164
92.09	2659	7590
93.73	2988	8117
95.37	2988	8070
97.01	3266	8117
98.65	3546	8309
100.30	3657	8260
101.94	3755	8260
103.58	3755	8510
105.22	3837	8615
106.86	3922	8459
108.50	3922	8408
110.14	3837	8510
111.78	3805	8309
113.42	3879	8309
115.06	4058	8309

Table A-1. Boring BTNB-R4, S - R1 quality assurance analysis P- and S_H-wave data

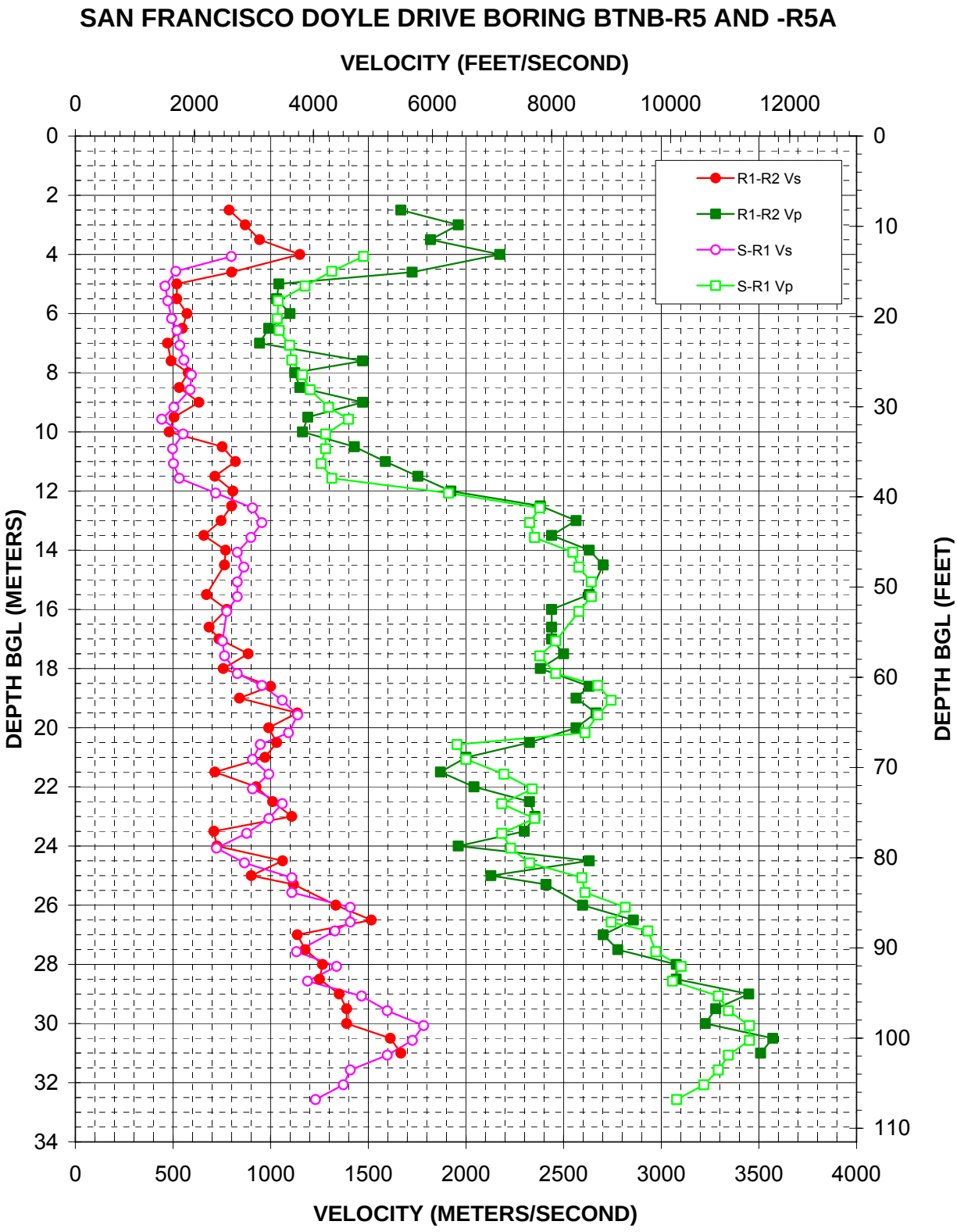


Figure A-2. Borings BTNB-R5 and –R5A, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.35	2620	4842
14.99	1688	4307
16.63	1507	3858
18.27	1553	3408
20.24	1618	3392
21.56	1708	3425
23.20	1755	3601
24.84	1824	3638
26.48	1950	3816
28.12	1929	3944
30.09	1656	4255
31.40	1451	4589
33.04	1810	4204
34.68	1633	4204
36.32	1648	4130
37.96	1747	4307
39.60	2356	6269
41.24	2975	7801
42.88	3134	7632
44.52	2950	7715
46.16	2721	8358
47.80	2831	8459
49.44	2721	8668
51.08	2721	8668
52.72	2544	8459
56.00	2472	8070
57.64	2507	7801
59.61	2721	8070
60.93	3134	8776
62.57	3476	9001
64.21	3735	8776
66.17	3582	8562
67.49	3107	6412
69.13	2975	6562
70.77	3250	7201
72.41	2975	7673
74.05	3476	7164
75.69	3250	7715
77.33	2877	7164
78.97	2372	7314
80.61	2843	7632
82.25	3638	8510
83.89	3638	8562
85.53	4619	9238
87.17	4619	9001
88.16	4361	9618
90.45	3715	9751
92.09	4388	10175
93.73	3901	10030
95.37	4809	10802
97.01	5240	10970
98.65	5851	11324
100.30	5662	11324
101.94	5240	10970
103.58	4619	10802
105.22	4501	10558
106.86	4035	10102

Table A-2. Borings BTNB-R5 and –R5A, S - R1 quality assurance analysis P- and S_H-wave data

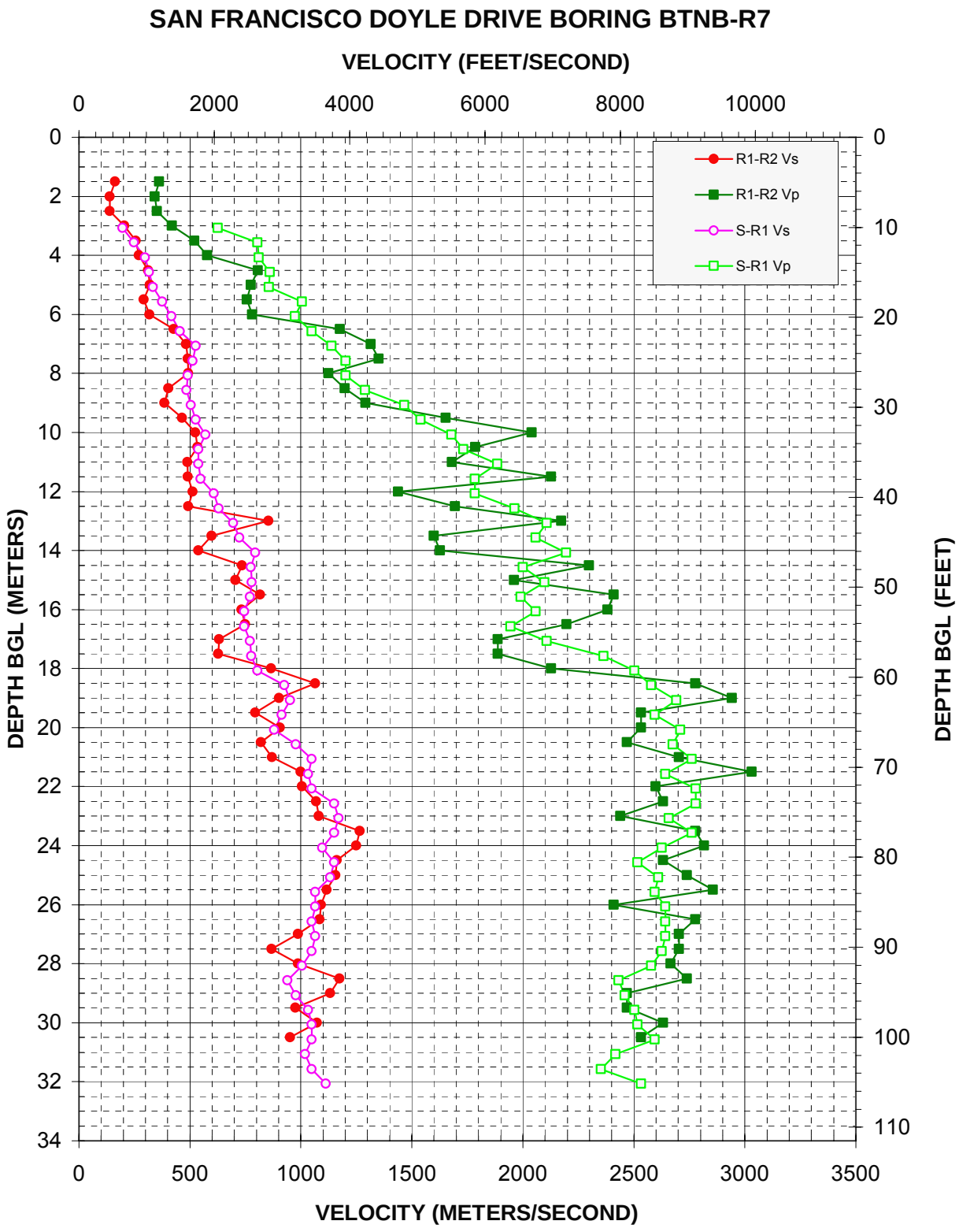


Figure A-3. Boring BTNB-R7, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
10.07	648	2053
11.71	817	2639
13.35	975	2659
14.99	1039	2820
16.63	1097	2808
18.27	1234	3296
19.91	1371	3191
21.56	1494	3442
23.20	1729	3735
24.84	1680	3944
26.48	1610	3944
28.12	1588	4230
29.76	1656	4809
31.40	1729	5051
33.04	1867	5507
34.68	1769	5685
36.32	1769	6186
37.96	1796	5851
39.60	1995	5851
41.24	2065	6441
42.88	2280	6917
44.52	2372	6751
46.16	2610	7201
47.80	2544	6562
49.44	2553	6883
51.08	2526	6531
52.72	2446	6751
54.36	2446	6383
56.00	2526	6917
57.64	2548	7758
59.28	2639	8212
60.93	3039	8459
62.57	3120	8831
64.21	3000	8510
65.85	2889	8887
67.49	3206	8776
69.13	3442	9059
70.77	3392	8668
72.41	3442	9118
74.05	3775	9118
75.69	3837	8722
77.33	3775	9059
78.97	3601	8615
80.61	3775	8260
82.25	3715	8562
83.89	3493	8510
85.53	3493	8668
87.17	3442	8668
88.81	3493	8668
90.45	3442	8615
92.09	3296	8459
93.73	3079	7978
95.37	3206	8070
97.01	3392	8212
98.65	3442	8260
100.30	3442	8510
101.94	3343	7933
103.58	3442	7715
105.22	3647	8309

Table A-3. Boring BTNB-R7, S - R1 quality assurance analysis
P- and S_H-wave data

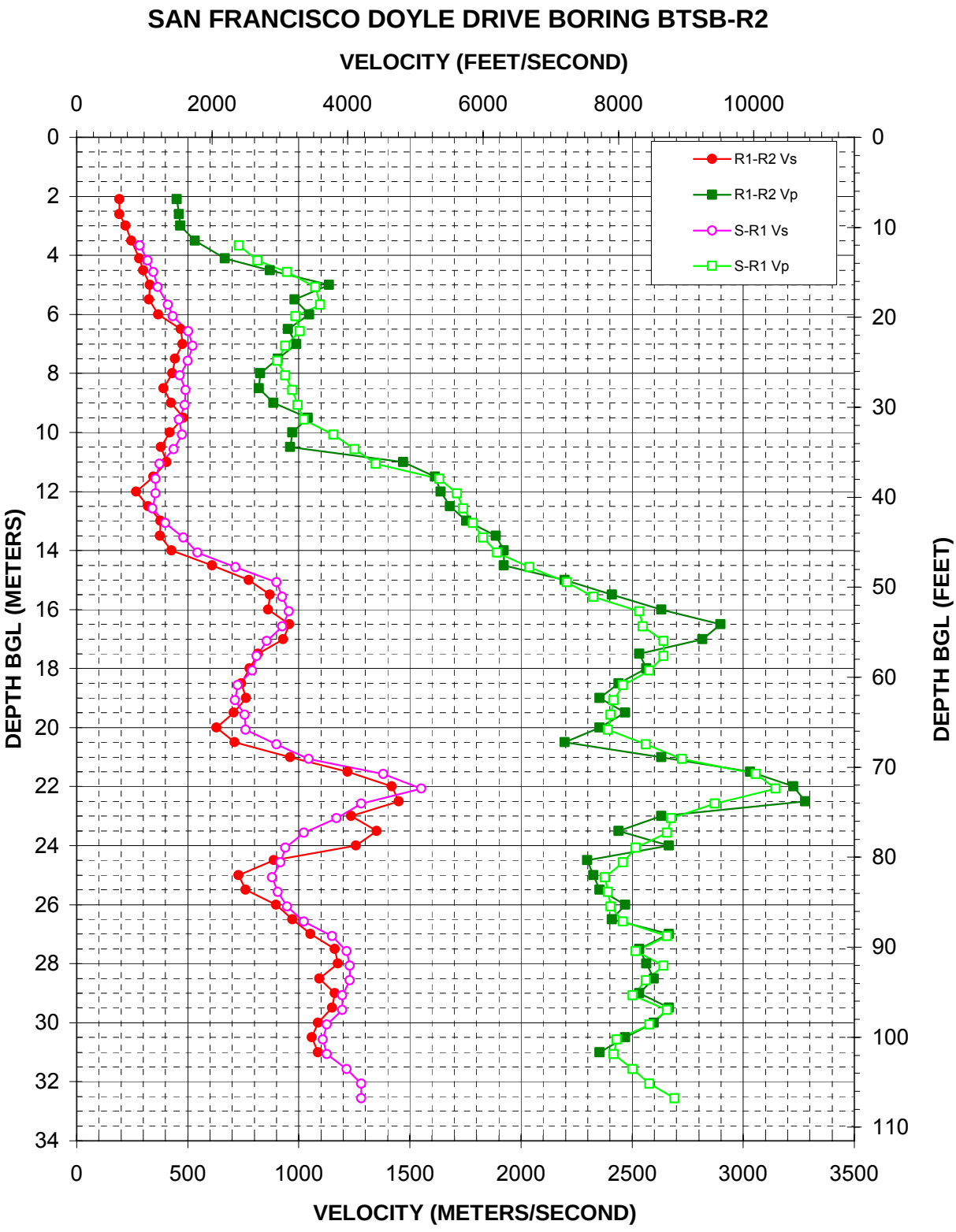


Figure A-4. Boring BTSB-R2, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
12.04	930	2396
13.68	1048	2670
14.99	1132	3107
16.63	1200	3528
18.60	1350	3601
19.91	1421	3235
21.56	1652	3296
23.20	1712	3079
24.84	1644	2962
26.48	1523	3079
28.12	1607	3184
29.76	1599	3266
31.40	1510	3359
33.04	1557	3795
34.68	1436	4106
36.32	1225	4416
37.96	1168	5360
39.60	1168	5617
41.24	1120	5708
42.88	1307	5851
44.52	1578	6001
46.16	1787	6213
47.80	2348	6687
49.44	2950	7238
51.08	3039	7632
52.72	3134	8309
54.36	3039	8358
56.00	2808	8668
57.64	2659	8668
59.28	2591	8459
60.93	2380	8070
62.57	2340	7933
64.21	2481	7889
65.85	2499	7845
67.49	2950	8408
69.13	3425	8944
70.77	4530	10030
72.41	5088	10325
74.05	4204	9424
75.69	3837	8776
77.33	3359	8722
78.97	3079	8260
80.61	3013	8070
82.25	2889	7801
83.89	2975	7845
85.53	3107	7889
87.17	3359	8070
88.81	3775	8722
90.45	3989	8260
92.09	4035	8668
93.73	4035	8408
95.37	3922	8212
97.01	3922	8722
98.65	3695	8459
100.30	3638	7978
101.94	3695	7933
103.58	3989	8212
105.22	4204	8459
106.86	4204	8831

Table A-4. Boring BTSB-R2, S - R1 quality assurance analysis P- and S_H-wave data

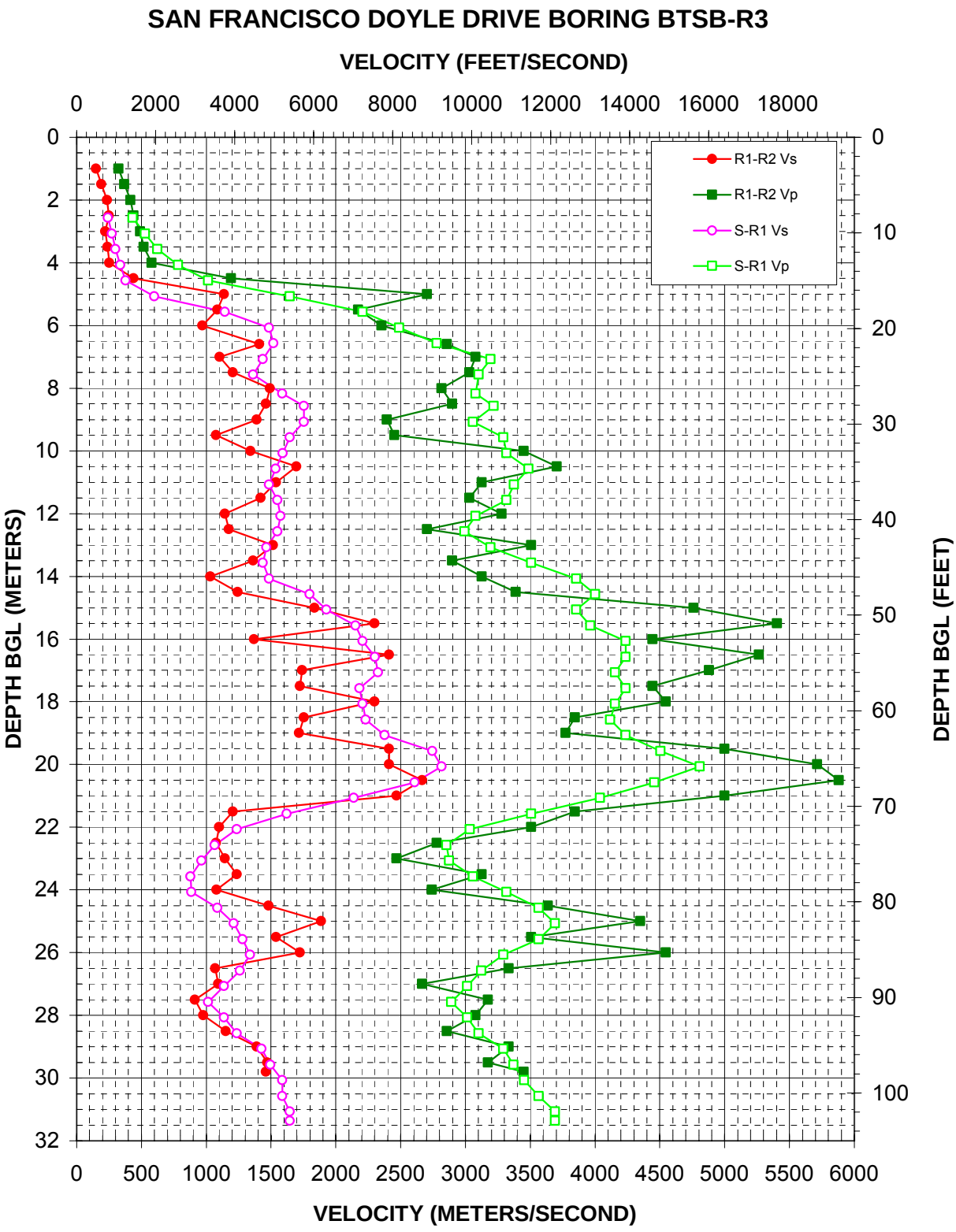


Figure A-5. Boring BTSB-R3, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
8.43	793	1418
10.07	889	1734
11.71	982	2047
13.35	1106	2572
14.99	1243	3327
16.63	1961	5401
18.27	3755	7238
19.91	4876	8164
21.56	4979	9118
23.20	4712	10479
24.84	4472	10175
26.80	5201	10102
28.12	5755	10558
29.76	5755	10030
31.40	5401	10802
33.04	5220	10885
34.68	5037	11435
36.32	4876	11074
37.96	5088	10885
39.60	5162	10102
41.24	5088	9820
42.88	4809	10479
44.52	4712	11510
46.16	4876	12650
47.80	5900	13123
49.44	6325	12650
51.08	7056	13002
52.72	7238	13903
54.36	7549	13903
56.00	7632	13633
57.64	7164	13903
59.28	7238	13633
60.93	7314	13502
62.57	7801	13903
64.21	9001	14781
65.85	9238	15778
67.49	8562	14627
69.13	7021	13247
70.77	5319	11510
72.41	4058	9959
74.05	3493	9361
75.69	3163	9424
77.33	2877	10030
78.97	2901	10885
80.61	3564	11702
82.25	3978	12105
83.89	4204	11702
85.53	4388	10802
87.17	4130	10250
88.81	3735	9889
90.45	3327	9488
92.09	3735	9889
93.73	4058	10175
95.37	4681	10802
97.01	4910	11057
98.65	5201	11324
100.30	5201	11702
101.94	5401	12105
102.92	5401	12105

Table A-5. Boring BTSB-R3, S - R1 quality assurance analysis P- and S_H-wave data

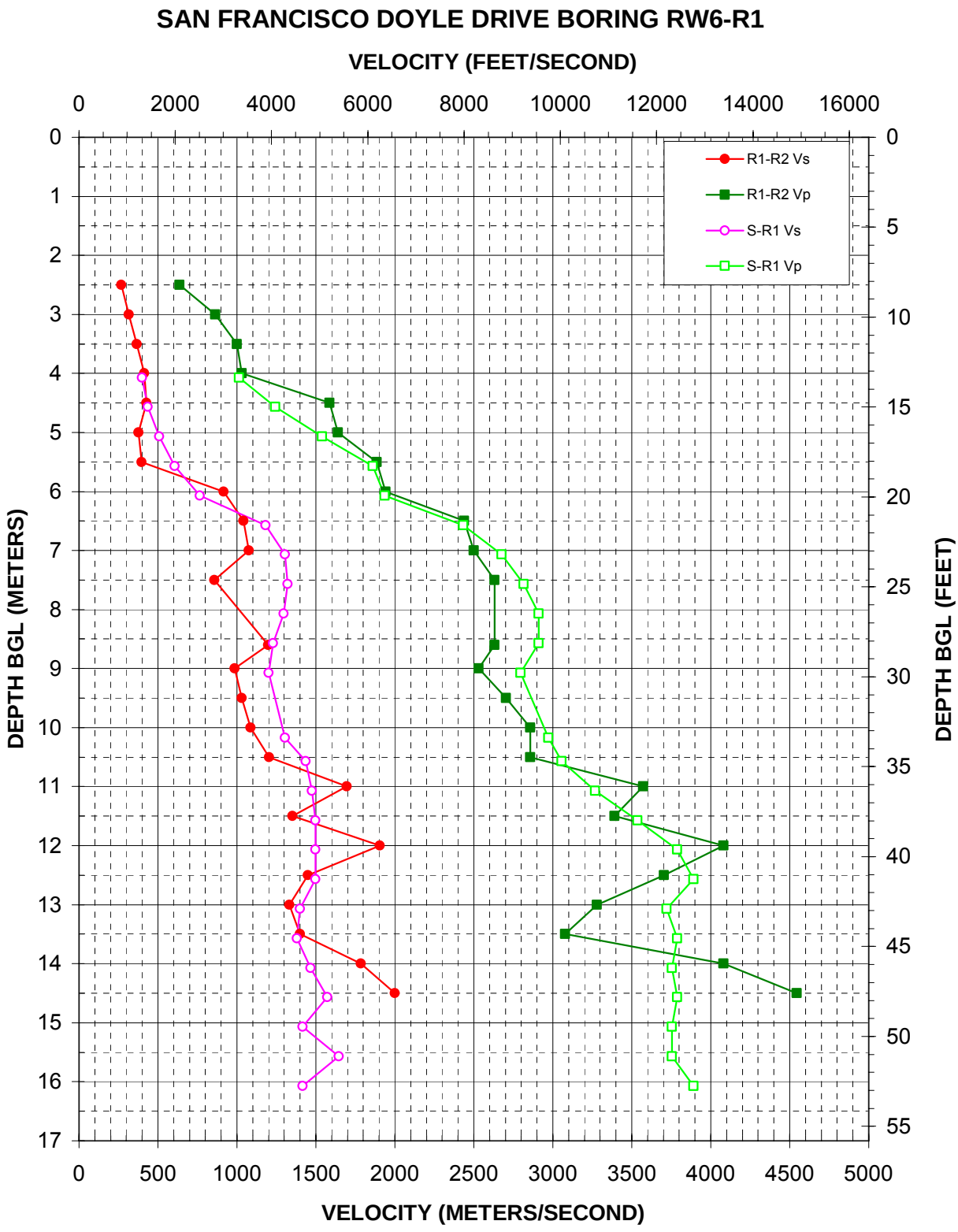


Figure A-6. Boring RW6-R1, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
13.35	1312	3327
14.99	1433	4082
16.63	1668	5051
18.27	1989	6105
19.91	2507	6354
21.56	3879	7978
23.20	4281	8776
24.84	4334	9238
26.48	4255	9552
28.12	4035	9552
29.76	3944	9178
33.37	4281	9751
34.68	4712	10030
36.32	4842	10719
37.96	4910	11605
39.60	4910	12427
41.24	4910	12765
42.88	4589	12210
44.52	4530	12427
46.16	4809	12318
47.80	5162	12427
49.44	4650	12318
51.08	5401	12318
52.72	4650	12765

Table A-6. Boring RW6-R1, S - R1 quality assurance analysis P- and S_H-wave data

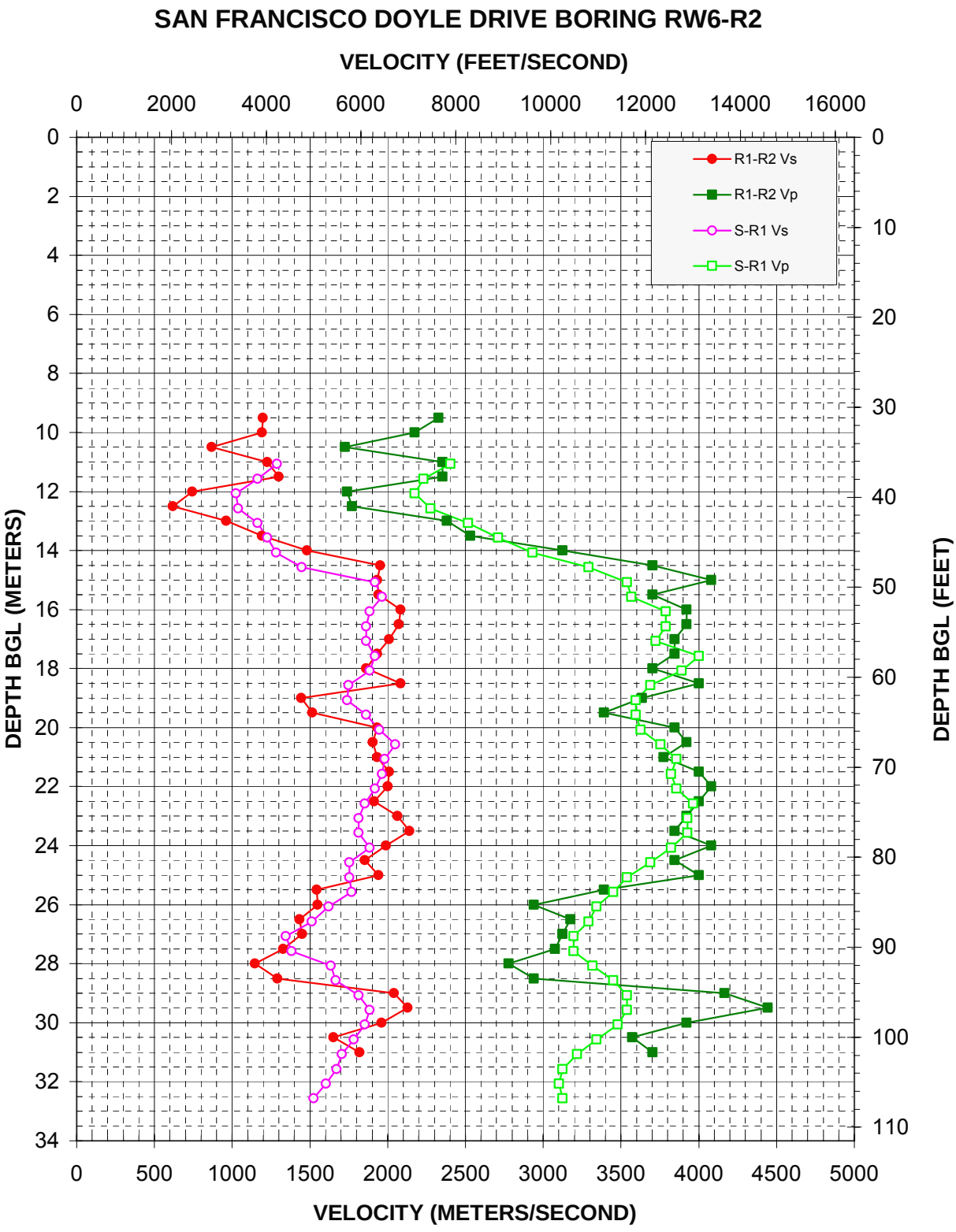


Figure A-7. Boring RW6-R2, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
36.32	4230	7889
37.96	3816	7314
39.60	3359	7128
41.24	3408	7469
42.88	3816	8260
44.52	4023	8887
46.16	4204	9618
47.80	4744	10802
49.44	6297	11605
51.08	6441	11702
52.72	6186	12427
54.36	6105	12427
56.00	6105	12210
57.64	6297	13123
59.28	6186	12765
60.93	5731	12105
62.57	5708	11800
64.21	6105	11800
65.85	6383	11900
67.49	6719	12318
69.13	6501	12650
70.77	6441	12537
72.41	6297	12650
74.05	6079	13002
75.69	5950	12883
77.33	5950	12883
78.97	6186	12537
80.61	5755	12105
82.25	5755	11605
83.89	5802	11324
85.53	5319	10970
87.17	4962	10802
88.81	4416	10479
90.45	4530	10479
92.09	5360	10885
93.73	5464	11324
95.37	5950	11605
97.01	6186	11605
98.65	6079	11416
100.30	5851	10970
101.94	5594	10558
103.58	5485	10250
105.22	5259	10175
106.86	4997	10250

Table A-7. Boring RW6-R2, S - R1 quality assurance analysis P- and S_H-wave data

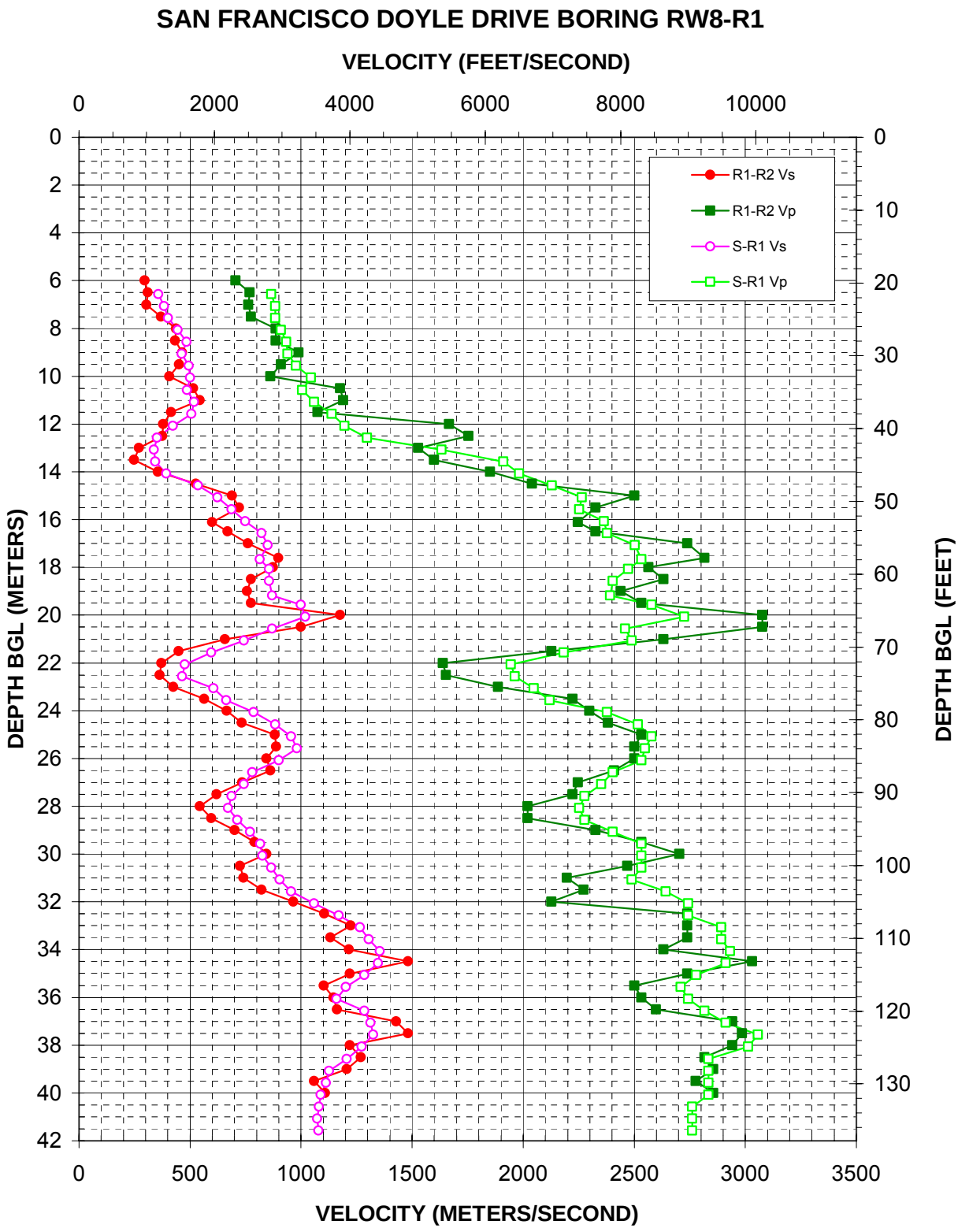


Figure A-8. Boring RW8-R1, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
21.56	1170	2843
23.20	1261	2901
24.84	1317	2901
26.48	1460	2988
28.12	1592	3066
29.76	1516	3079
31.40	1621	3206
33.04	1644	3425
34.68	1599	3296
36.32	1700	3476
37.96	1660	3735
39.60	1390	3922
41.24	1157	4255
42.88	1109	5360
44.52	1131	6269
46.16	1293	6501
47.80	1760	6986
49.44	2047	7430
51.08	2258	7391
52.72	2455	7758
54.36	2700	7801
56.00	2786	8212
57.97	2670	8309
59.28	2808	8117
60.93	2808	7889
62.89	2854	7845
64.21	3281	8459
65.85	3343	8944
67.49	2854	8070
69.13	2438	8164
70.77	1956	7164
72.41	1564	6383
74.05	1523	6441
75.69	1989	6719
77.33	2174	6951
78.97	2581	7801
80.61	2901	8260
82.25	3134	8459
83.89	3221	8358
85.53	2950	8309
87.17	2562	7889
88.81	2438	7715
90.45	2258	7469
92.09	2201	7391
93.73	2340	7469
95.37	2526	7889
97.01	2680	8309
98.65	2711	8309
100.30	2843	8309
101.94	2962	8164
103.58	3134	8668
105.22	3476	9001
106.86	3837	9001
108.50	4154	9488
110.14	4281	9488
111.78	4444	9618
113.42	4416	9552
115.06	4217	9118
116.70	3944	8887
118.34	3805	9001
119.98	4217	9238
121.62	4307	9552
123.26	4347	10030
124.90	4179	9889
126.54	3955	9299
128.18	3695	9299
129.82	3647	9299
131.46	3573	9299
133.10	3546	9059
134.74	3519	9059
136.38	3537	9059

Table A-8. Boring RW8-R1, S - R1 quality assurance analysis P- and S_H-wave data

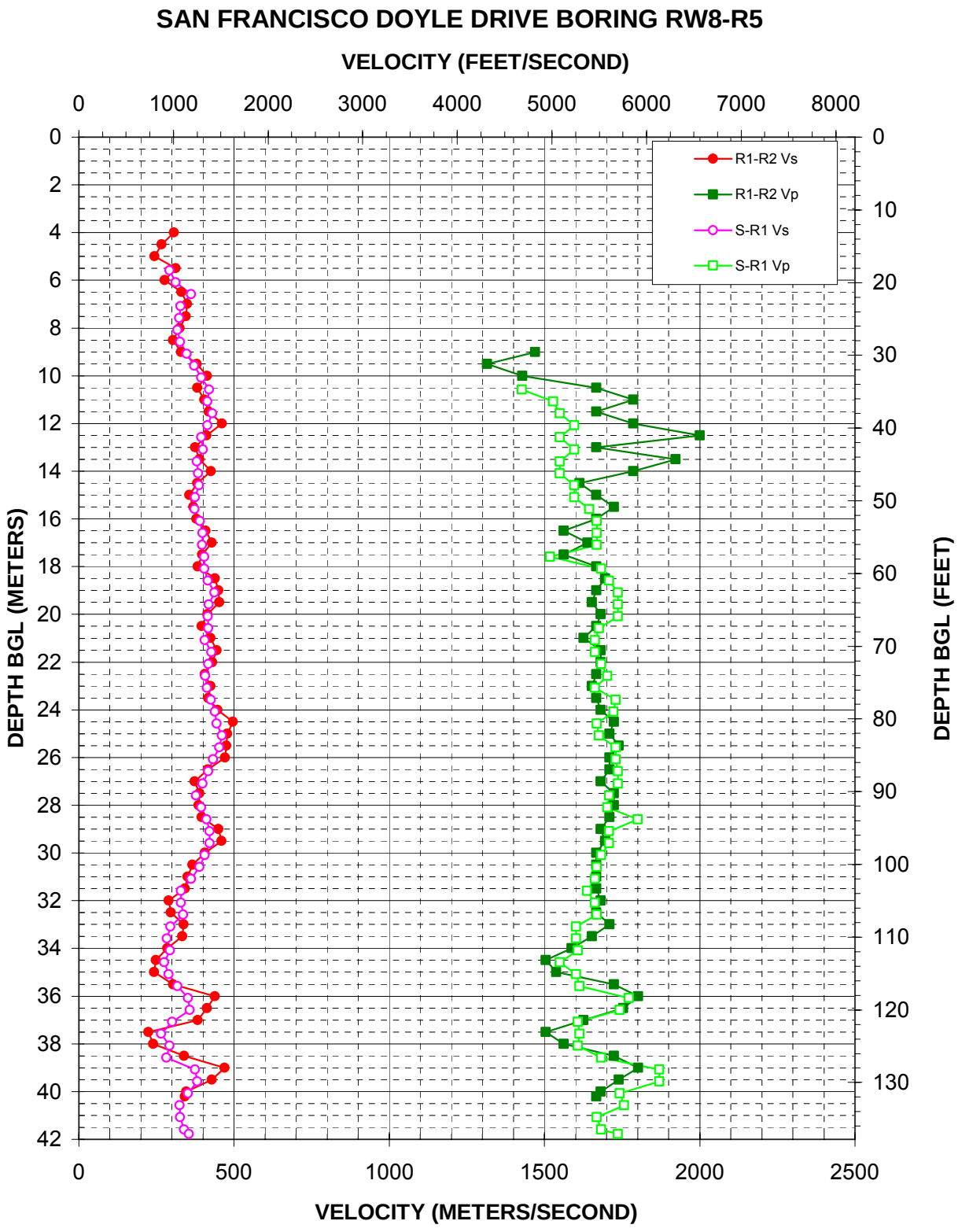


Figure A-9. Boring RW8-R5, R1 - R2 high resolution analysis and S - R1 quality assurance analysis P- and S_H-wave data

Depth (feet)	V_s (feet/sec)	V_p (feet/sec)
18.32	957	-
19.96	1023	-
21.60	1187	-
23.24	1075	-
24.88	1063	-
26.53	1041	-
28.17	1072	-
29.81	1141	-
31.45	1219	-
33.09	1294	-
34.73	1380	4684
36.37	1359	5014
38.01	1413	5085
39.65	1359	5235
41.29	1294	5085
42.93	1314	5235
44.57	1249	5085
46.21	1262	5085
47.85	1271	5235
49.49	1227	5235
51.13	1223	5394
52.77	1280	5476
54.41	1309	5476
56.05	1304	5476
57.69	1328	4979
59.33	1328	5519
60.97	1364	5606
62.61	1435	5696
64.25	1374	5696
65.89	1364	5696
67.54	1366	5498
69.18	1331	5455
70.82	1401	5455
72.46	1366	5519
74.10	1338	5584
75.74	1356	5455
77.38	1399	5673
79.02	1438	5650
80.66	1459	5476
82.30	1515	5498
83.94	1486	5673
85.58	1418	5673
87.22	1369	5696
88.86	1306	5696
90.50	1238	5606
92.14	1294	5584
93.78	1348	5908
95.42	1382	5606
97.06	1382	5606
98.70	1331	5519
100.34	1274	5476
101.98	1187	5455
103.62	1082	5373
105.26	1080	5455
106.90	1104	5476
108.55	967	5254
110.19	932	5254
111.83	962	5274
113.47	901	5085
115.11	949	5254
116.75	1041	5293
118.39	1156	5812
120.03	1175	5718
121.67	989	5274
123.31	870	5293
124.95	959	5274
126.59	927	5519
128.23	1227	6137
129.87	1253	6137
131.51	1156	5718
133.15	1066	5765
134.79	1071	5476
136.43	1112	5519
137.09	1163	5696

Table A-9. Boring RW8-R5, S - R1 quality assurance analysis P- and S_H-wave data

APPENDIX B

TELEVIEWER BASED CALIPER LOGS

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

16 Jun 2008

ARUP

Borehole: BTNB-R4

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

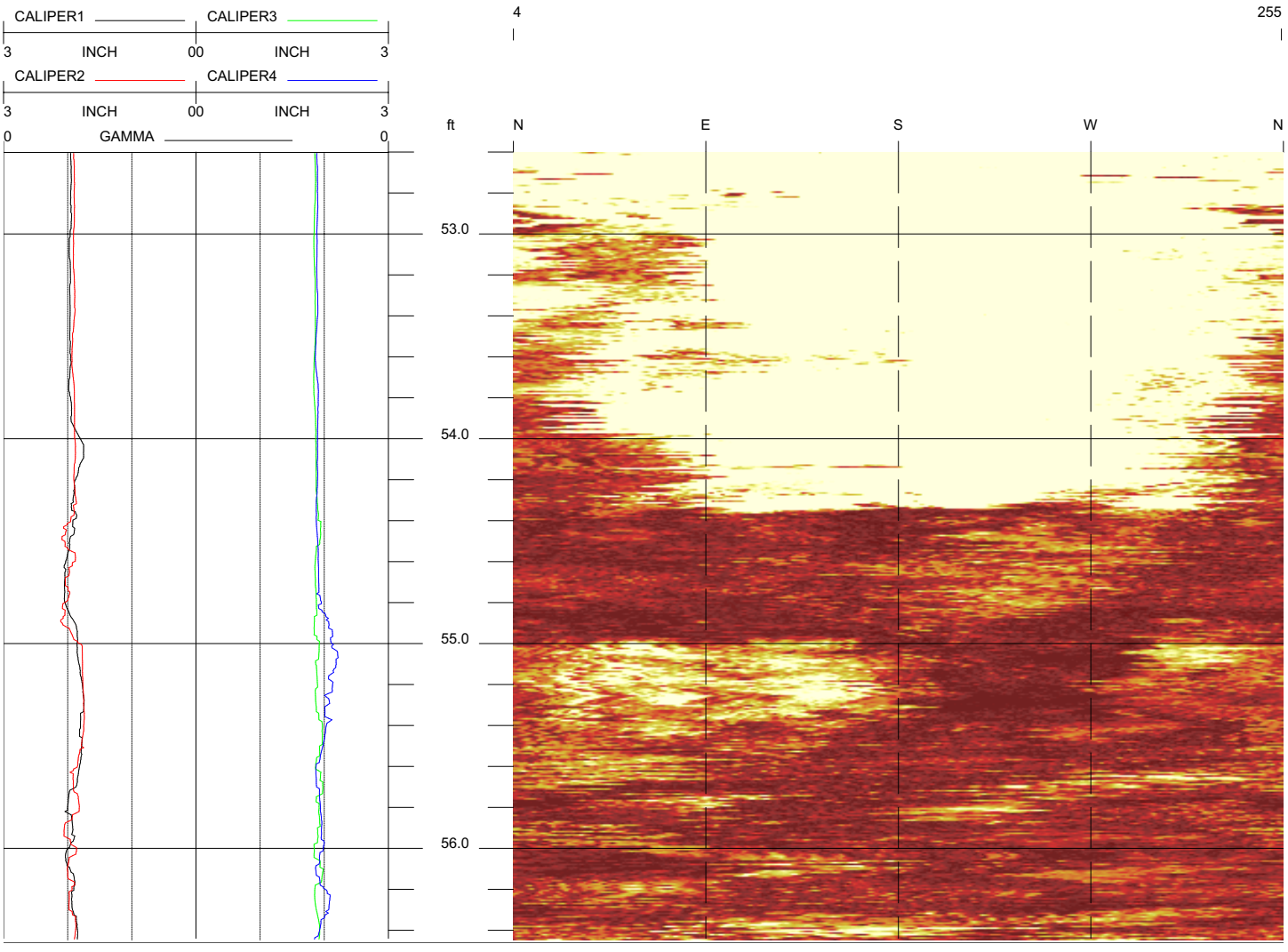
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 123.060 to 52.600ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE

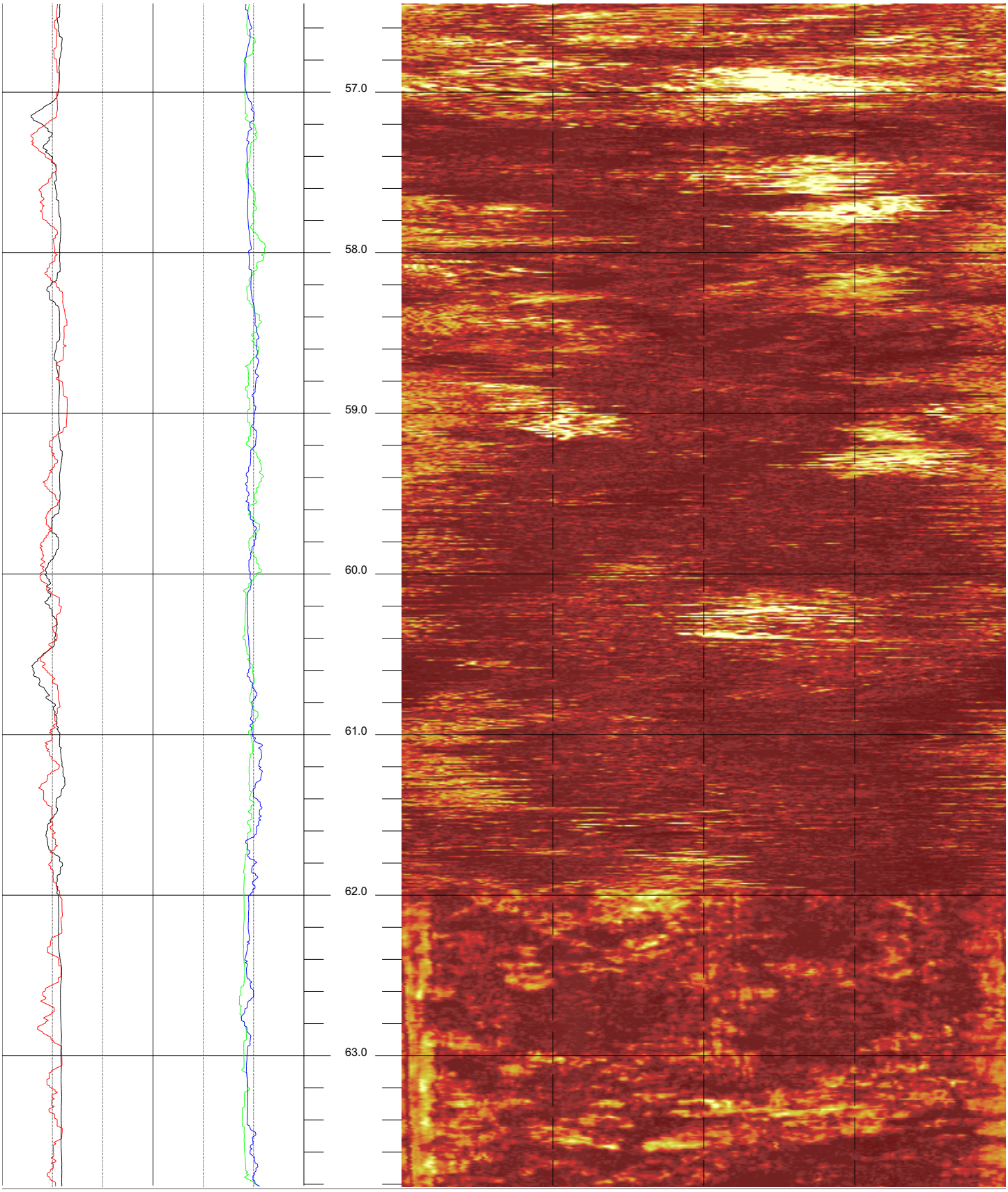


BTNB-R4

56.448 to 52.600ft

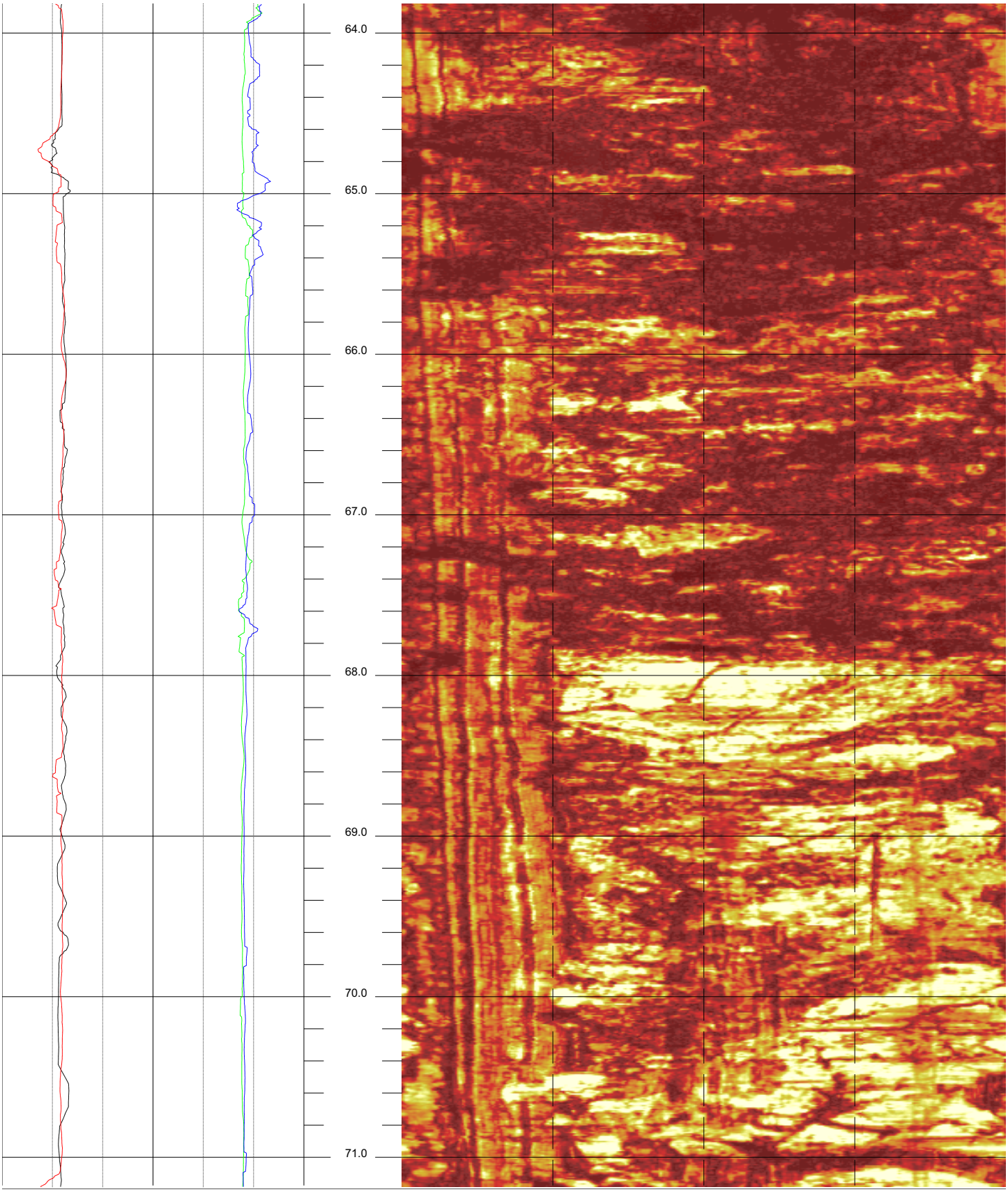
1

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 1 of 11



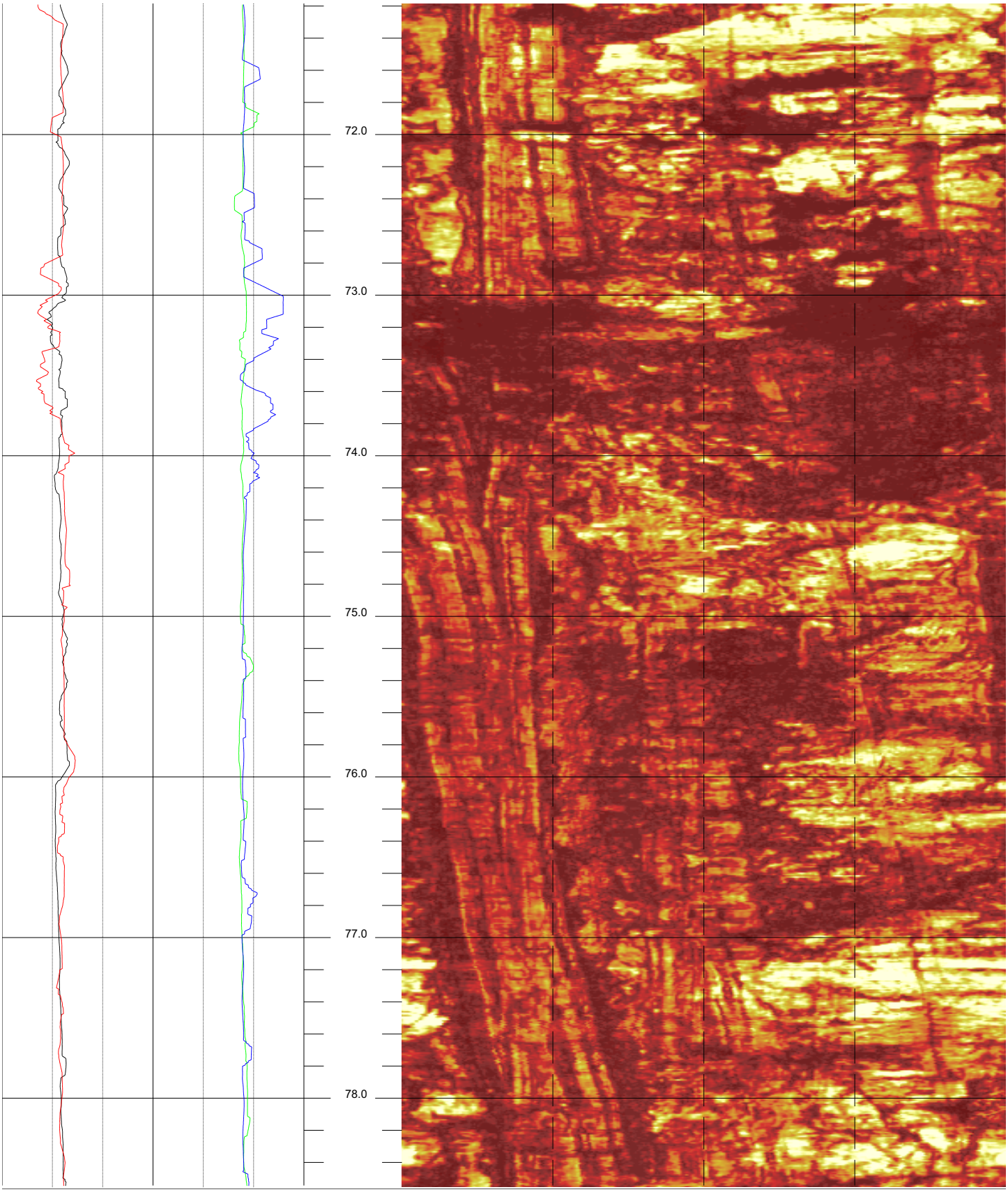
BTNB-R4 63.816 to 56.448ft 2

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 2 of 11



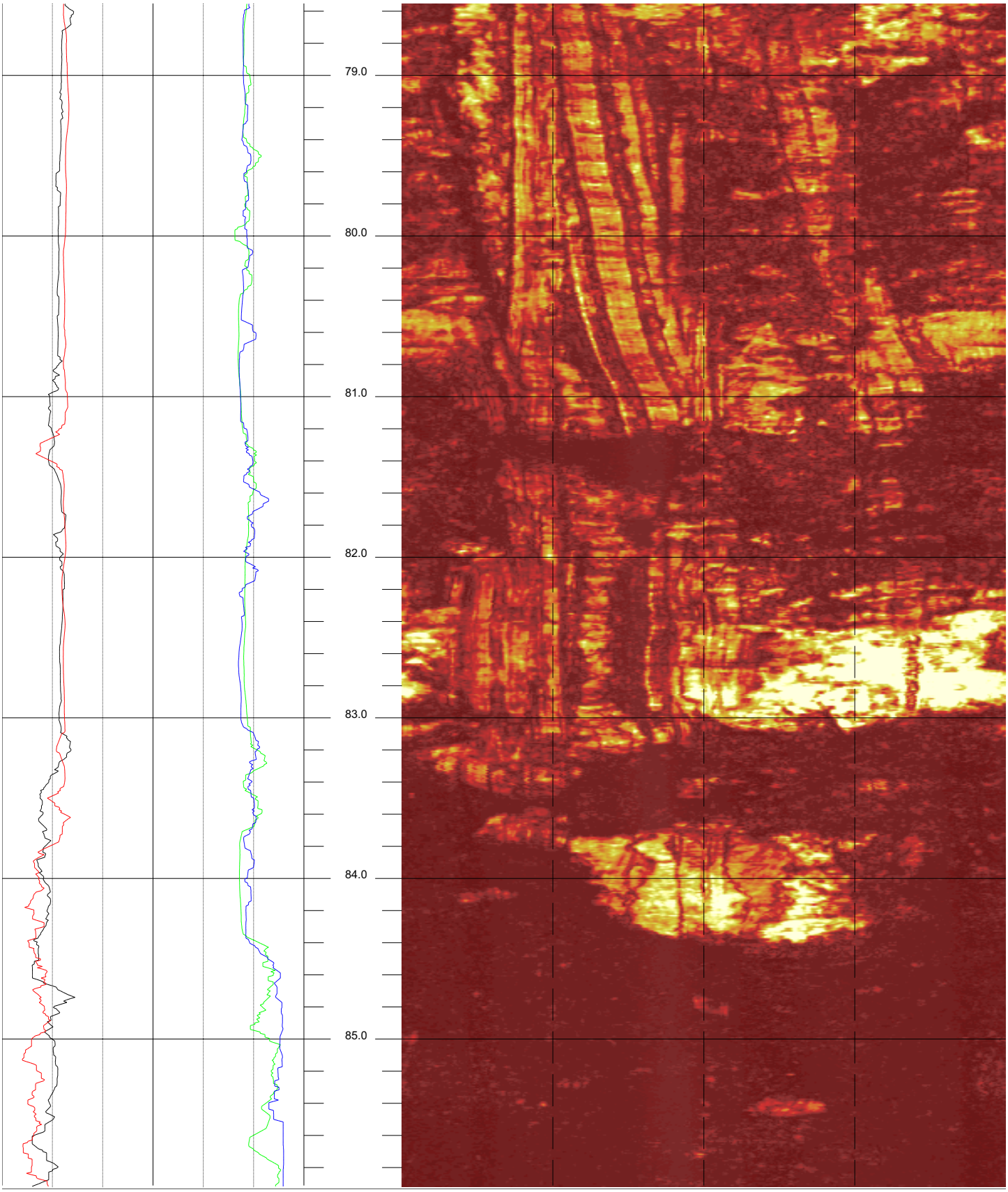
BTNB-R4 71.184 to 63.816ft 3

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 3 of 11



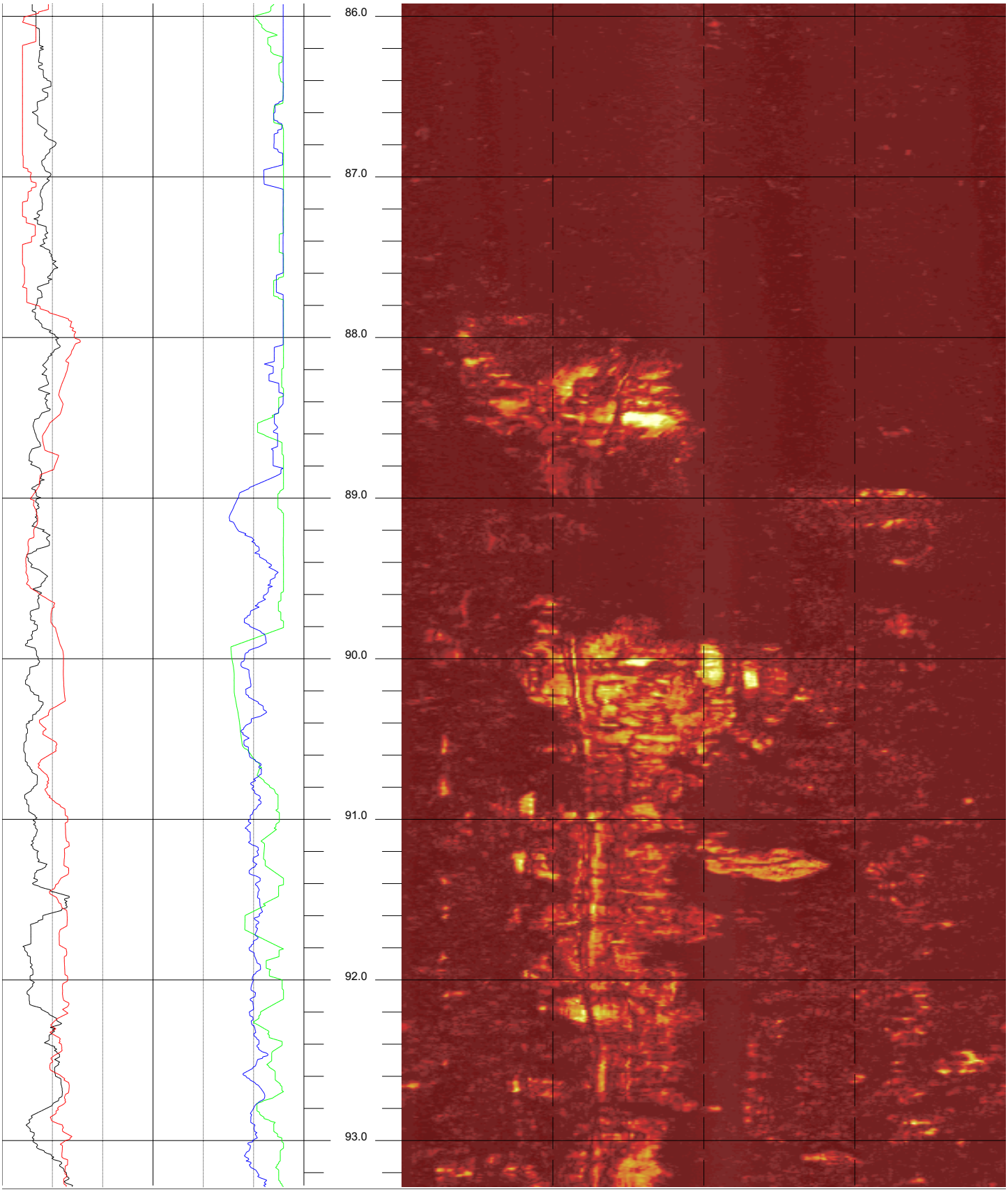
BTNB-R4 78.552 to 71.184ft 4

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 4 of 11



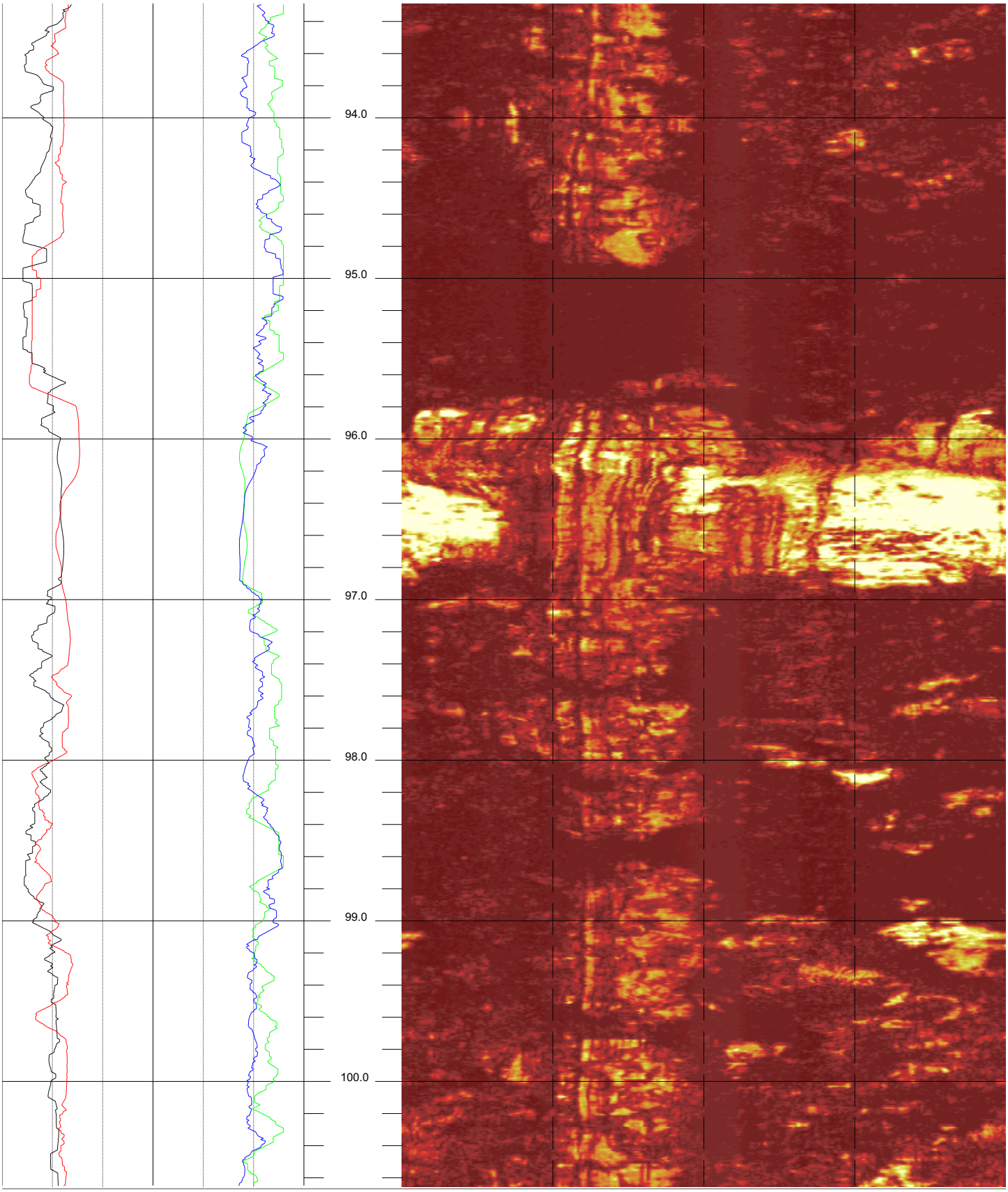
BTNB-R4 85.920 to 78.552ft 5

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 5 of 11



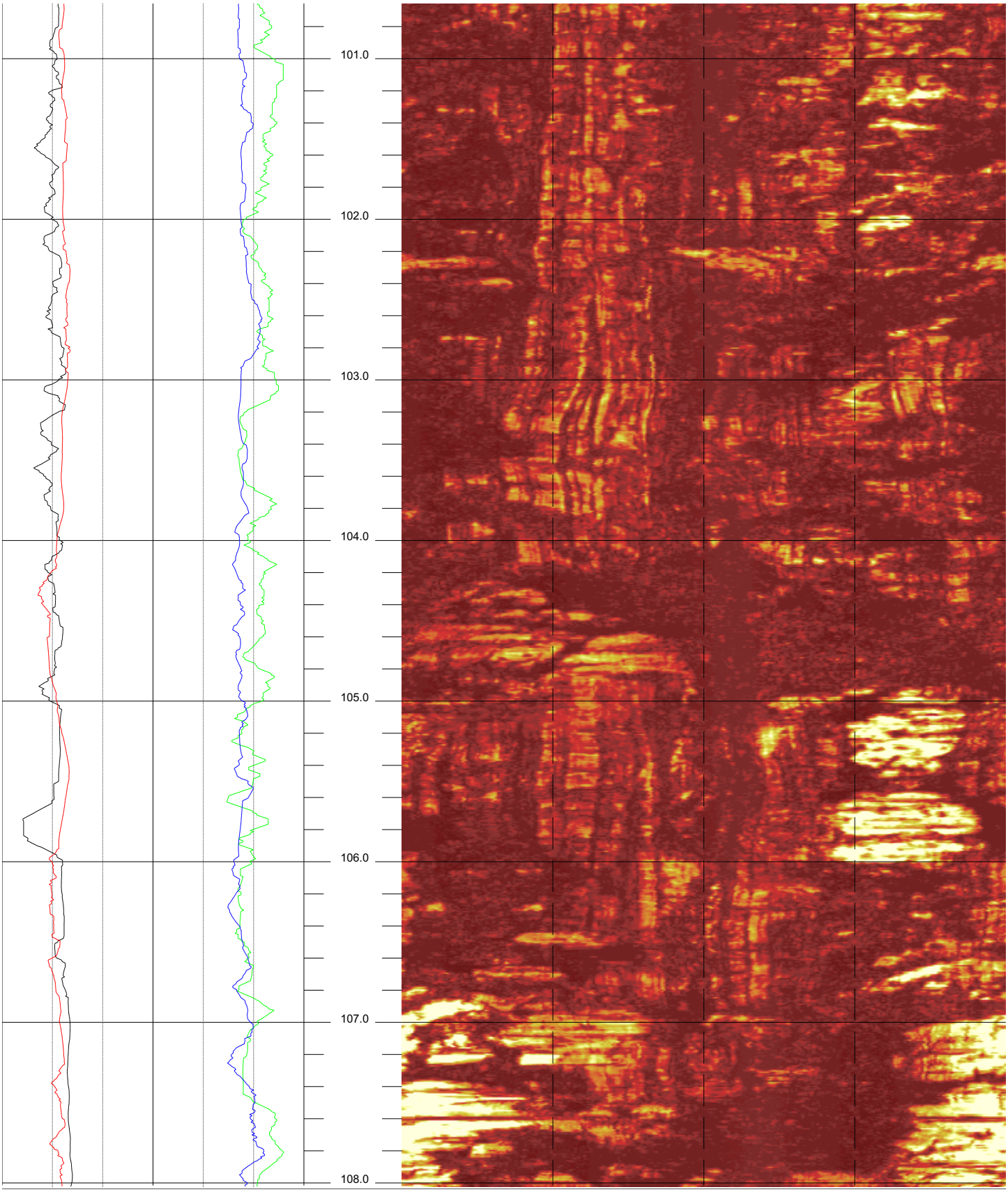
BTNB-R4 93.288 to 85.920ft 6

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 6 of 11



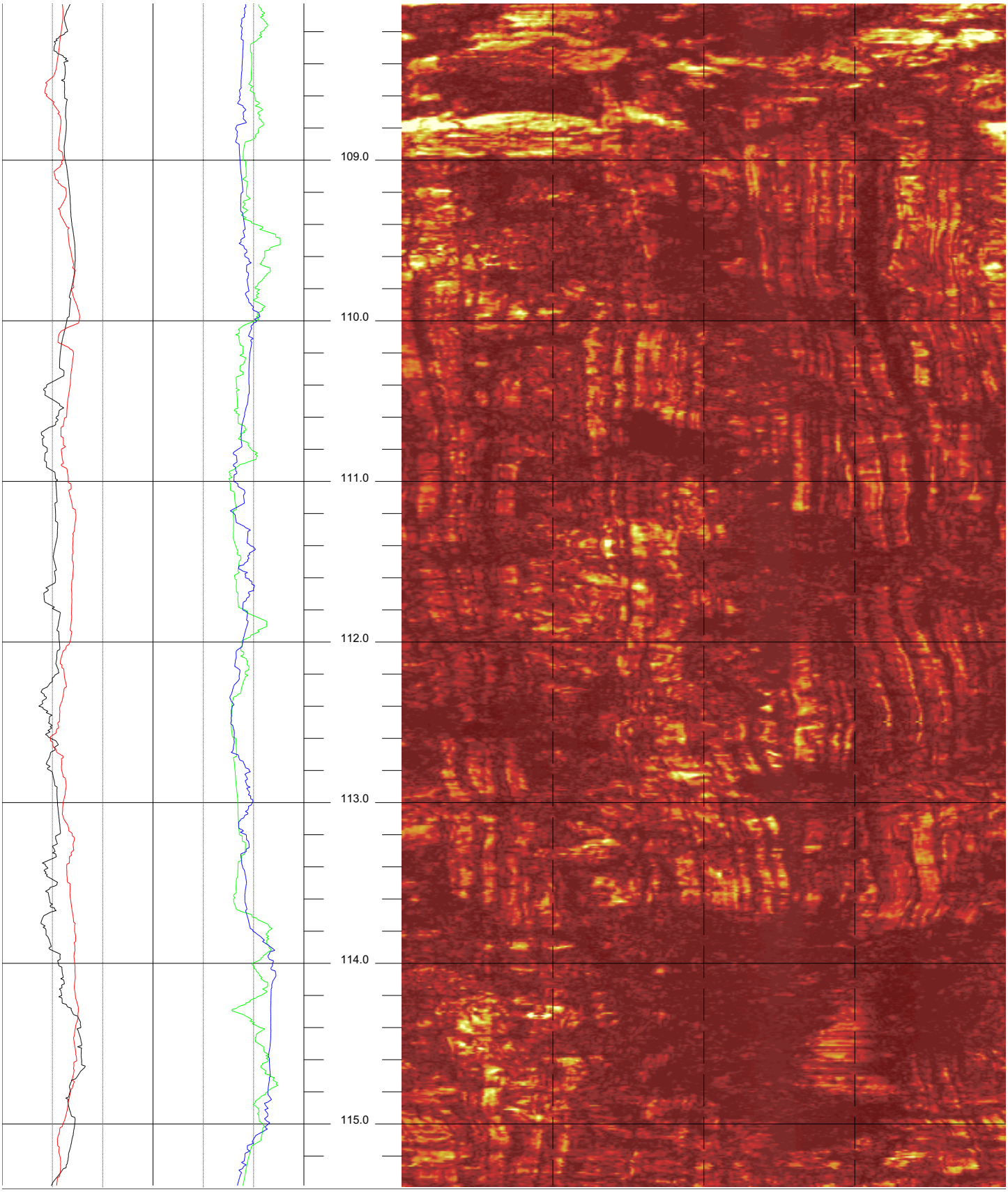
BTNB-R4 100.656 to 93.288fl 7

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 7 of 11



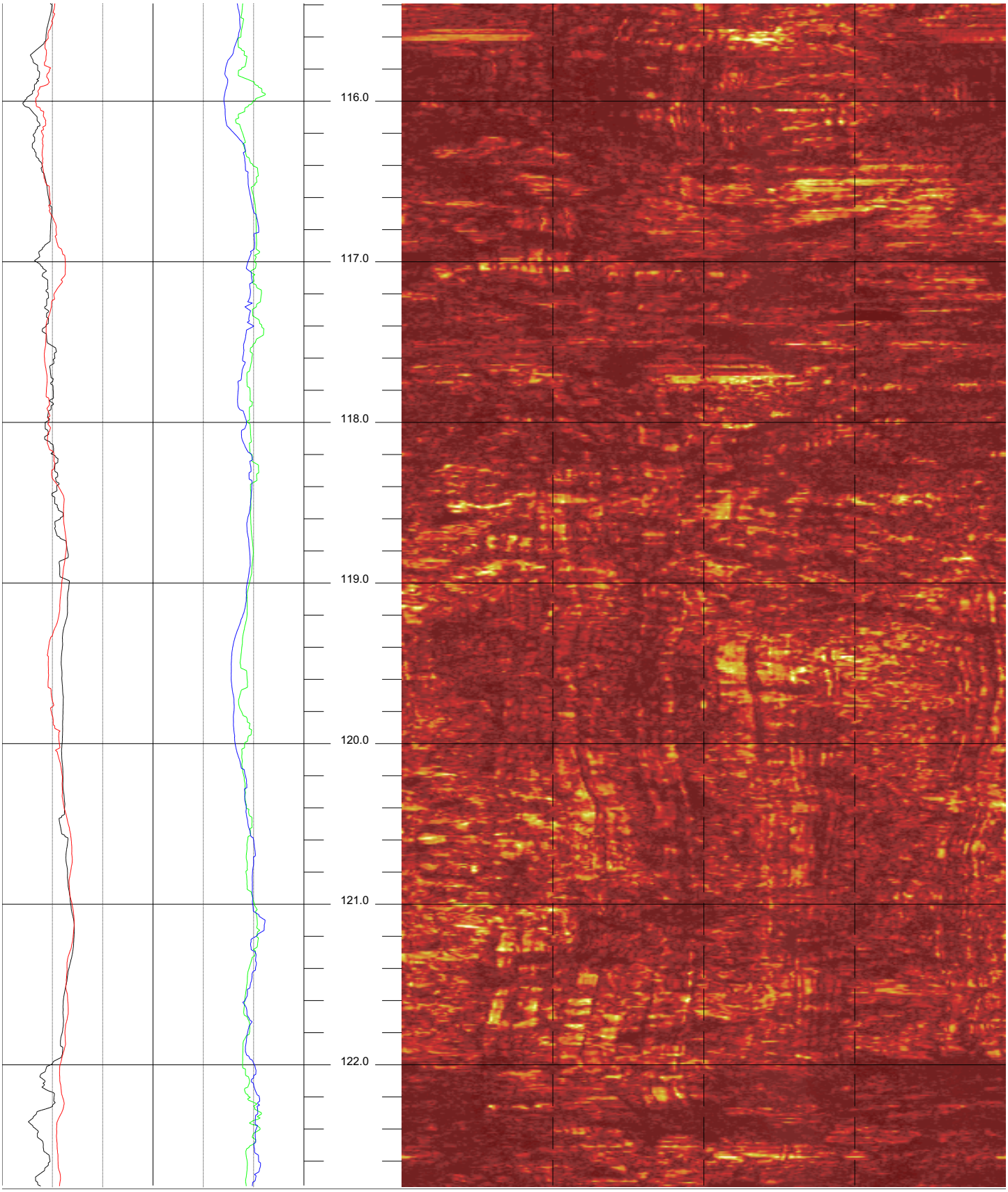
BTNB-R4 108.024 to 100.656fl 8

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 8 of 11



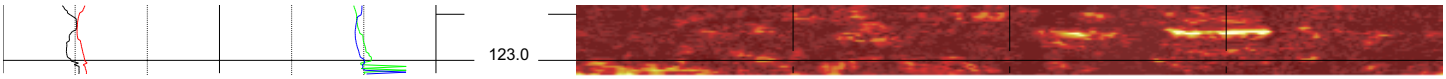
BTNB-R4 115.392 to 108.024fl 9

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 9 of 11



BTNB-R4 122.760 to 115.392fl 10

Doyle Drive BTNB-R4 Acoustic Televiewer based Caliper Sheet 10 of 11


123.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

16 Jun 2008

ARUP

Borehole: BTNB-R5

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

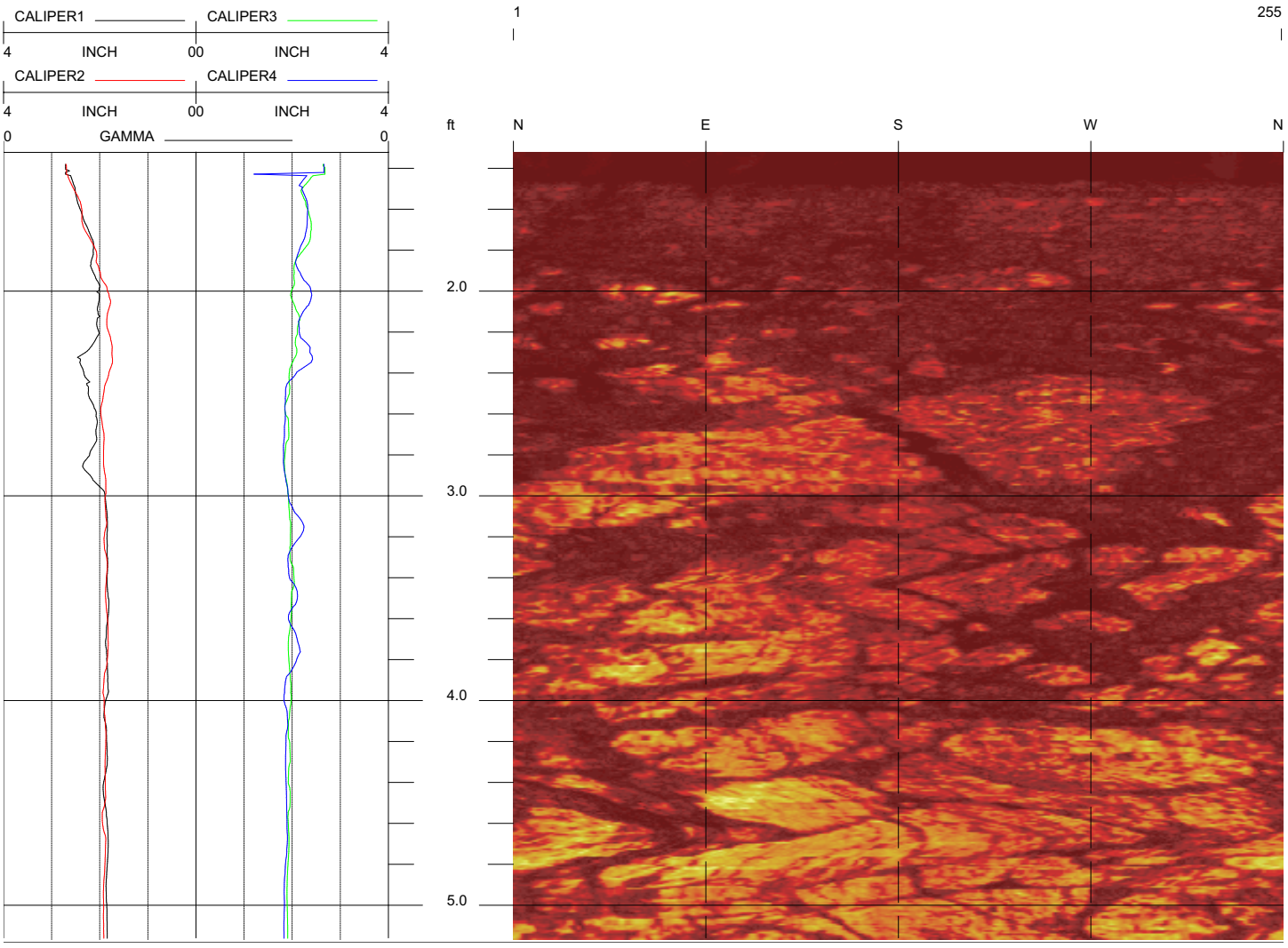
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 106.160 to 1.320ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

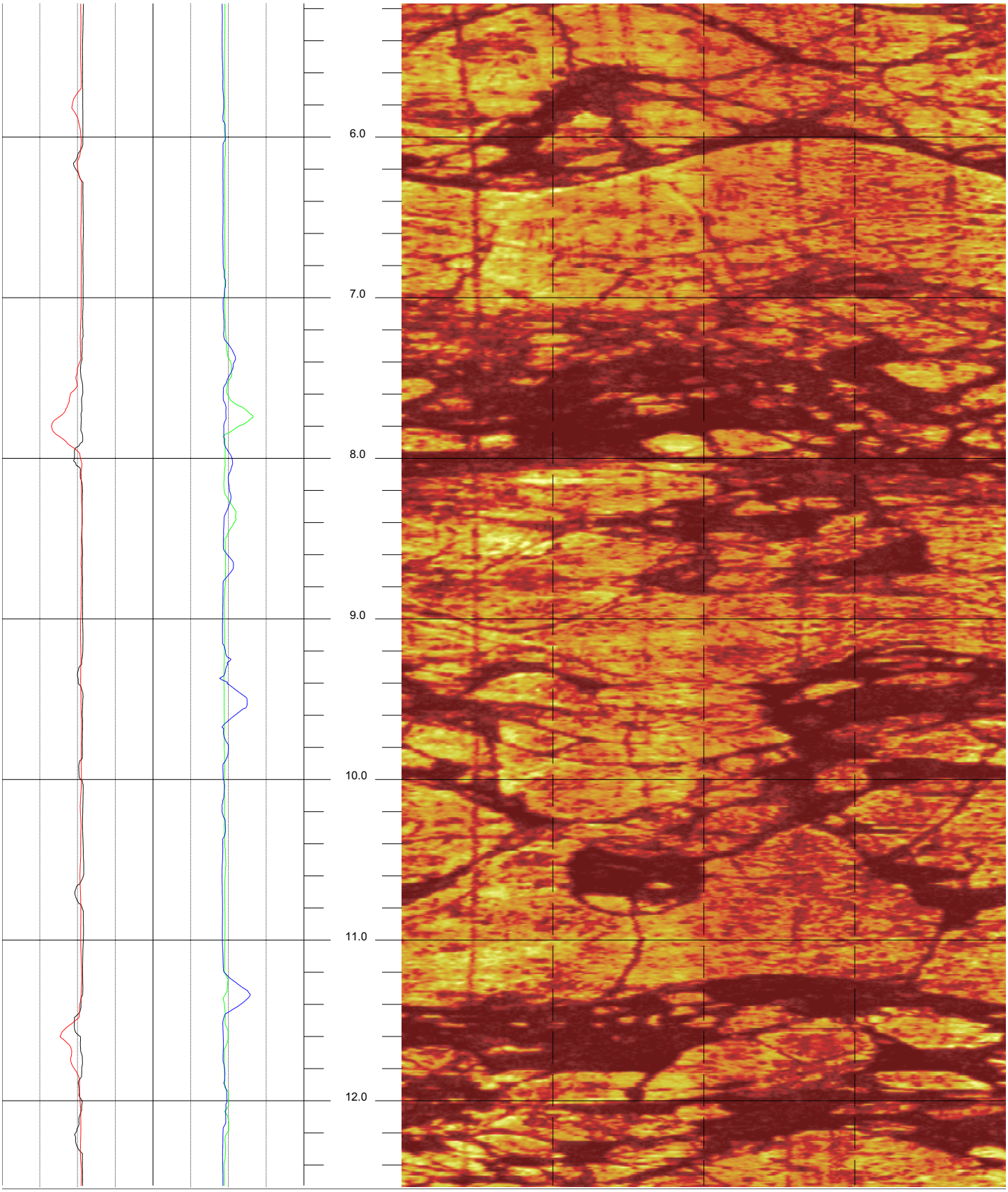
Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE



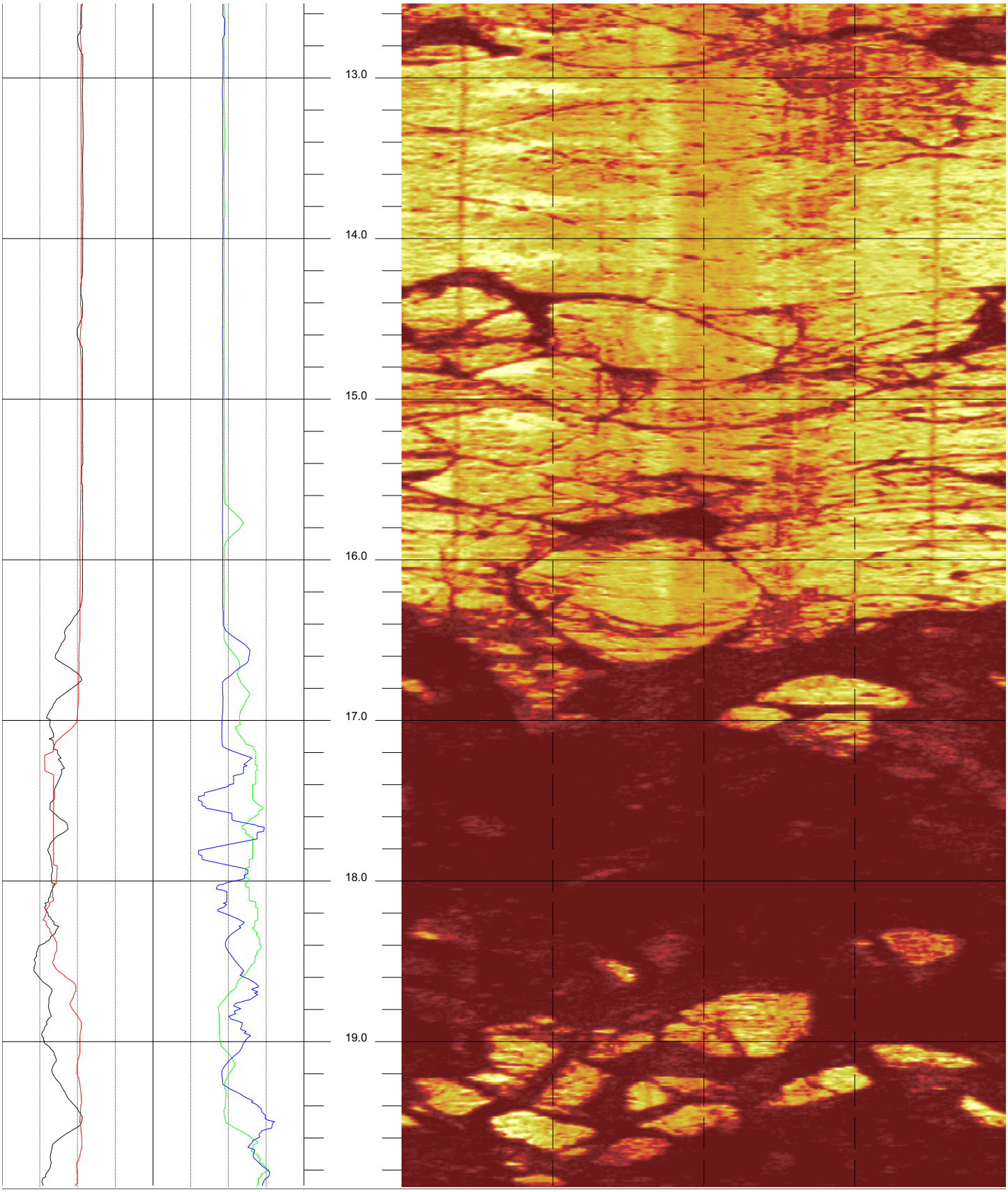
BTNB-R5 5.168 to 1.320fl 1

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 1 of 15



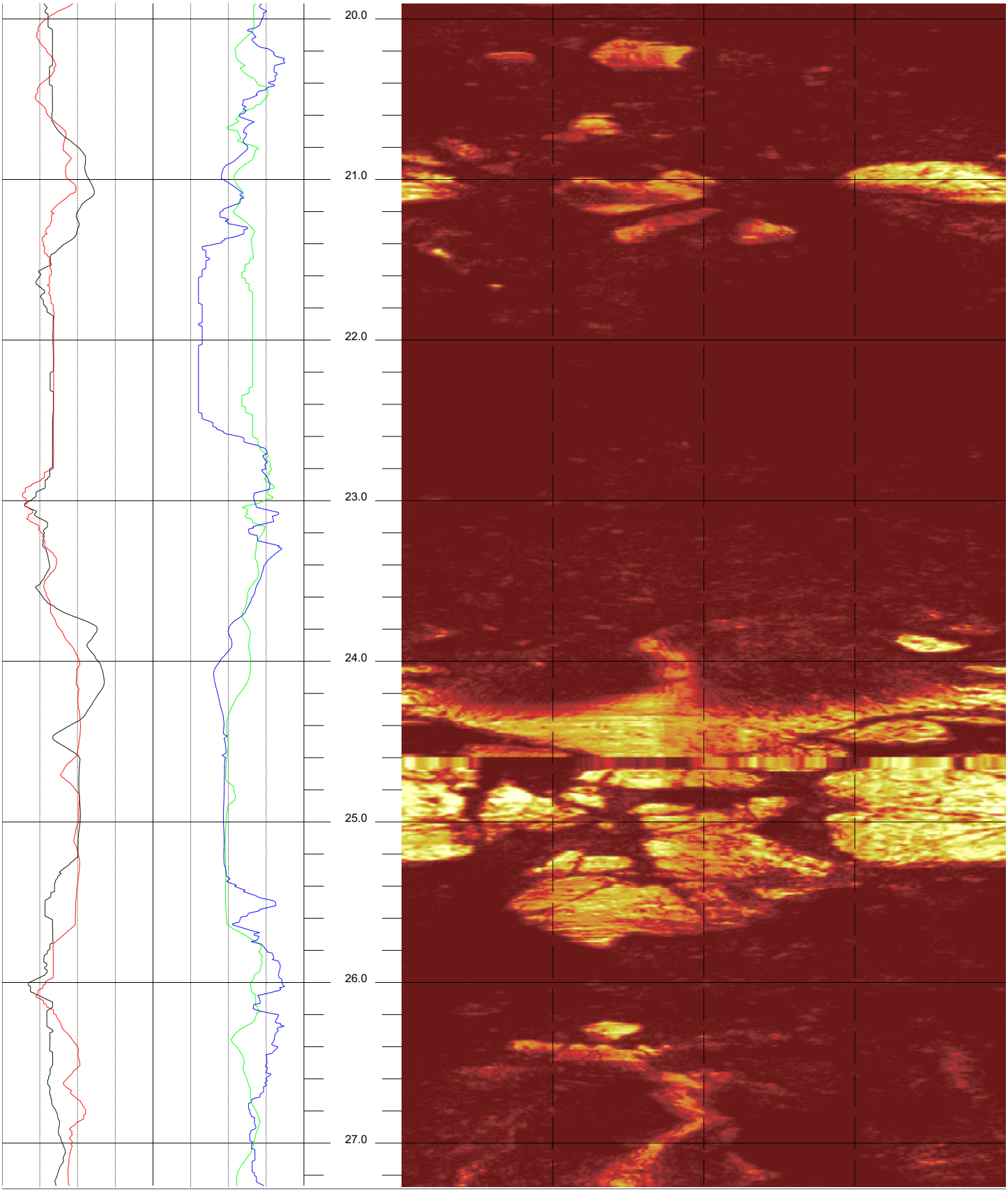
BTNB-R5 12.536 to 5.168ft 2

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 2 of 15



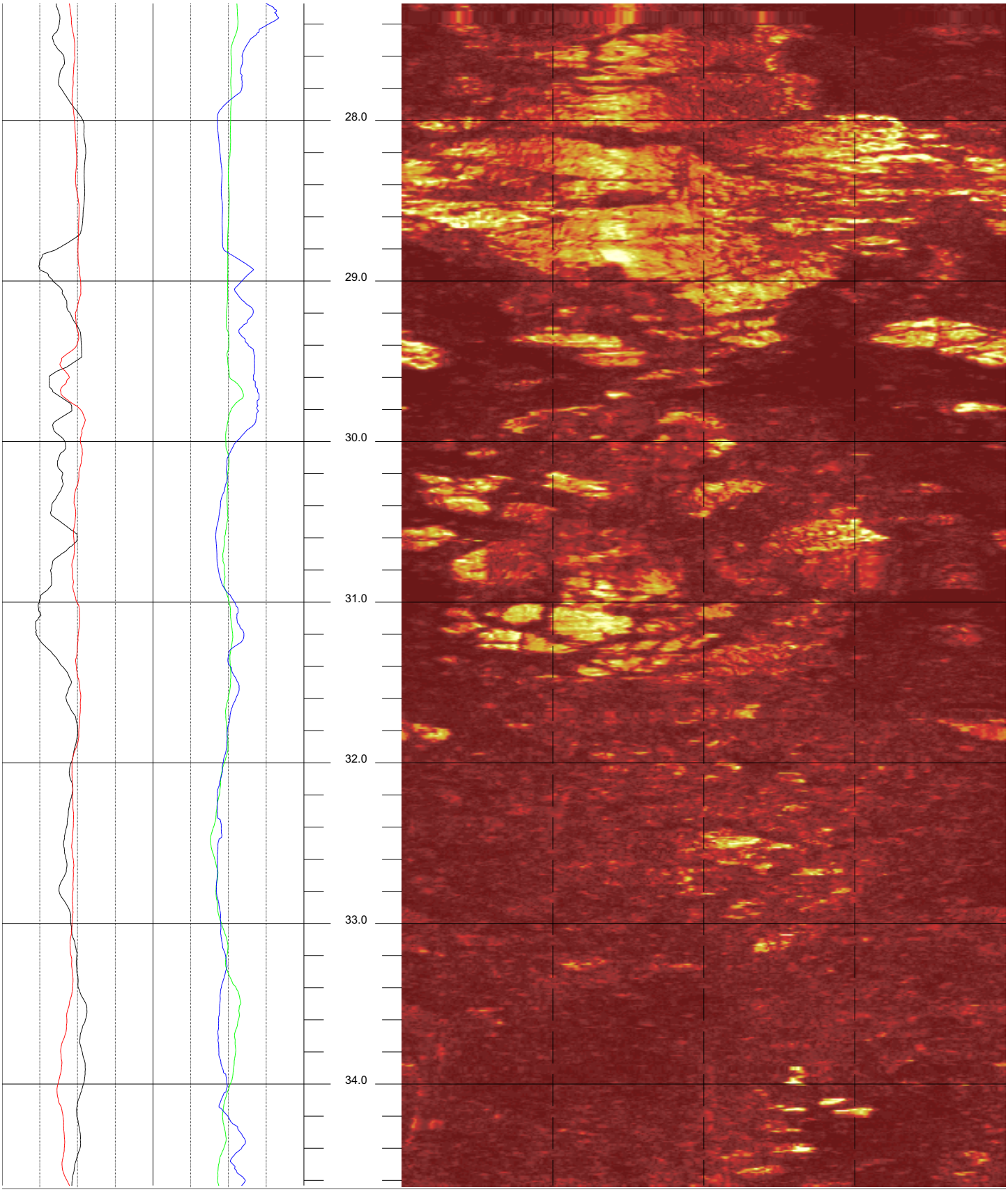
BTNB-R5 19.904 to 12.536ft 3

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 3 of 15



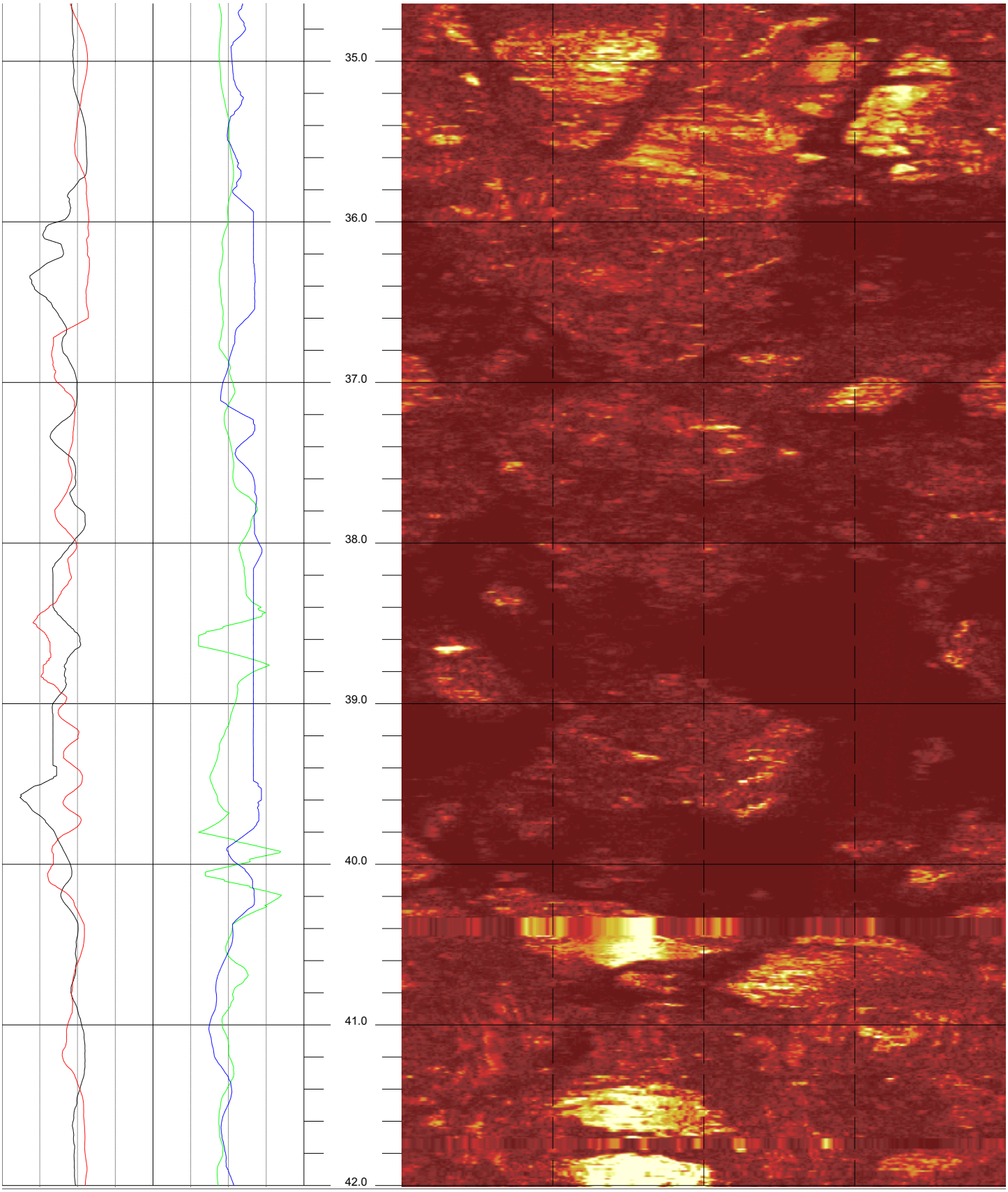
BTNB-R5 27.272 to 19.904ft 4

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 4 of 15



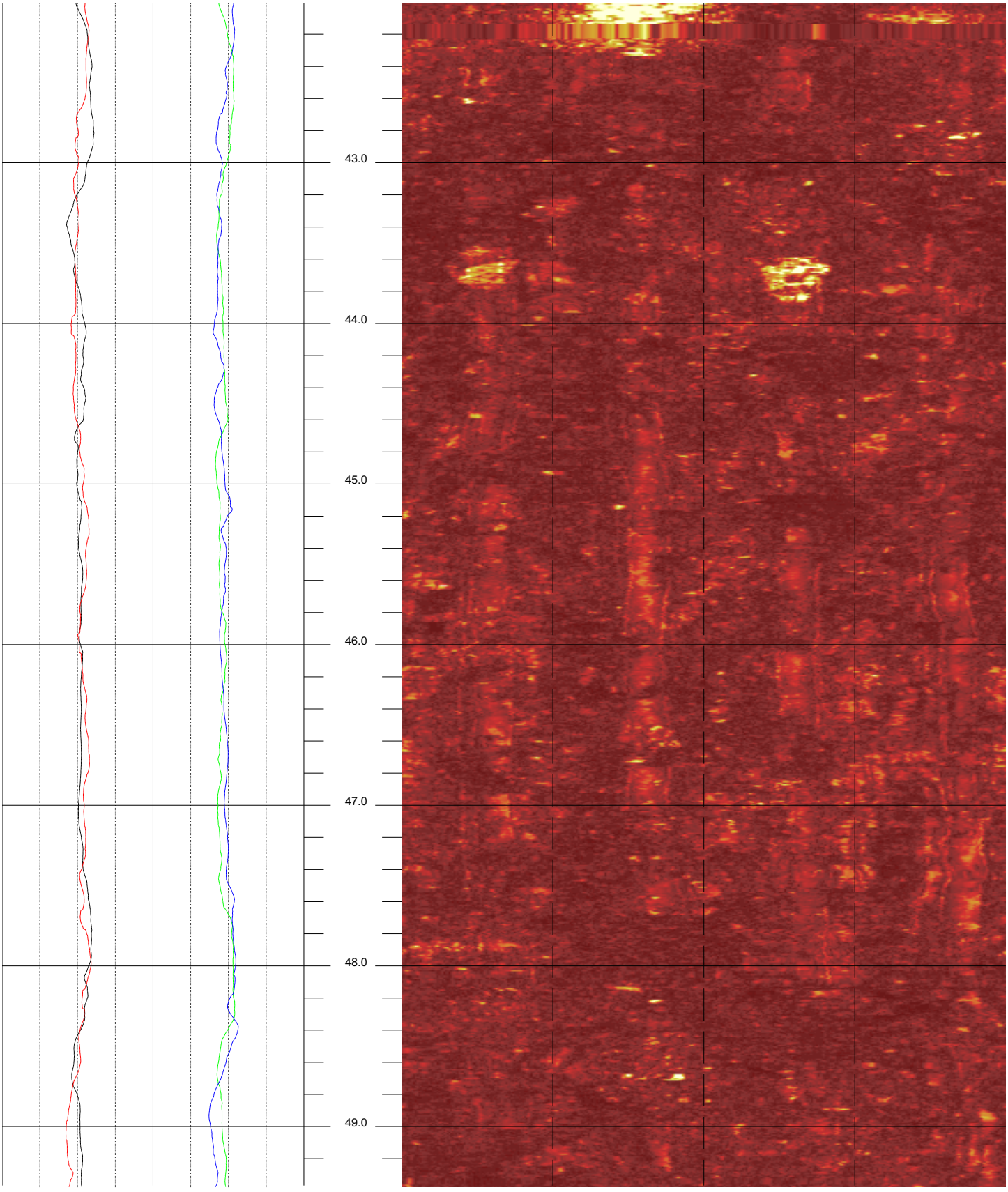
BTNB-R5 34.640 to 27.272ft 5

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 5 of 15



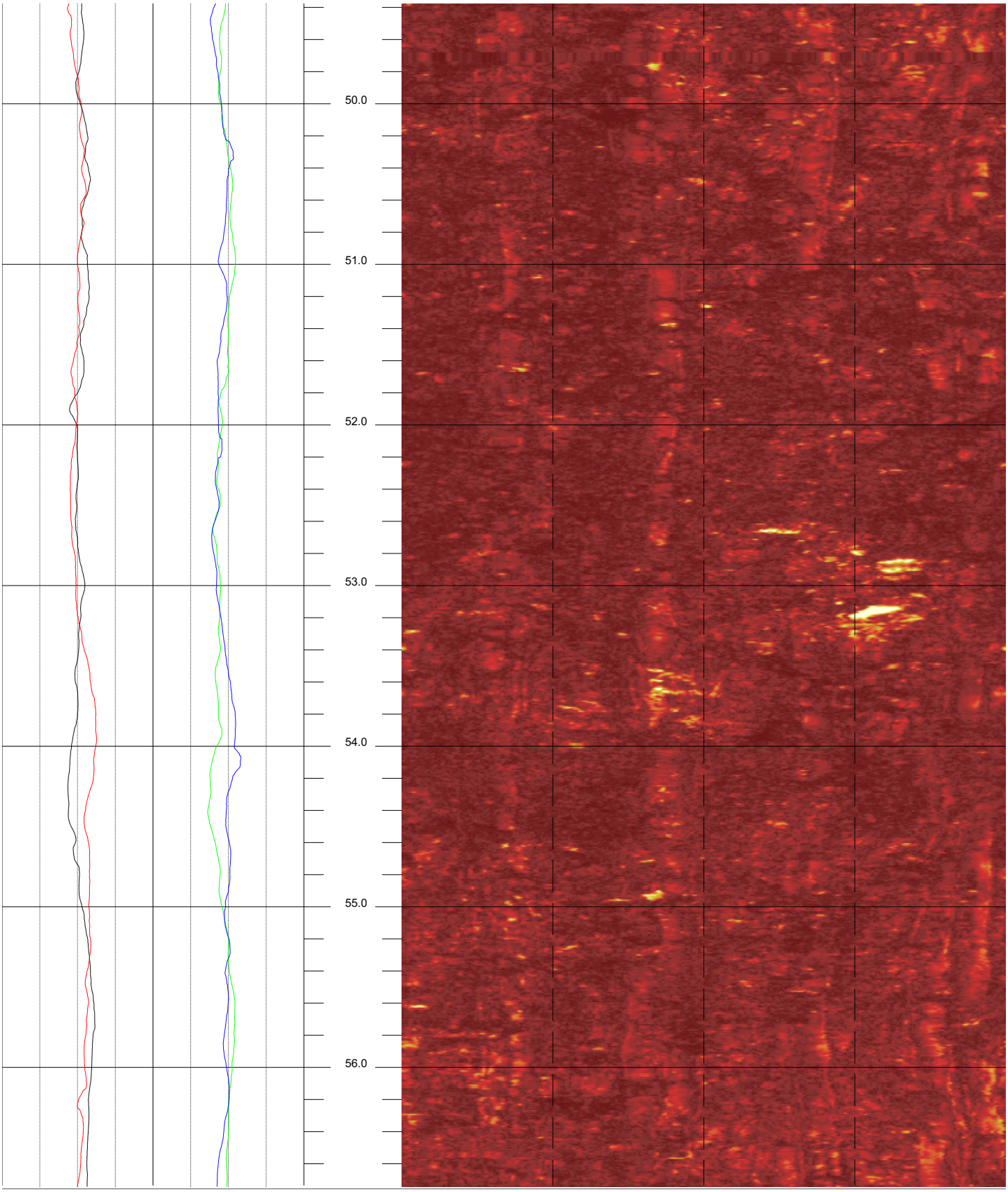
BTNB-R5 42.008 to 34.640ft 6

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 6 of 15



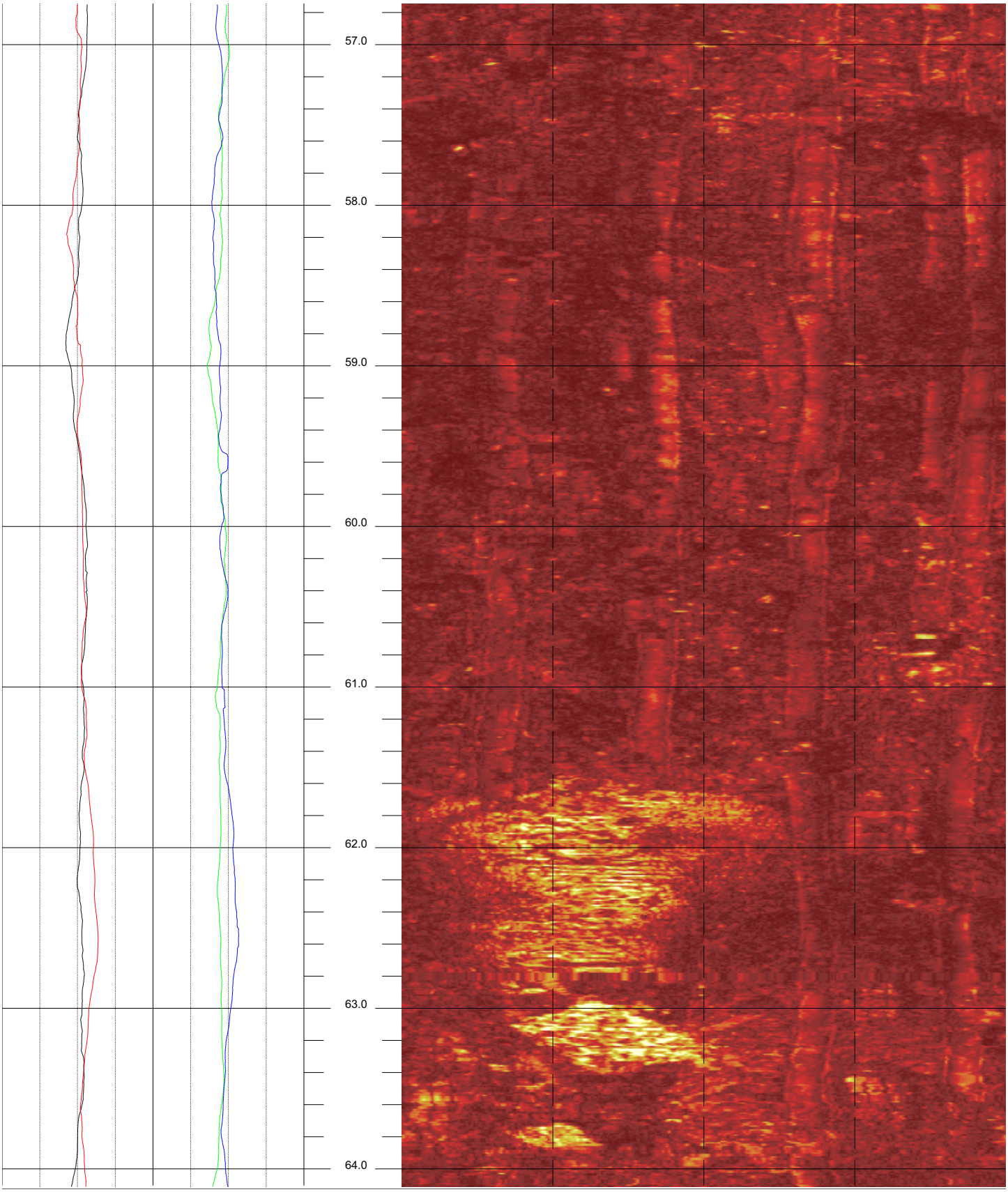
BTNB-R5 49.376 to 42.008ft 7

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 7 of 15



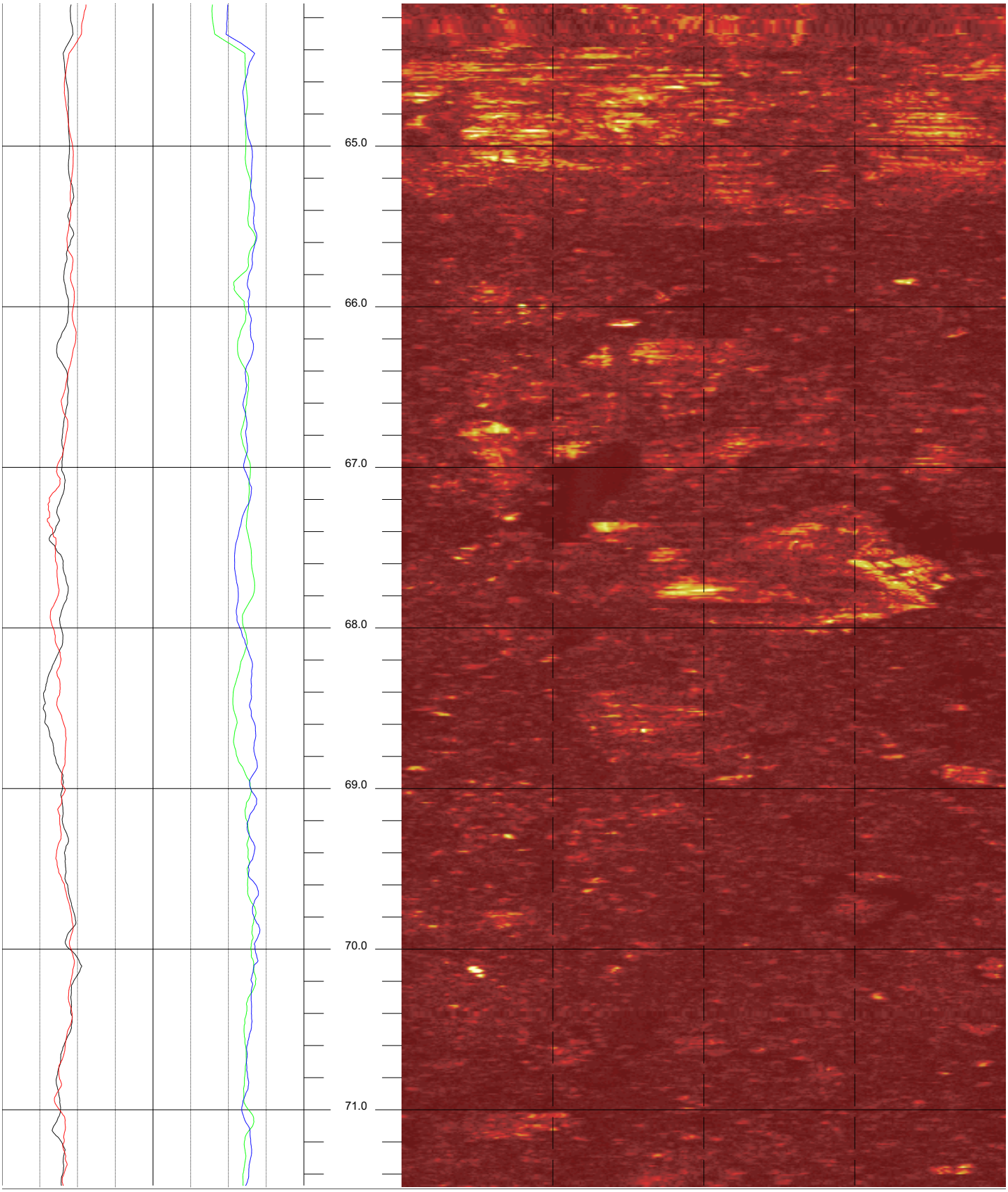
BTNB-R5 56.744 to 49.376ft 8

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 8 of 15



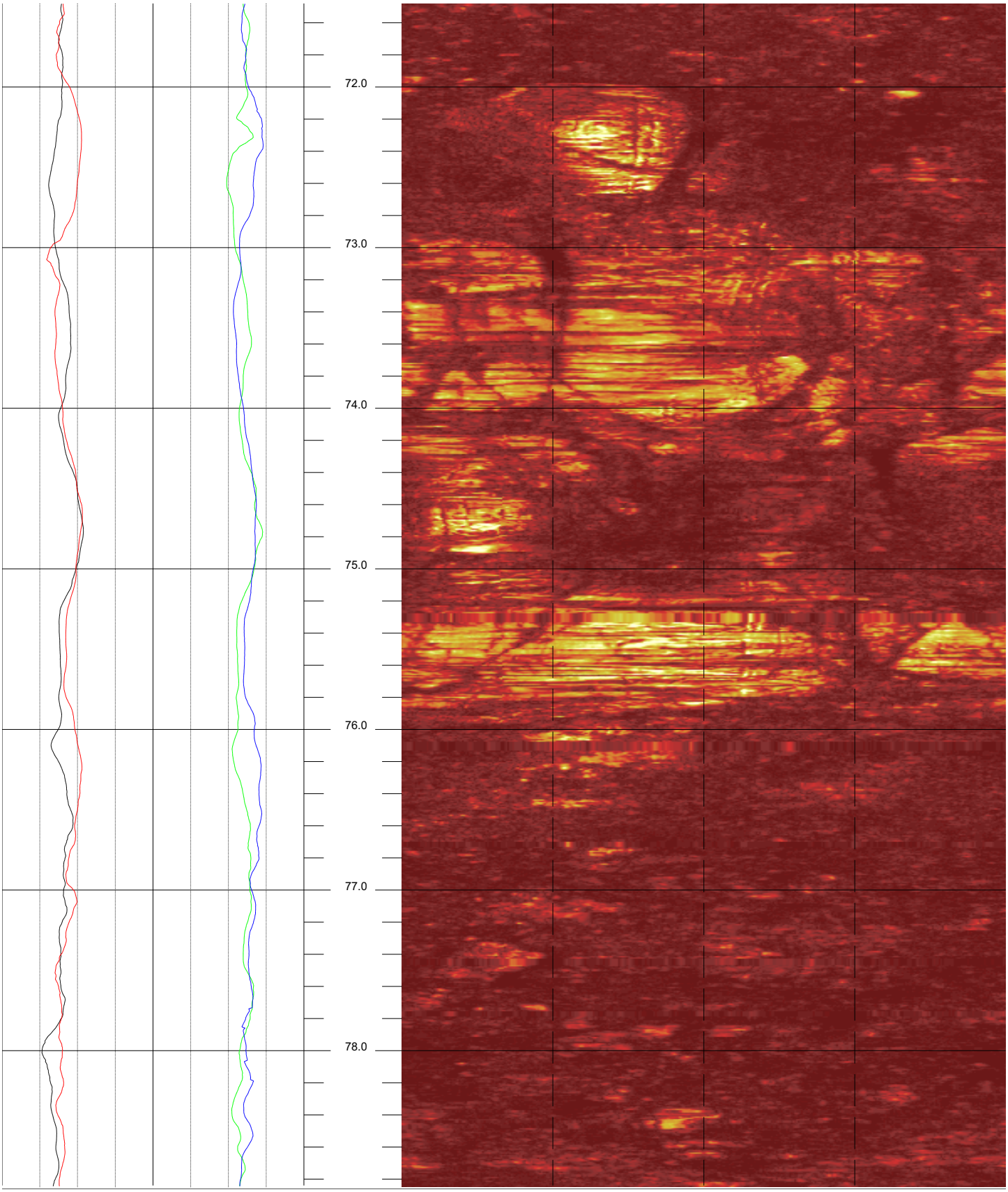
BTNB-R5 64.112 to 56.744ft 9

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 9 of 15



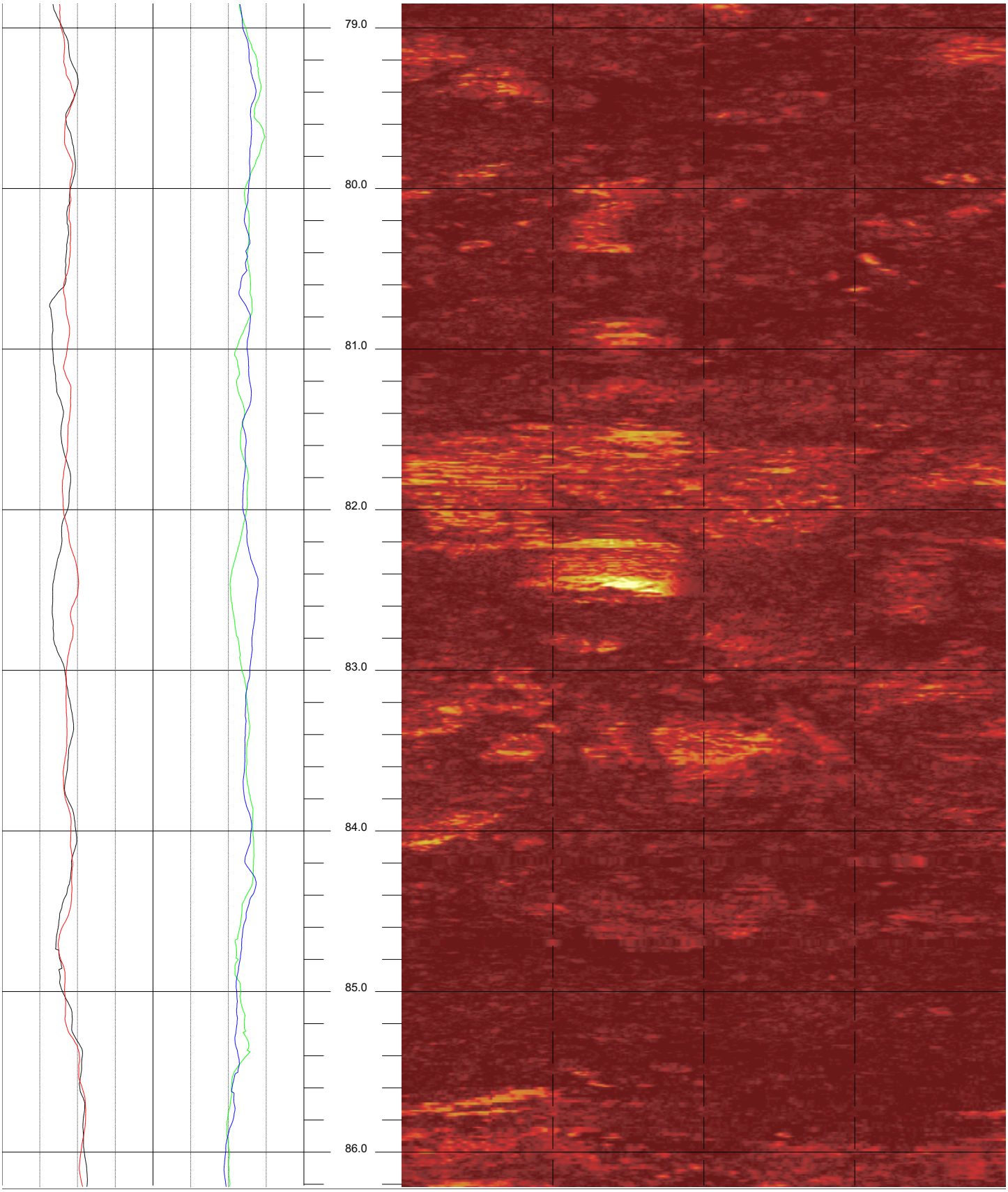
BTNB-R5 71.480 to 64.112ft 10

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 10 of 15



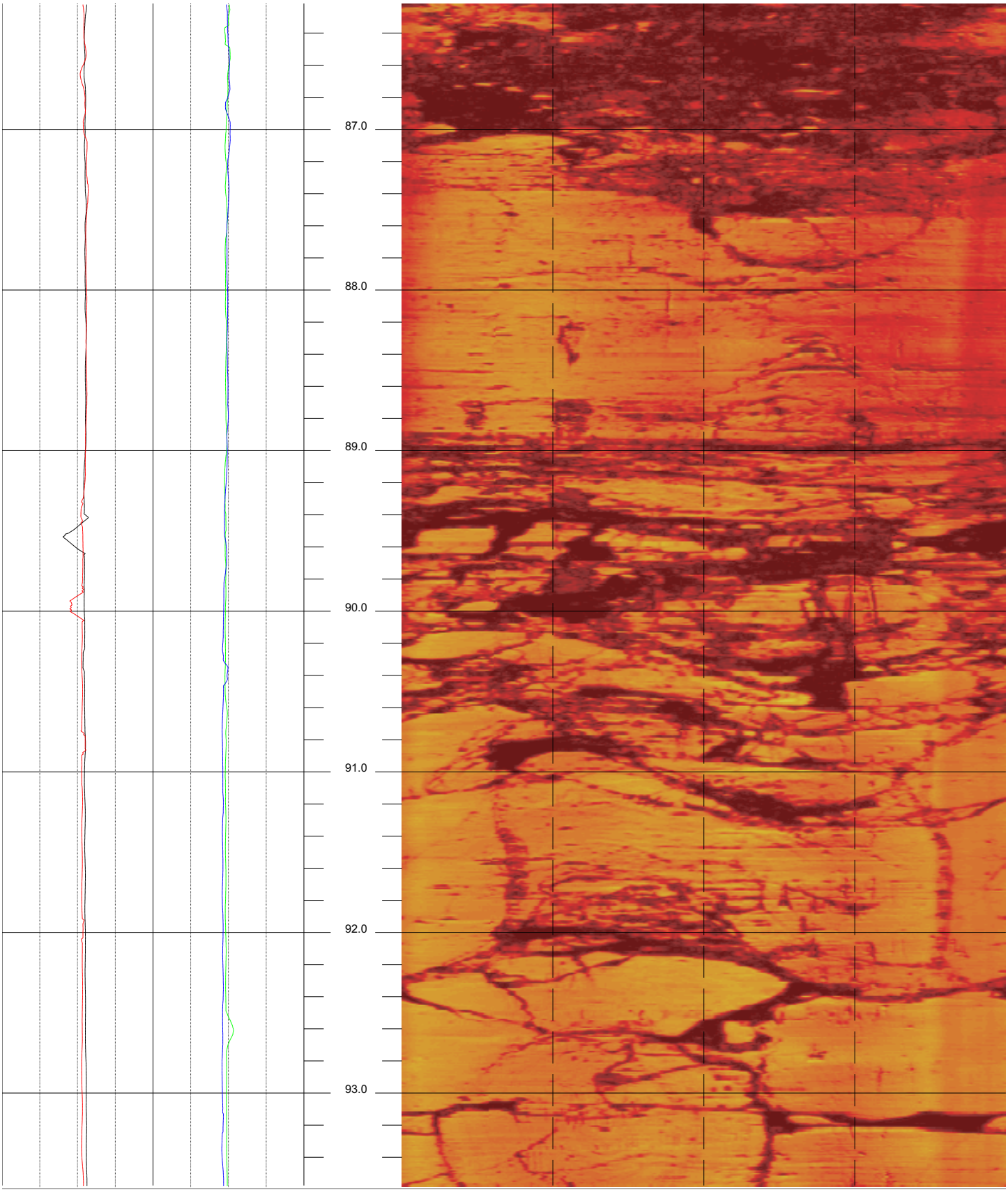
BTNB-R5 78.848 to 71.480ft 11

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 11 of 15



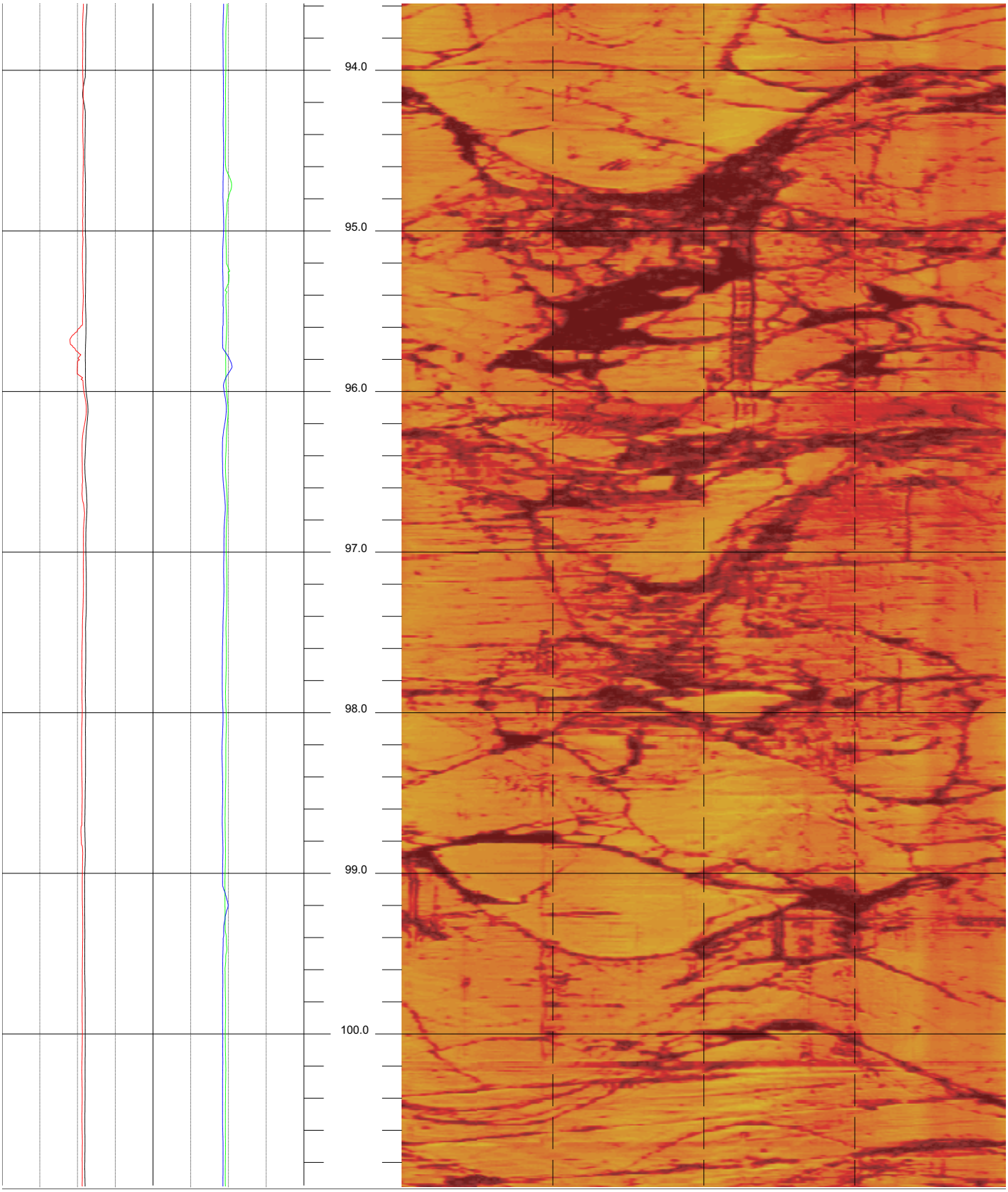
BTNB-R5 86.216 to 78.848ft 12

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 12 of 15



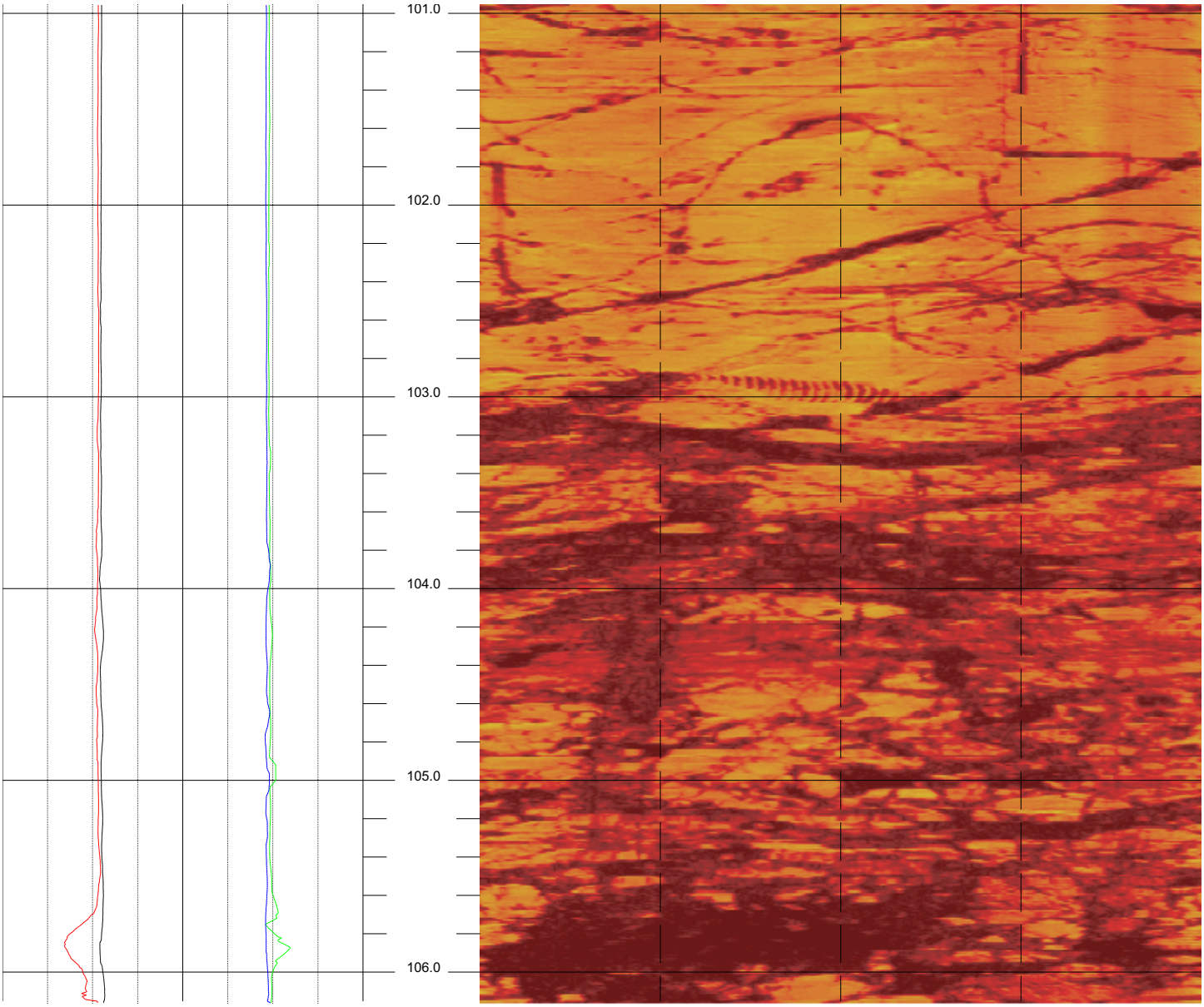
BTNB-R5 93.584 to 86.216ft 13

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 13 of 15



BTNB-R5 100.952 to 93.584fl 14

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer based Caliper Sheet 14 of 15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102.0
103.0
104.0
105.0
106.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

14 Jun 2008

ARUP

Borehole: BTNB-R7

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

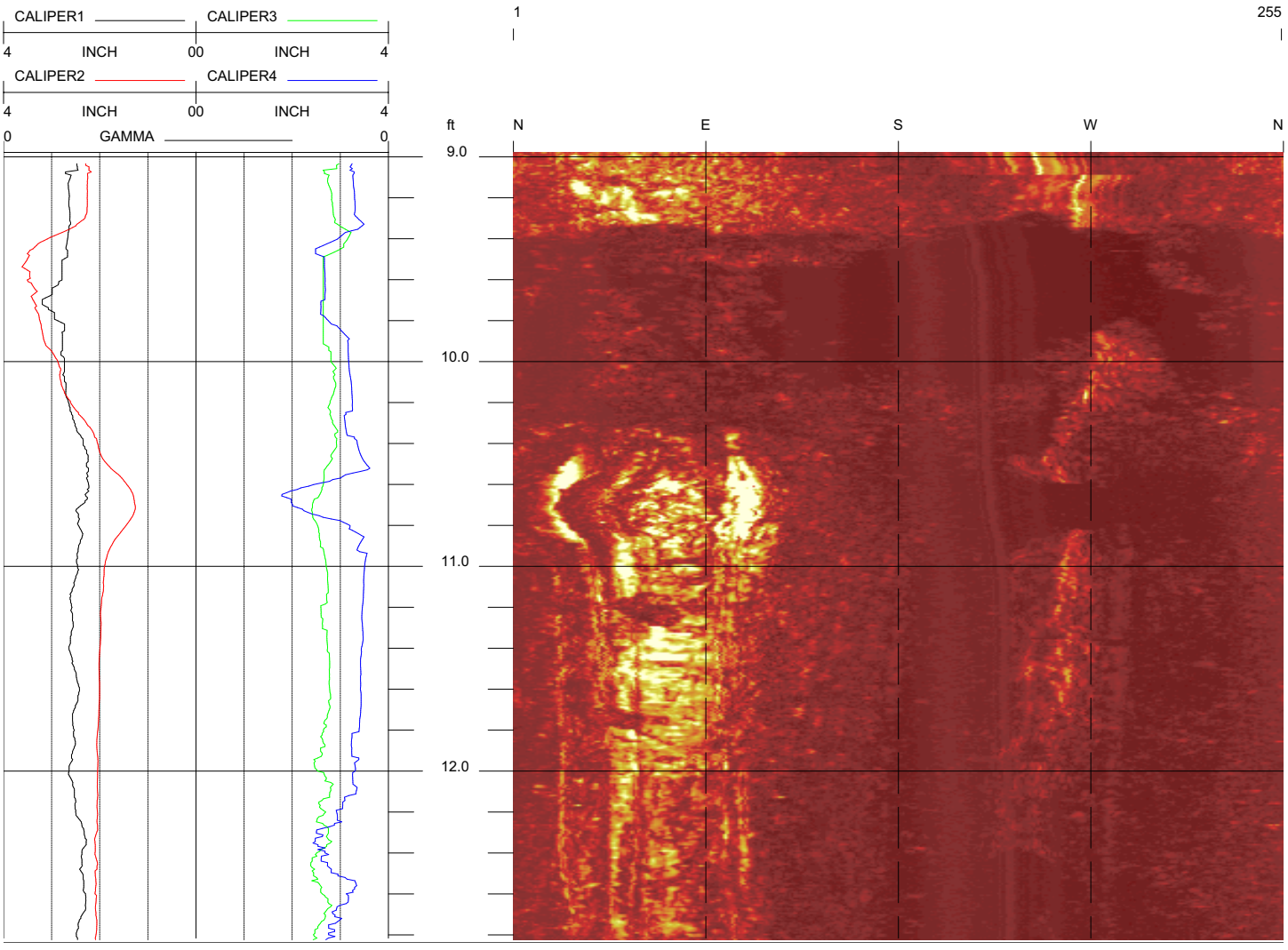
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 111.968 to 8.976ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

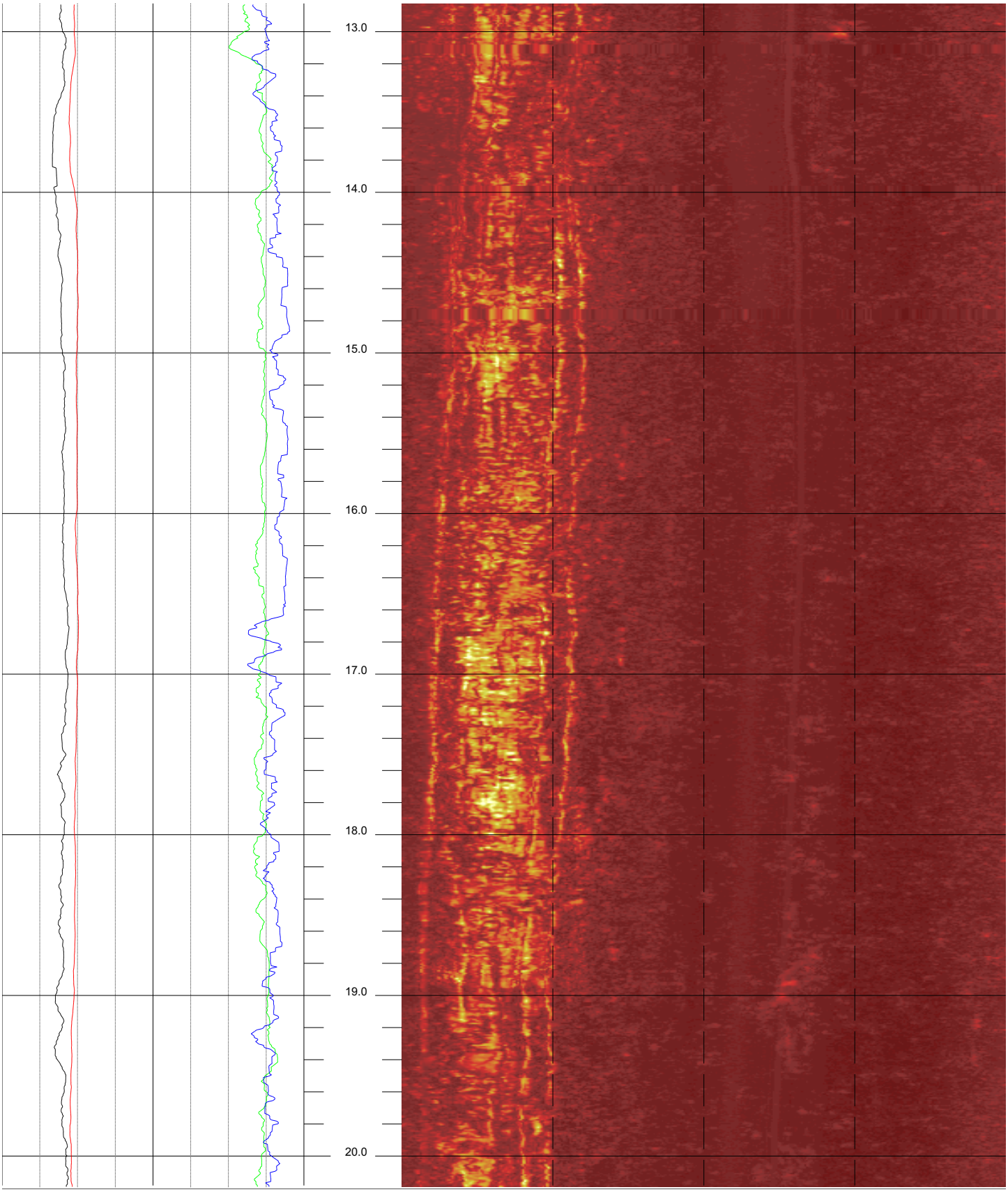
Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE



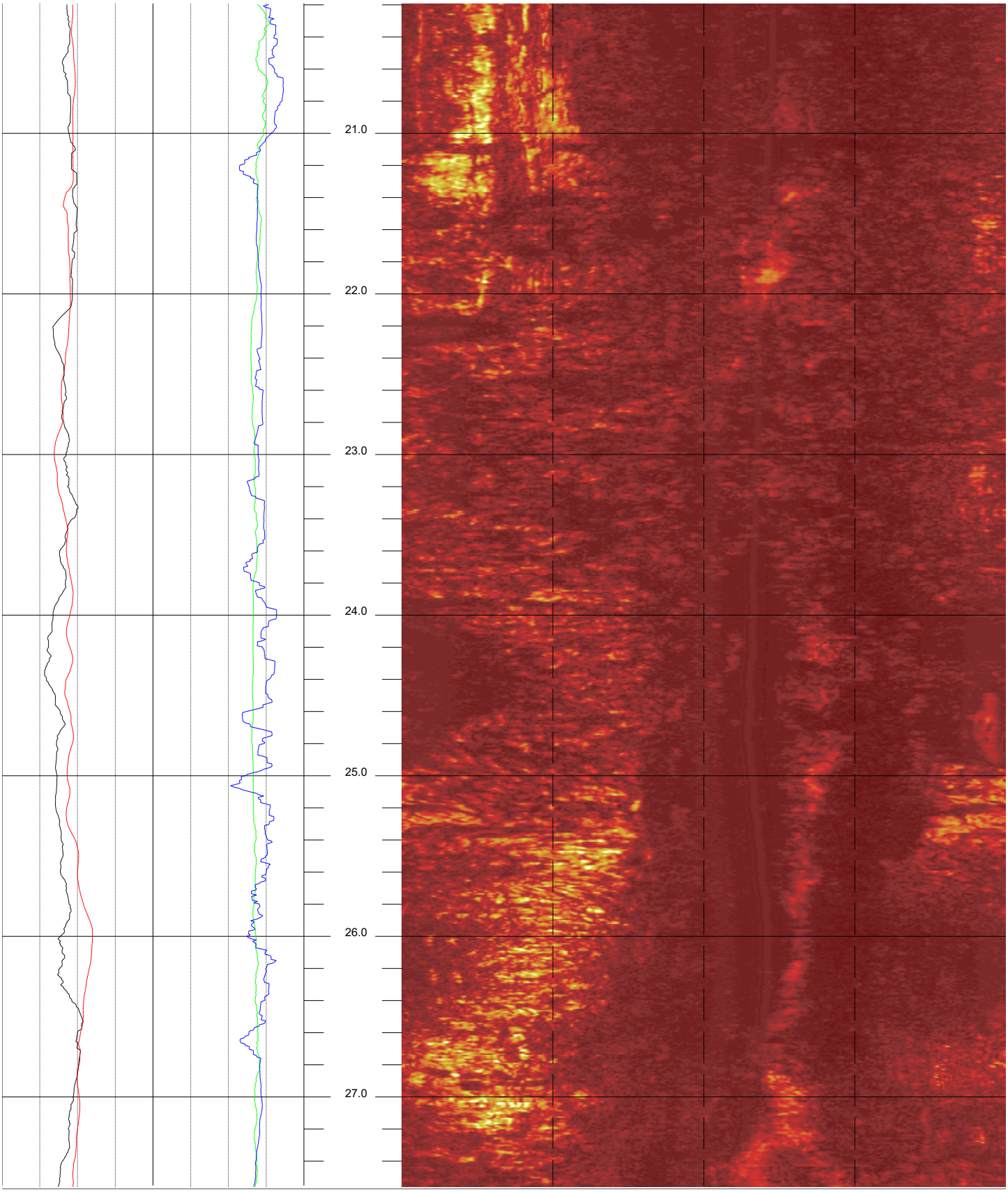
BTNB-R7 12.824 to 8.976ft 1

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 1 of 15



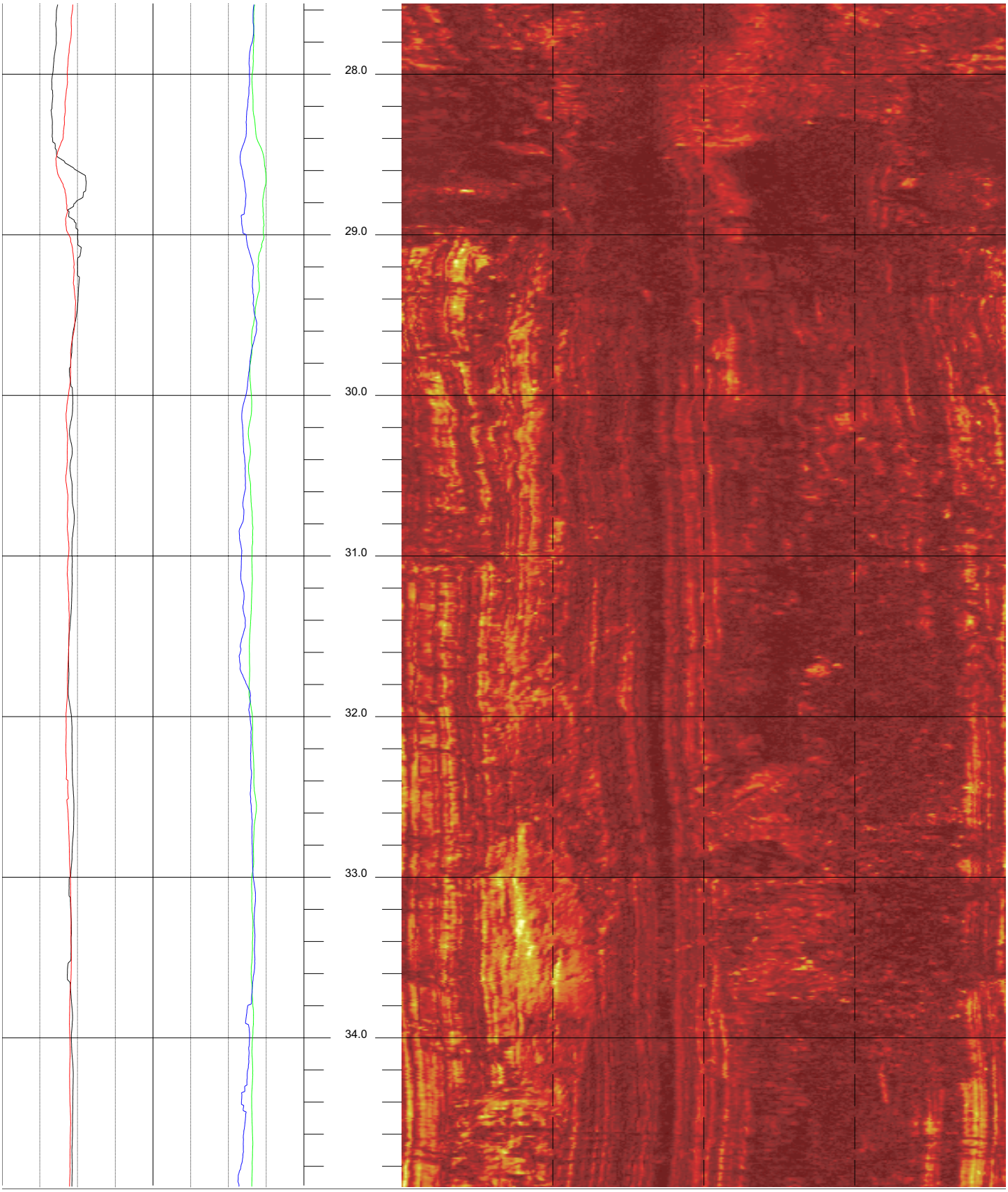
BTNB-R7 20.192 to 12.824ft 2

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 2 of 15



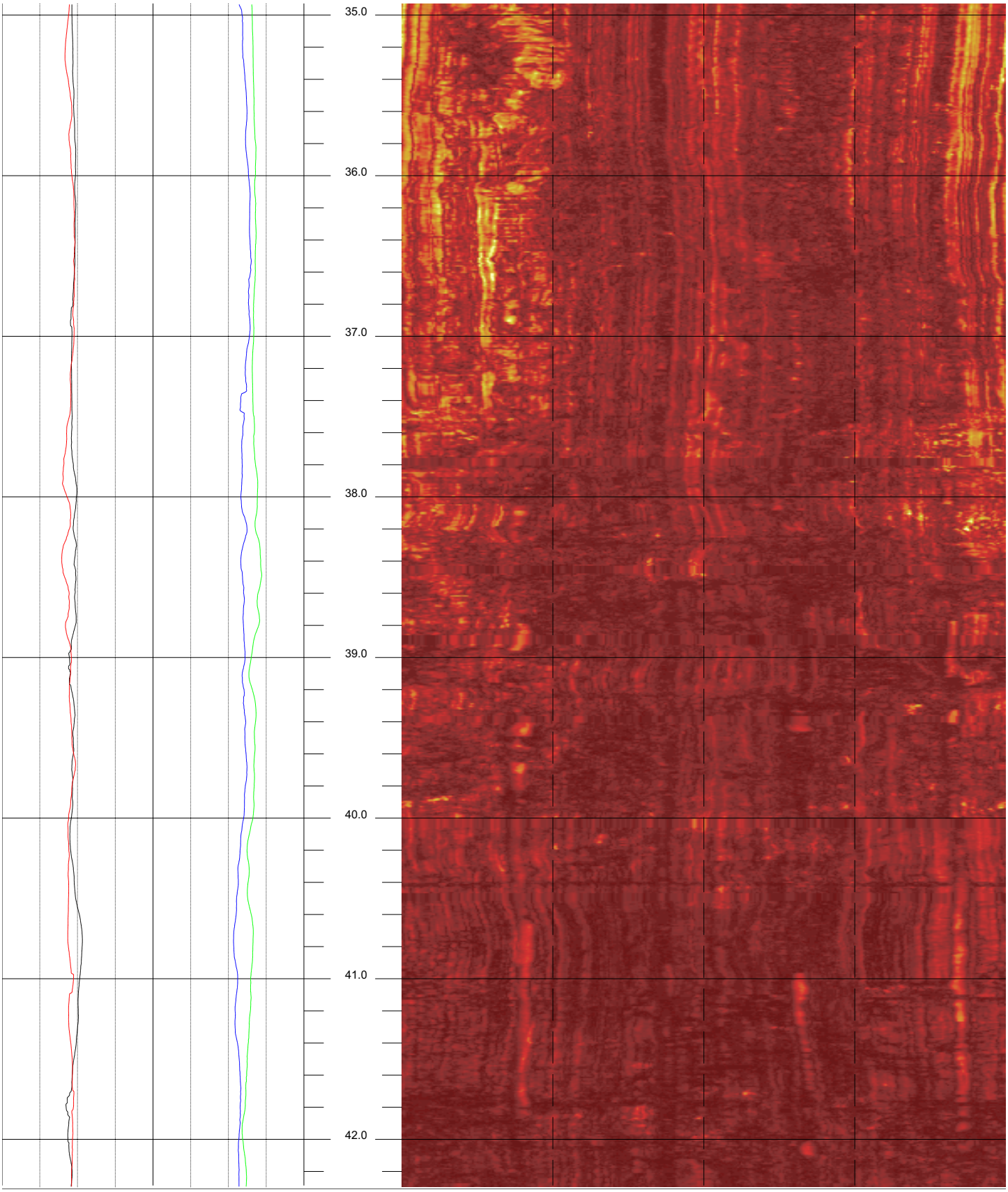
BTNB-R7 27.560 to 20.192ft 3

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 3 of 15



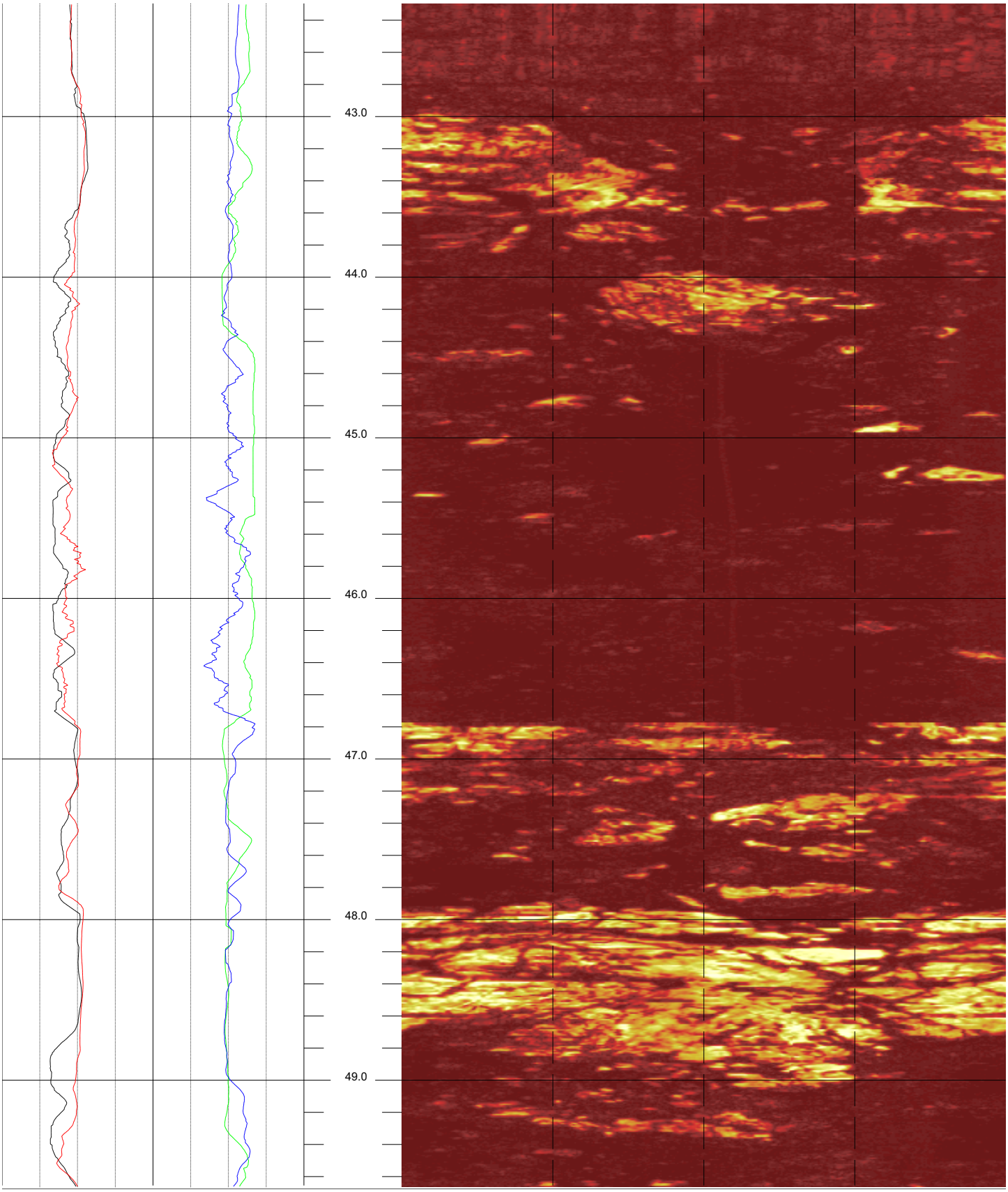
BTNB-R7 34.928 to 27.560ft 4

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 4 of 15



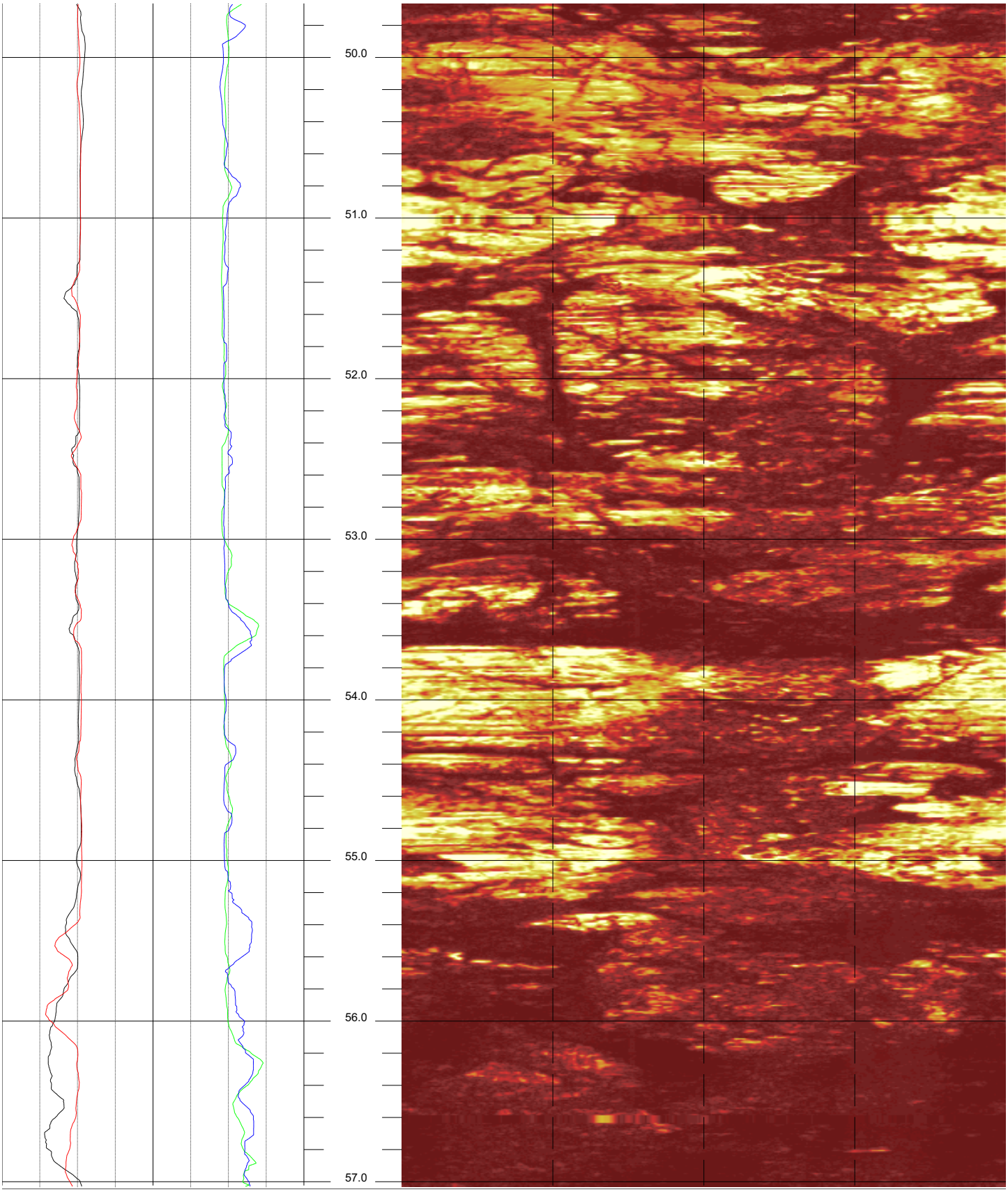
BTNB-R7 42.296 to 34.928ft 5

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 5 of 15



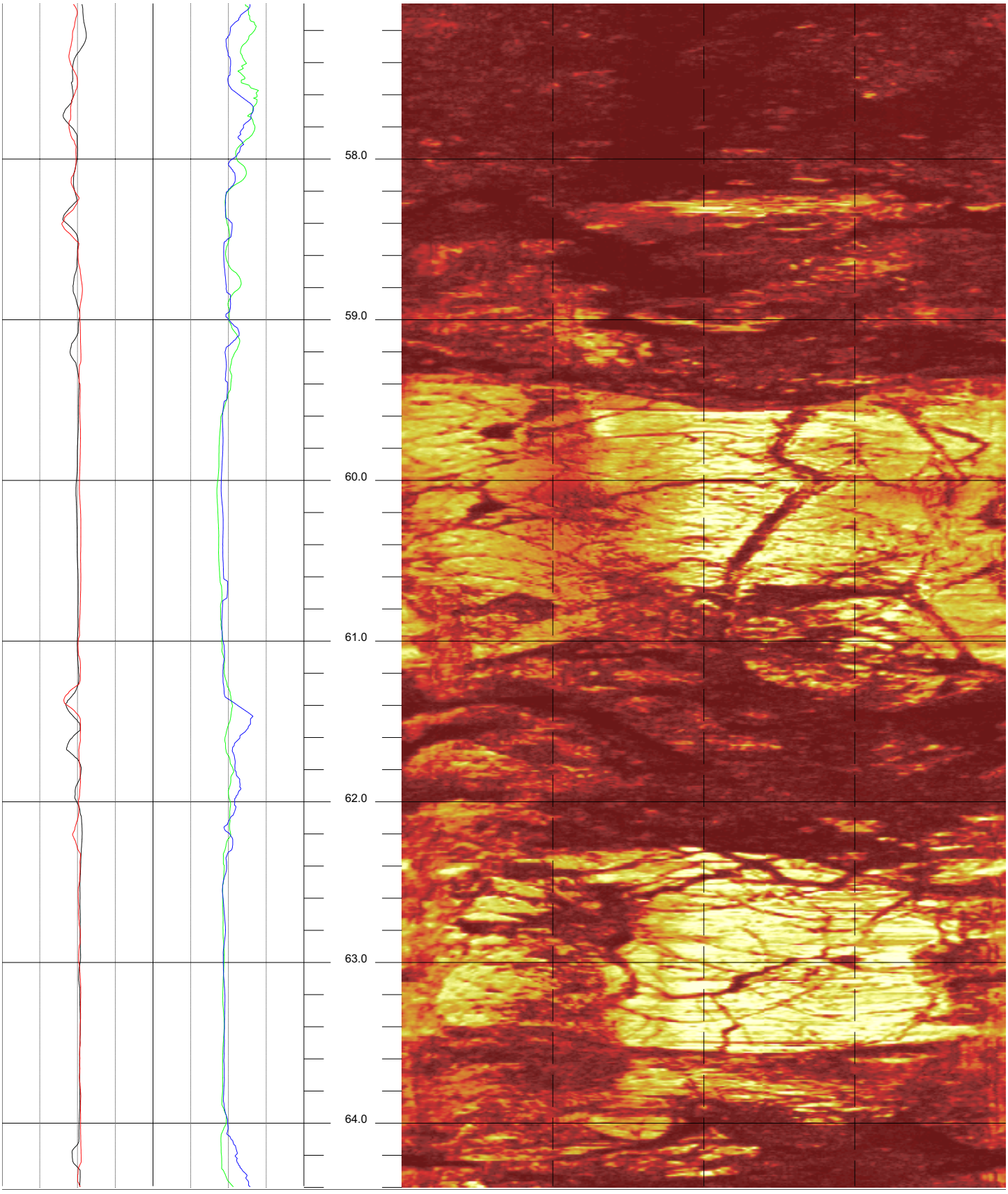
BTNB-R7 49.664 to 42.296ft 6

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 6 of 15



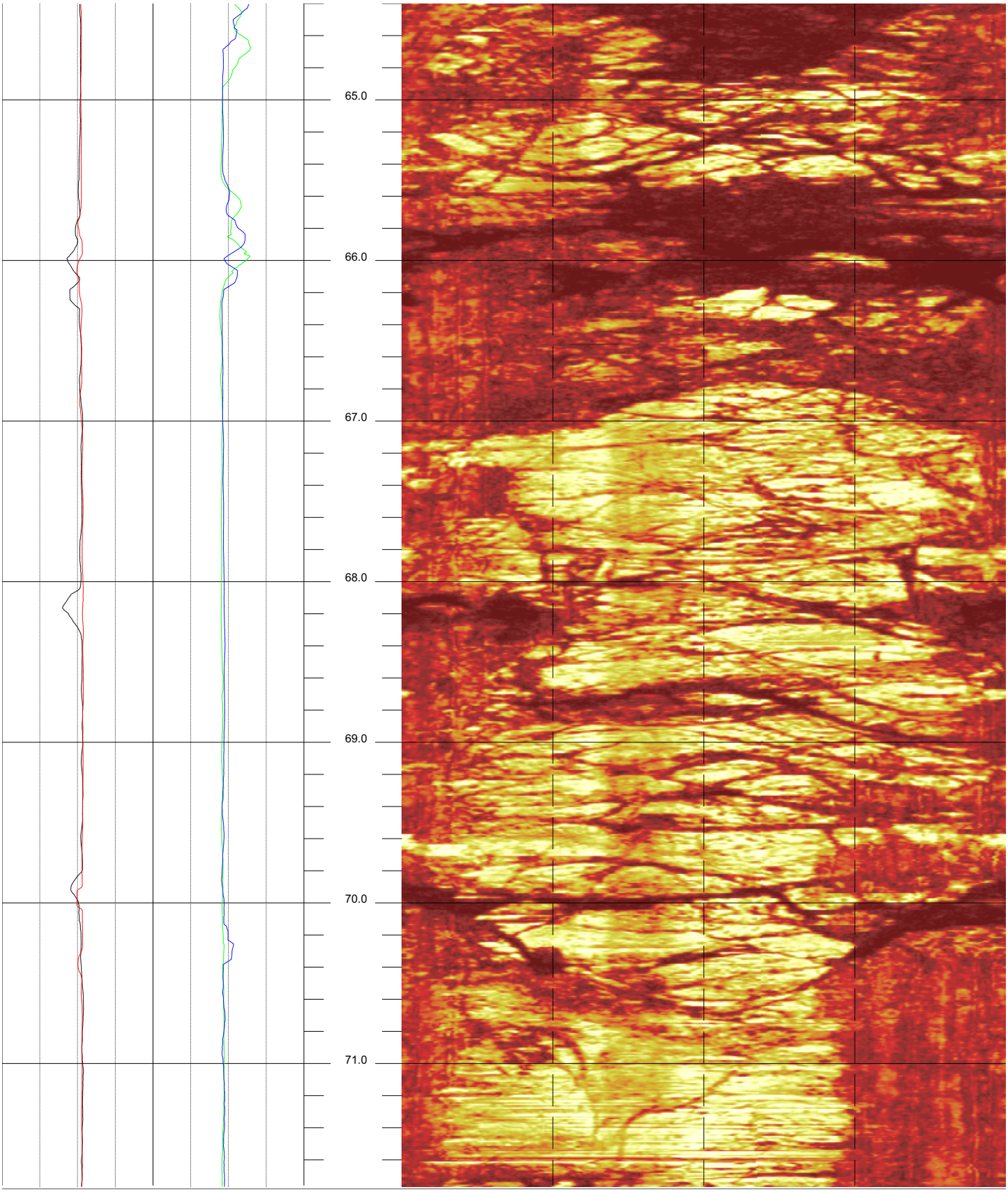
BTNB-R7 57.032 to 49.664ft 7

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 7 of 15



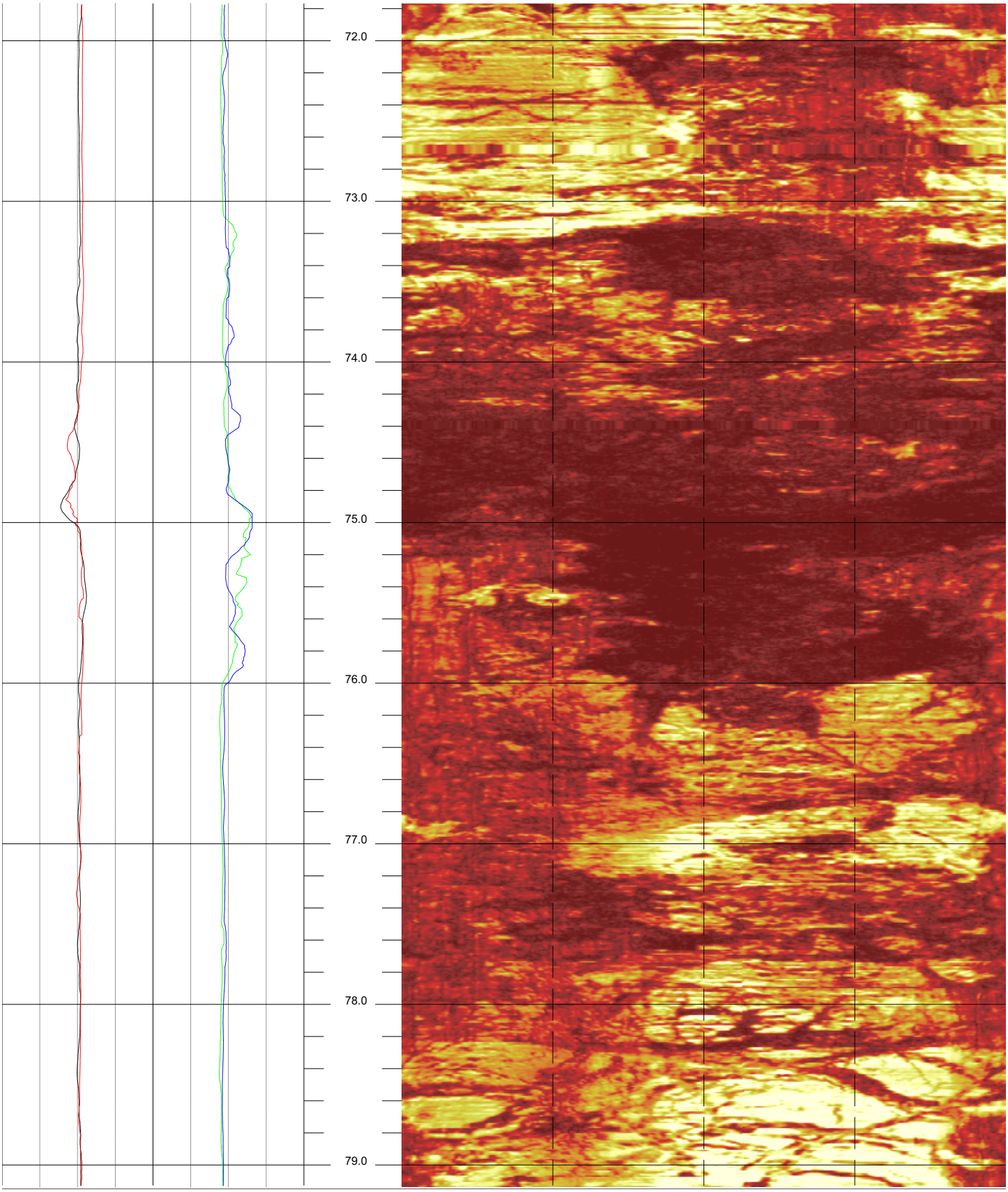
BTNB-R7 64.400 to 57.032ft 8

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 8 of 15



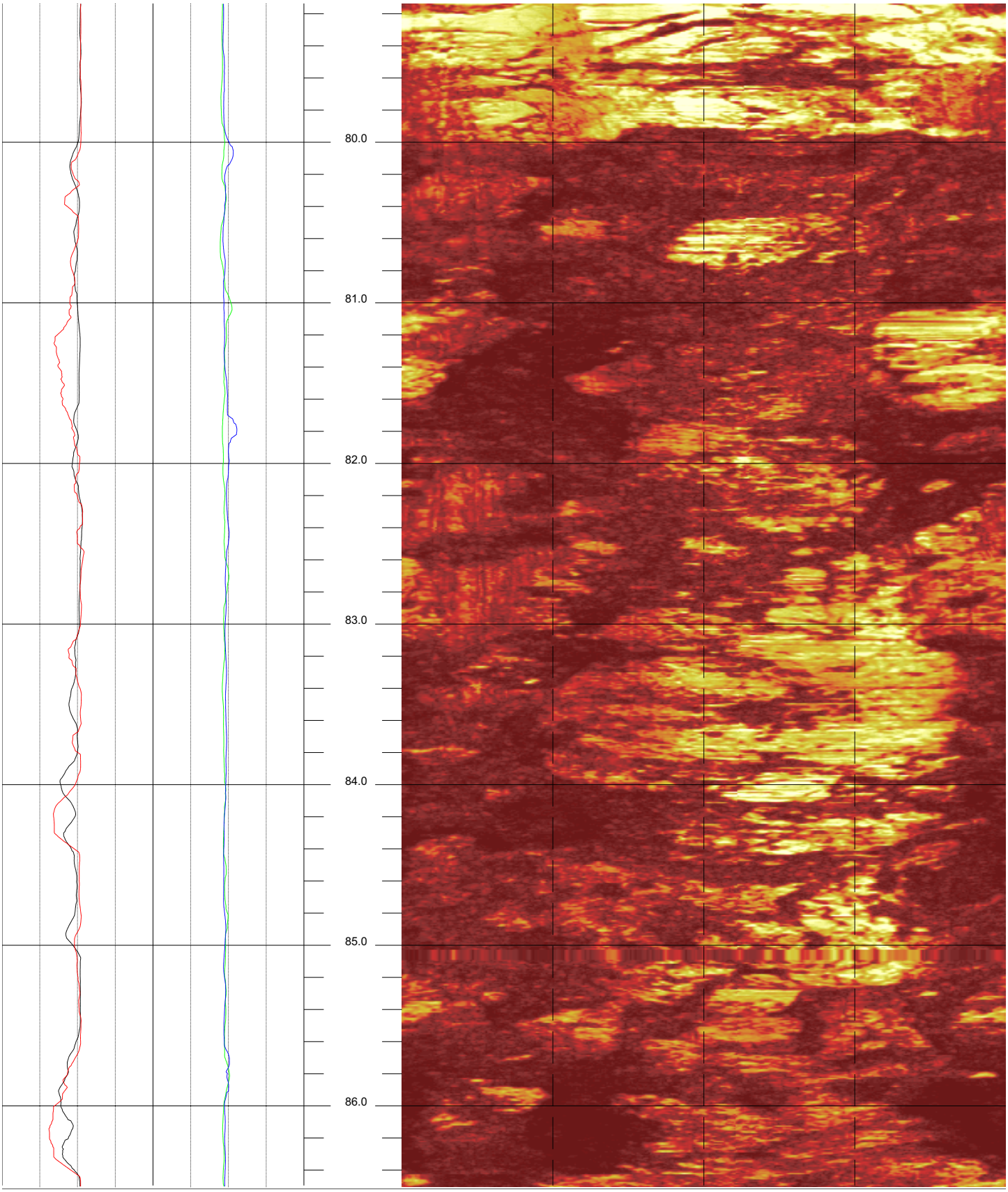
BTNB-R7 71.768 to 64.400ft 9

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 9 of 15



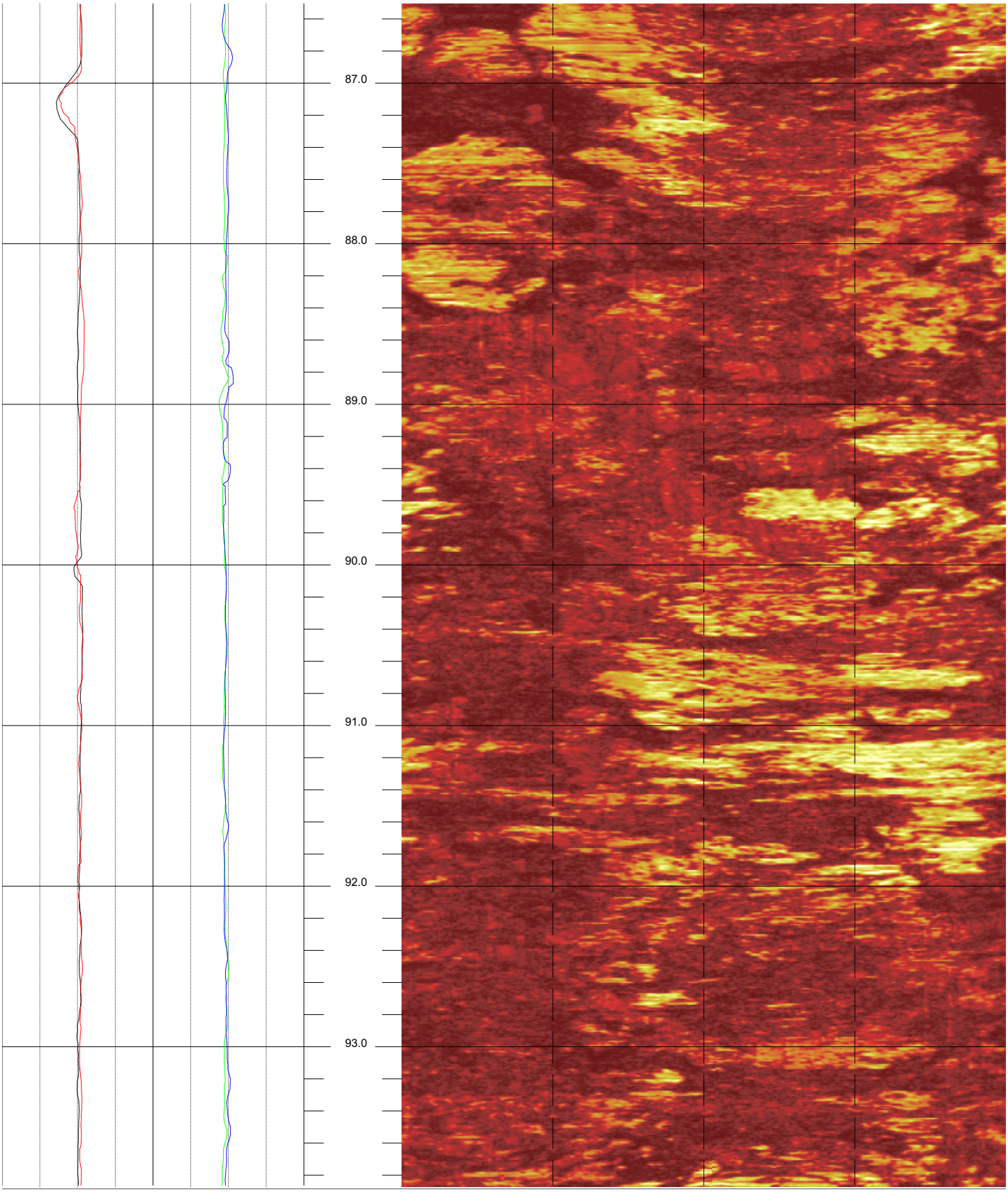
BTNB-R7 79.136 to 71.768ft 10

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 10 of 15



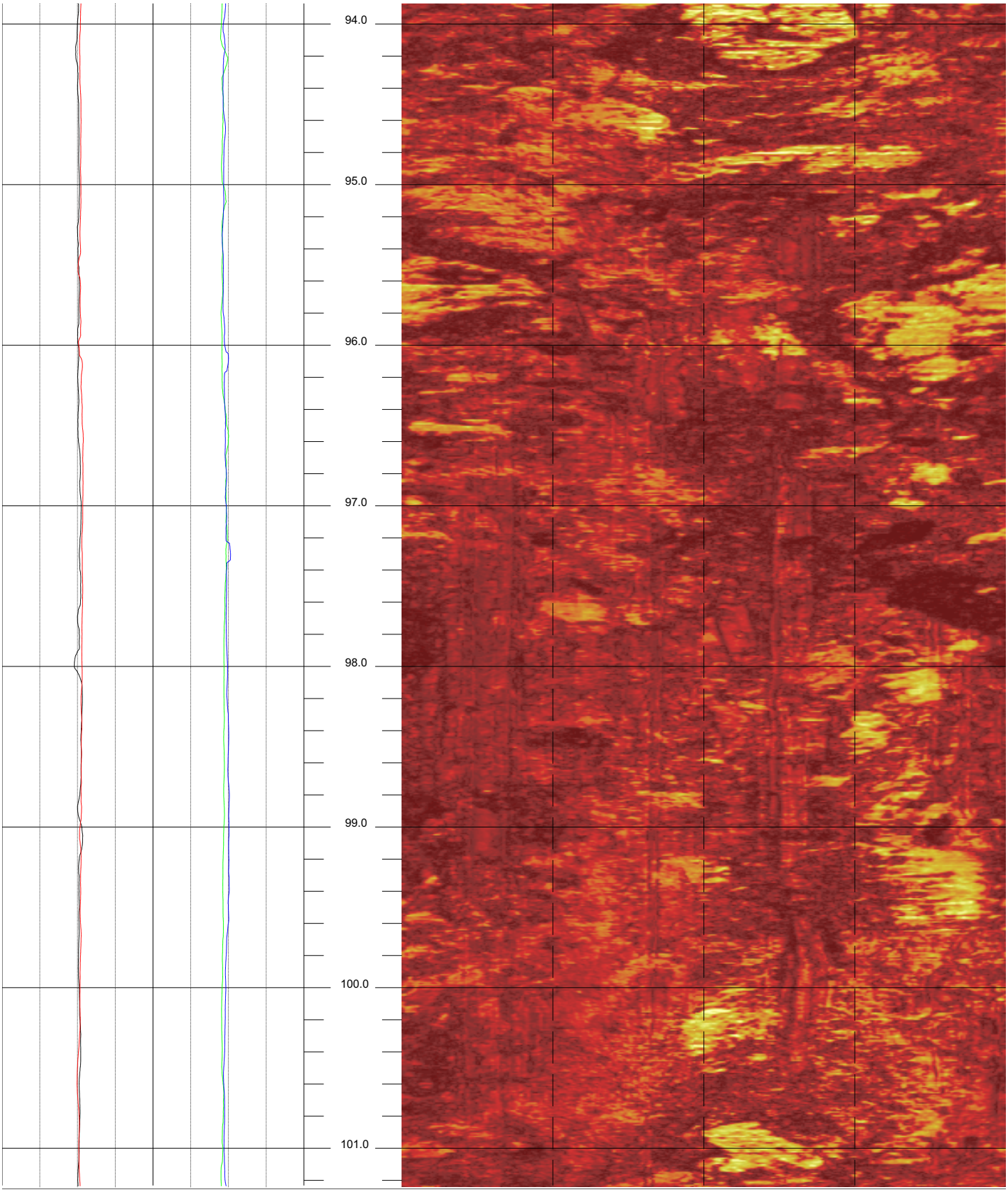
BTNB-R7 86.504 to 79.136ft 11

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 11 of 15



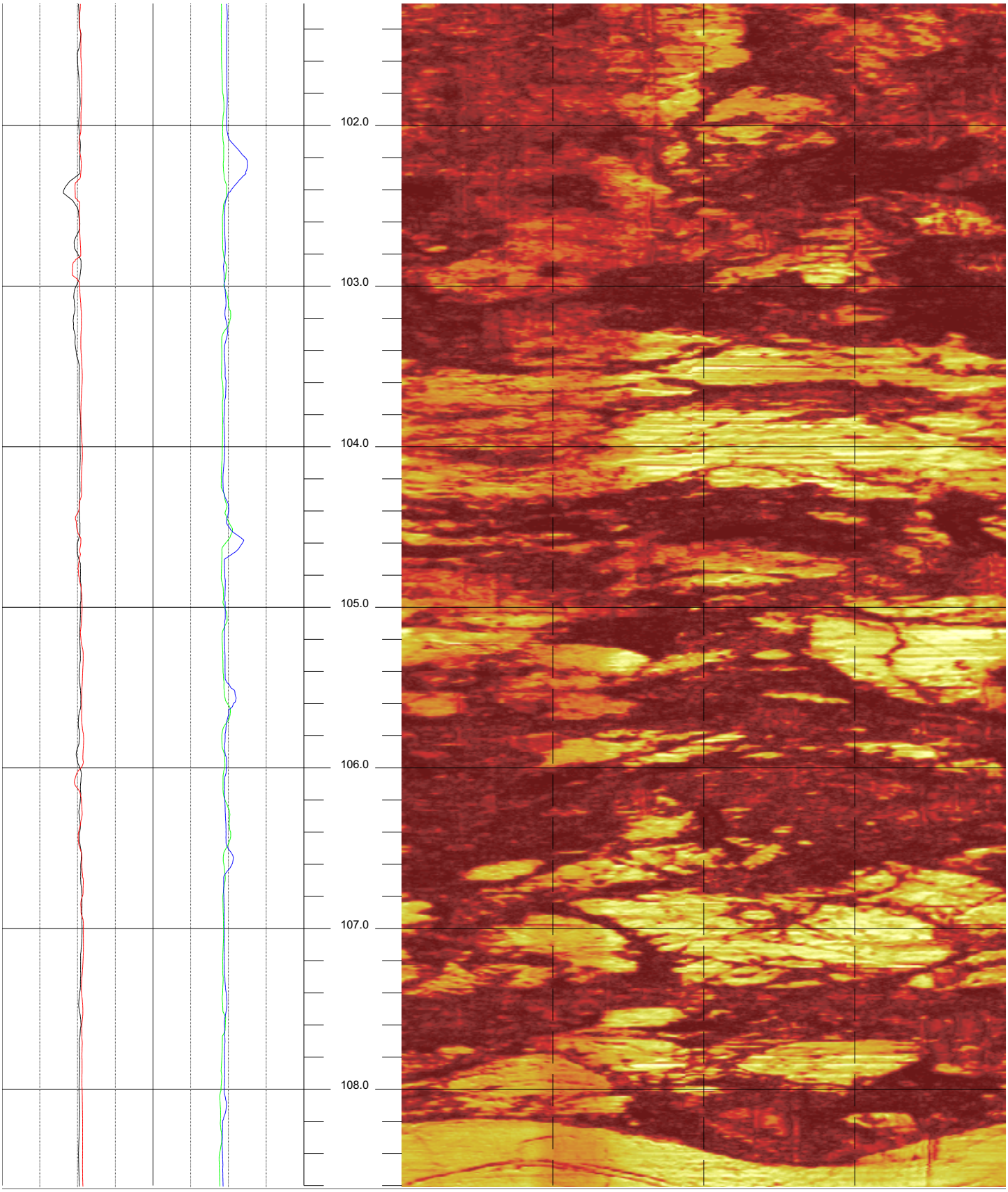
BTNB-R7 93.872 to 86.504ft 12

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 12 of 15



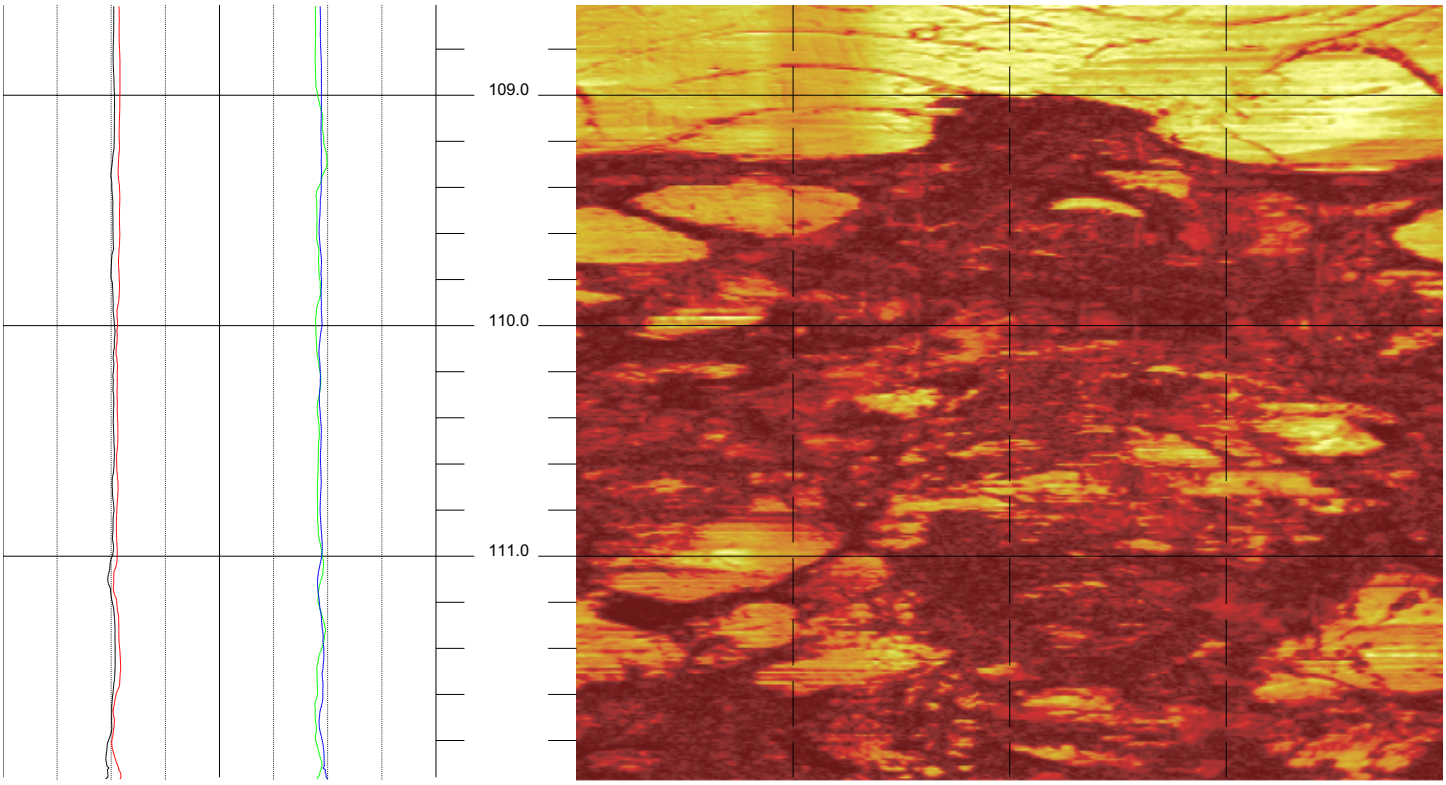
BTNB-R7 101.240 to 93.872fl 13

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 13 of 15



BTNB-R7 108.608 to 101.240fl 14

Doyle Drive BTNB-R7 Acoustic Televiewer Derived Caliper Sheet 14 of 15


109.0
110.0
111.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

14 Jun 2008

ARUP

Borehole: BTSB-R3

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

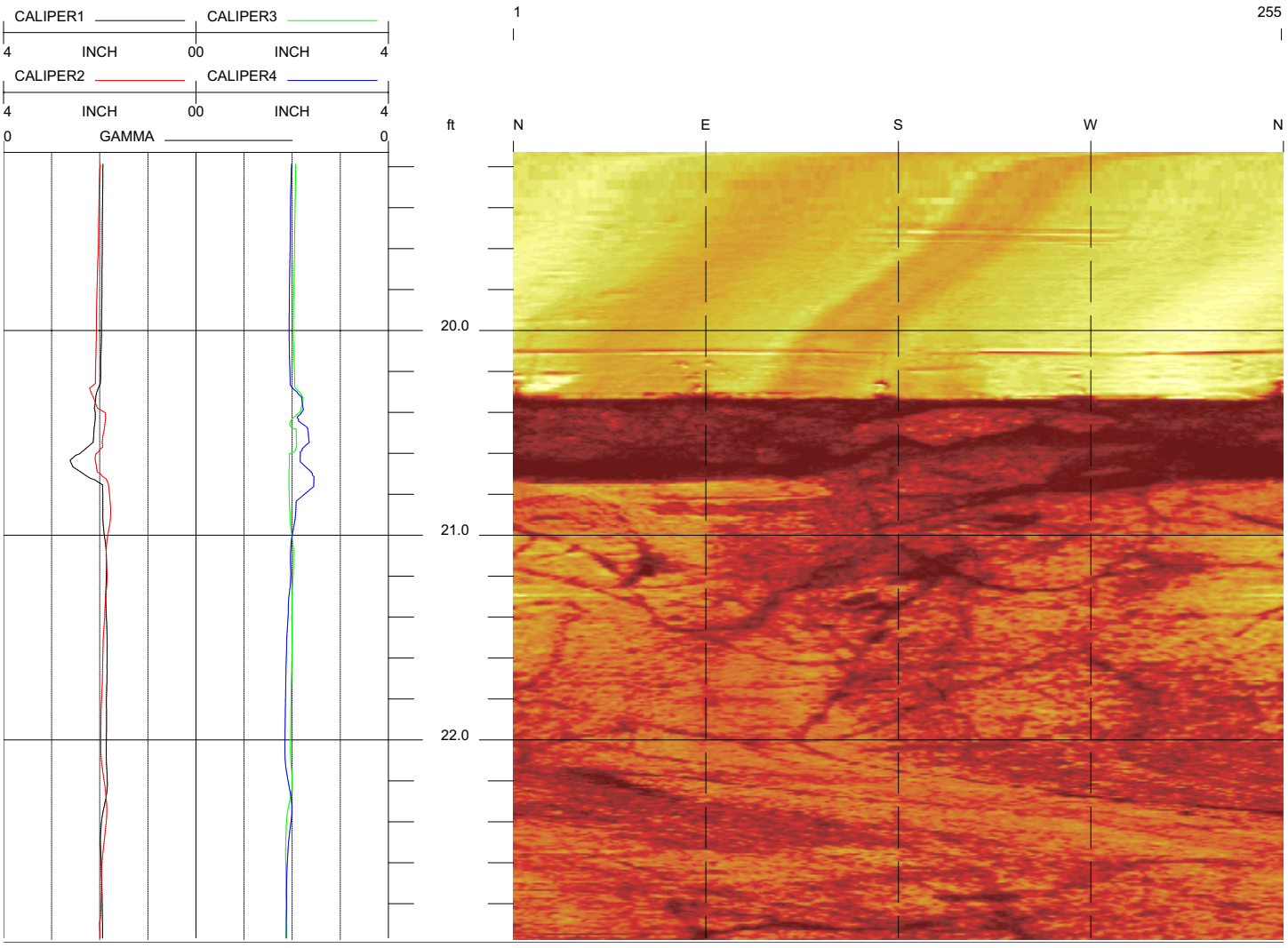
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 108.368 to 19.128ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

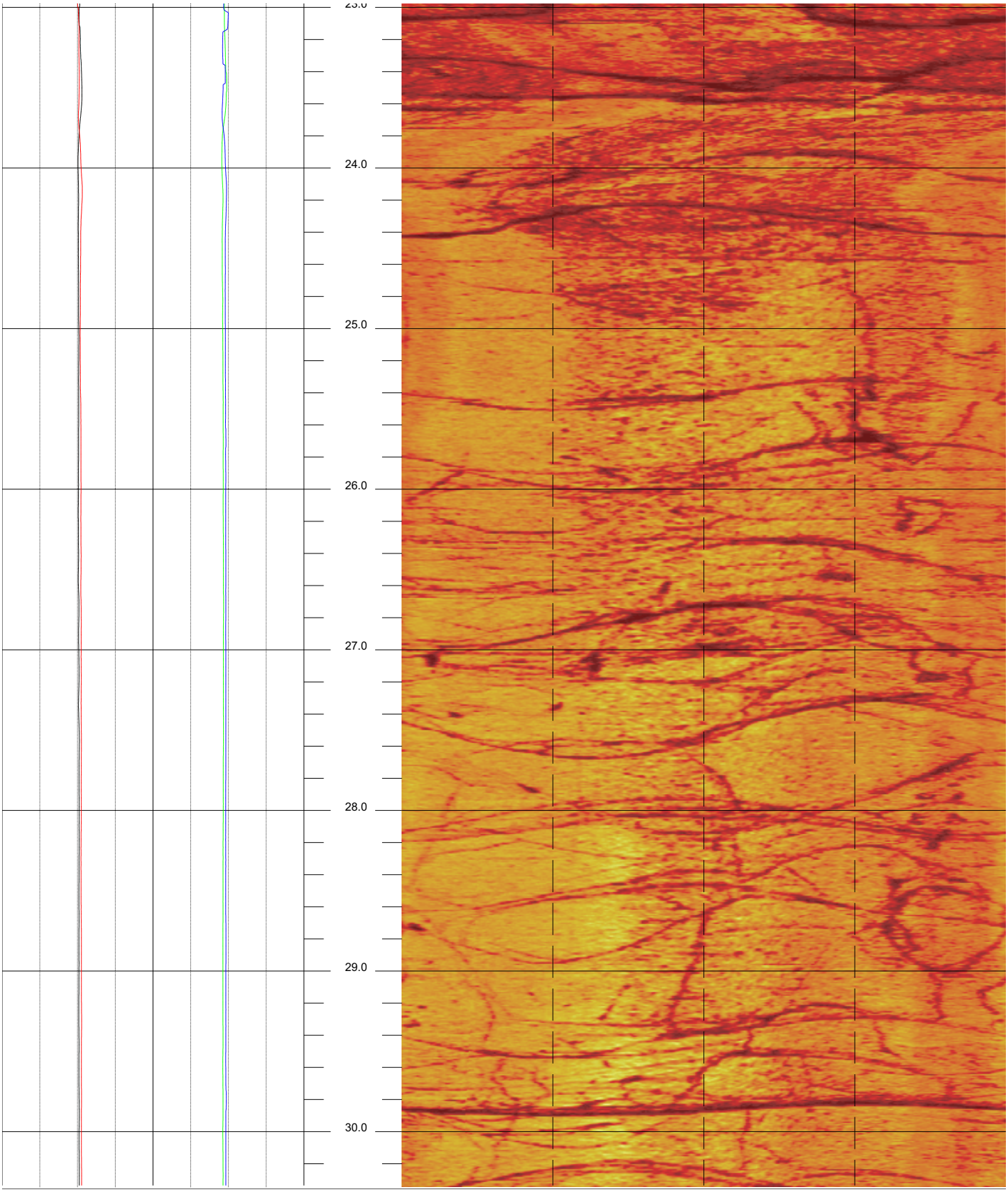
Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE

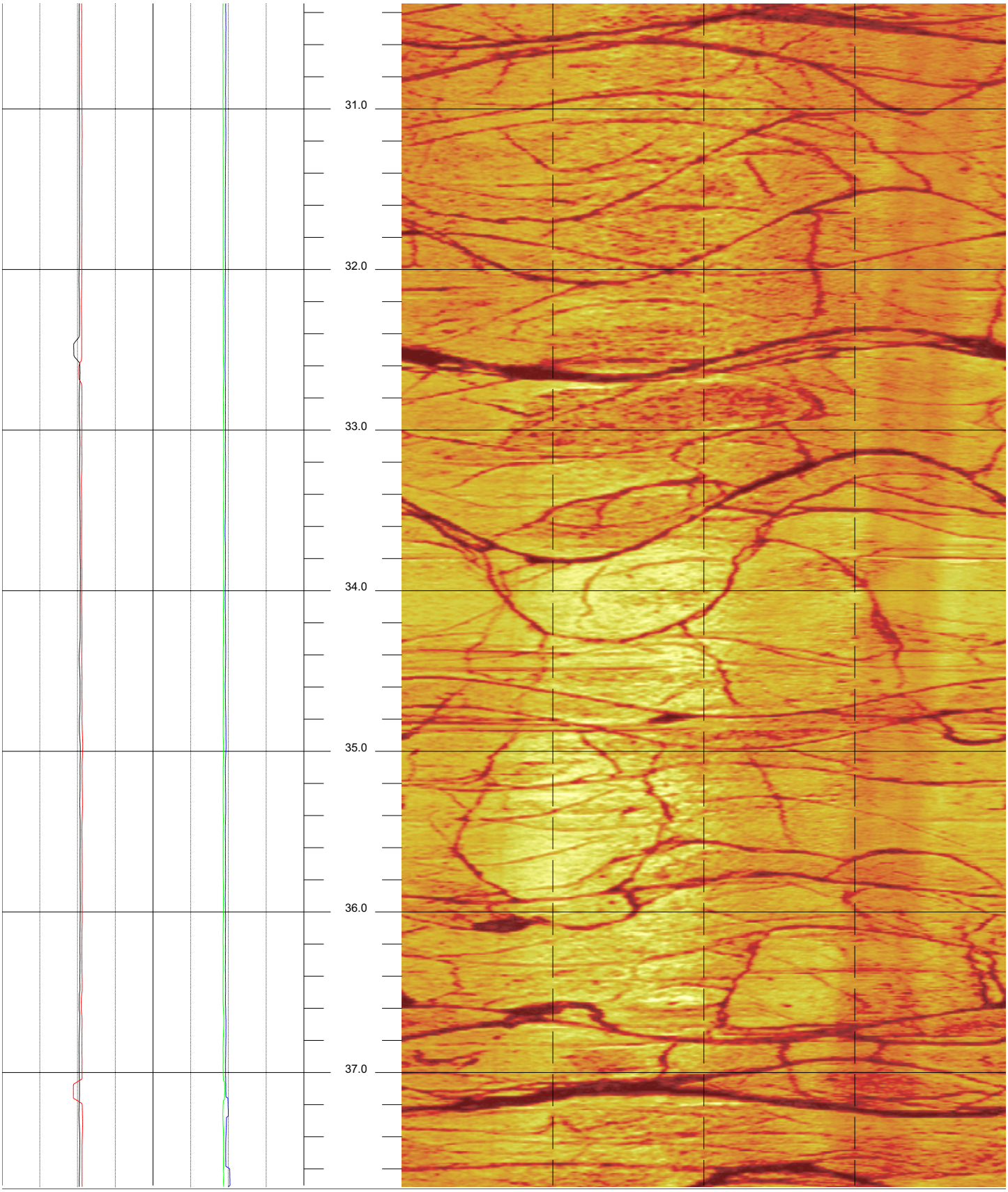


BTSB-R3 22.976 to 19.128ft 1

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 1 of 13

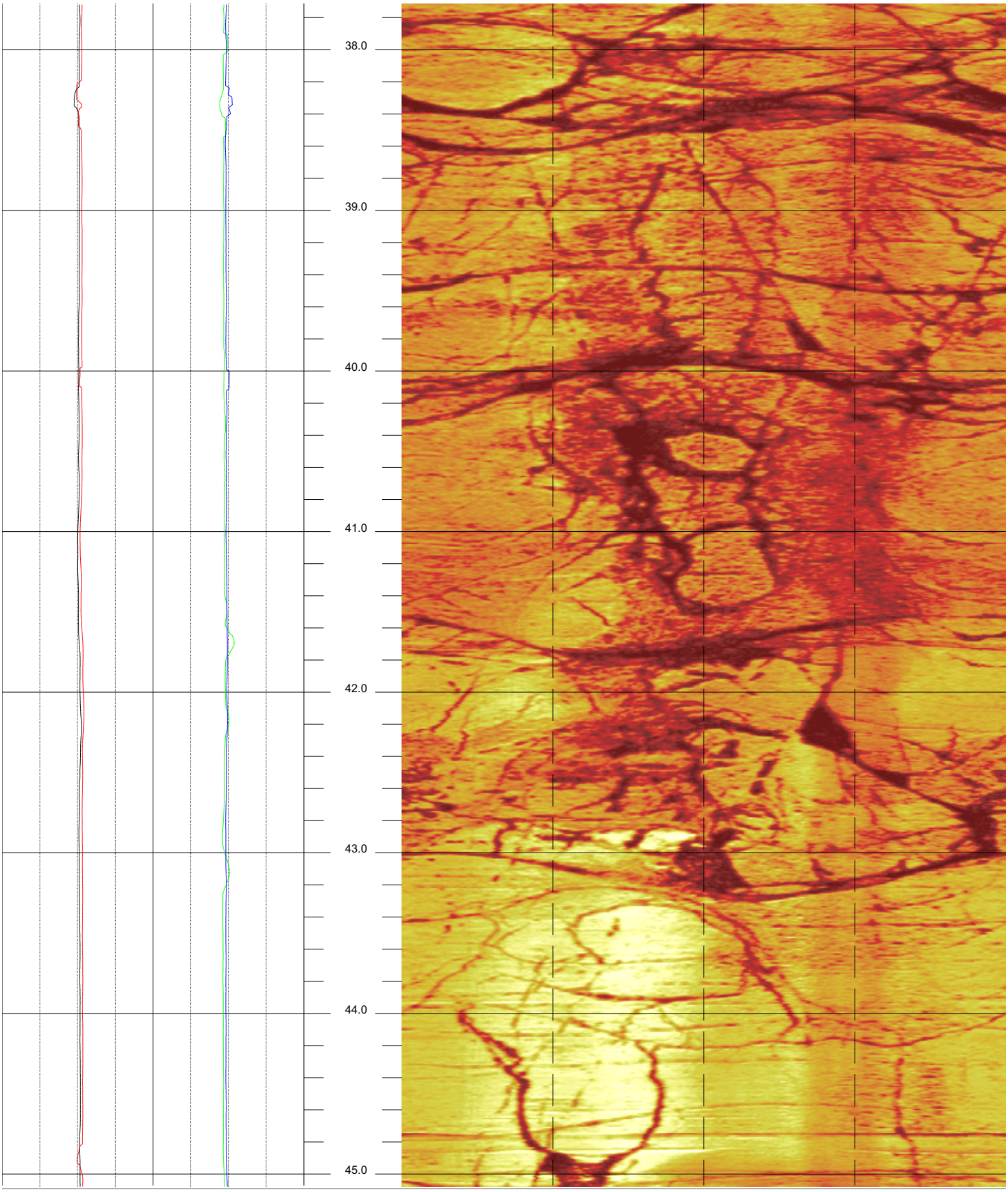


Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 2 of 13



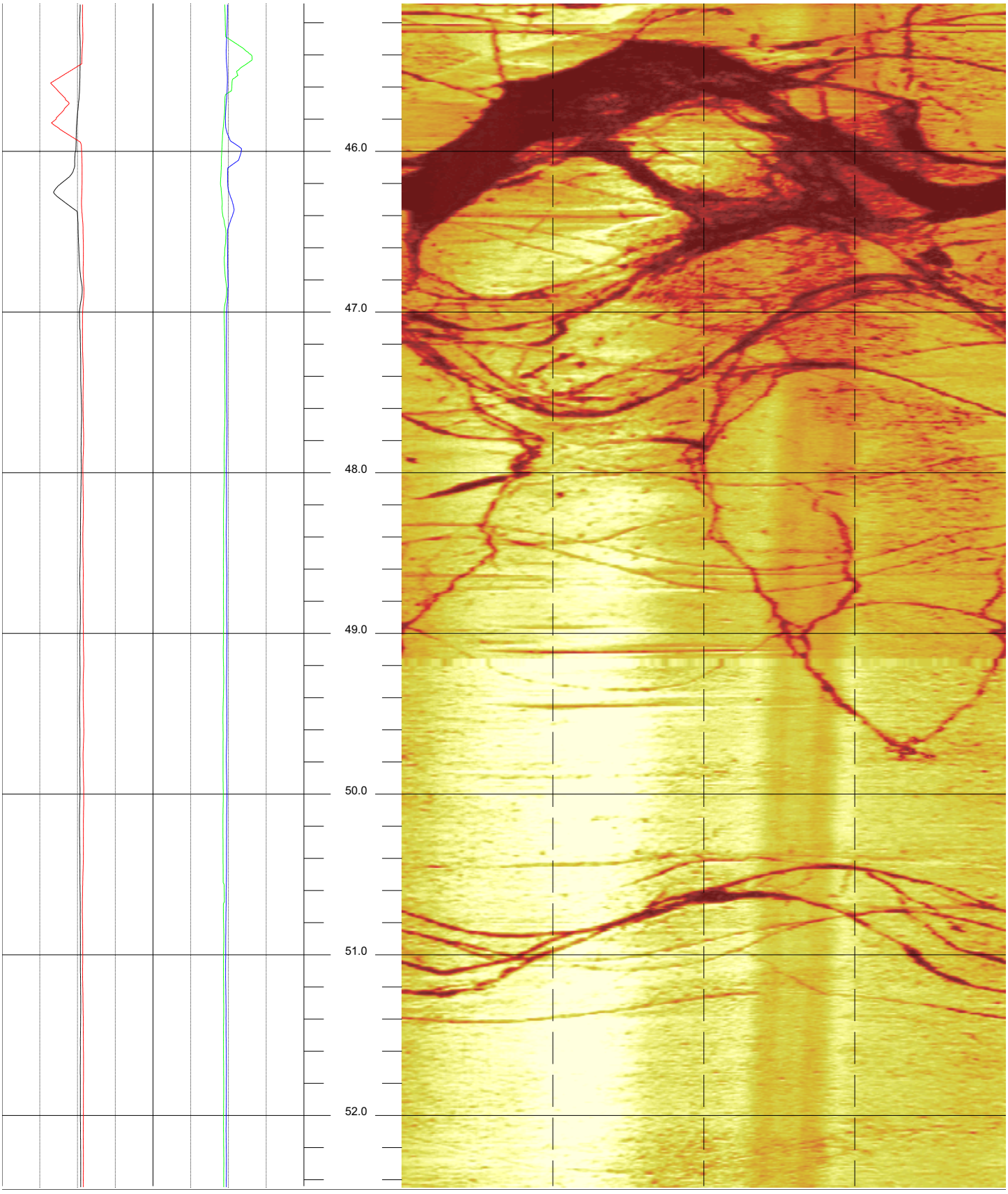
BTSB-R3 37.712 to 30.344ft 3

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 3 of 13



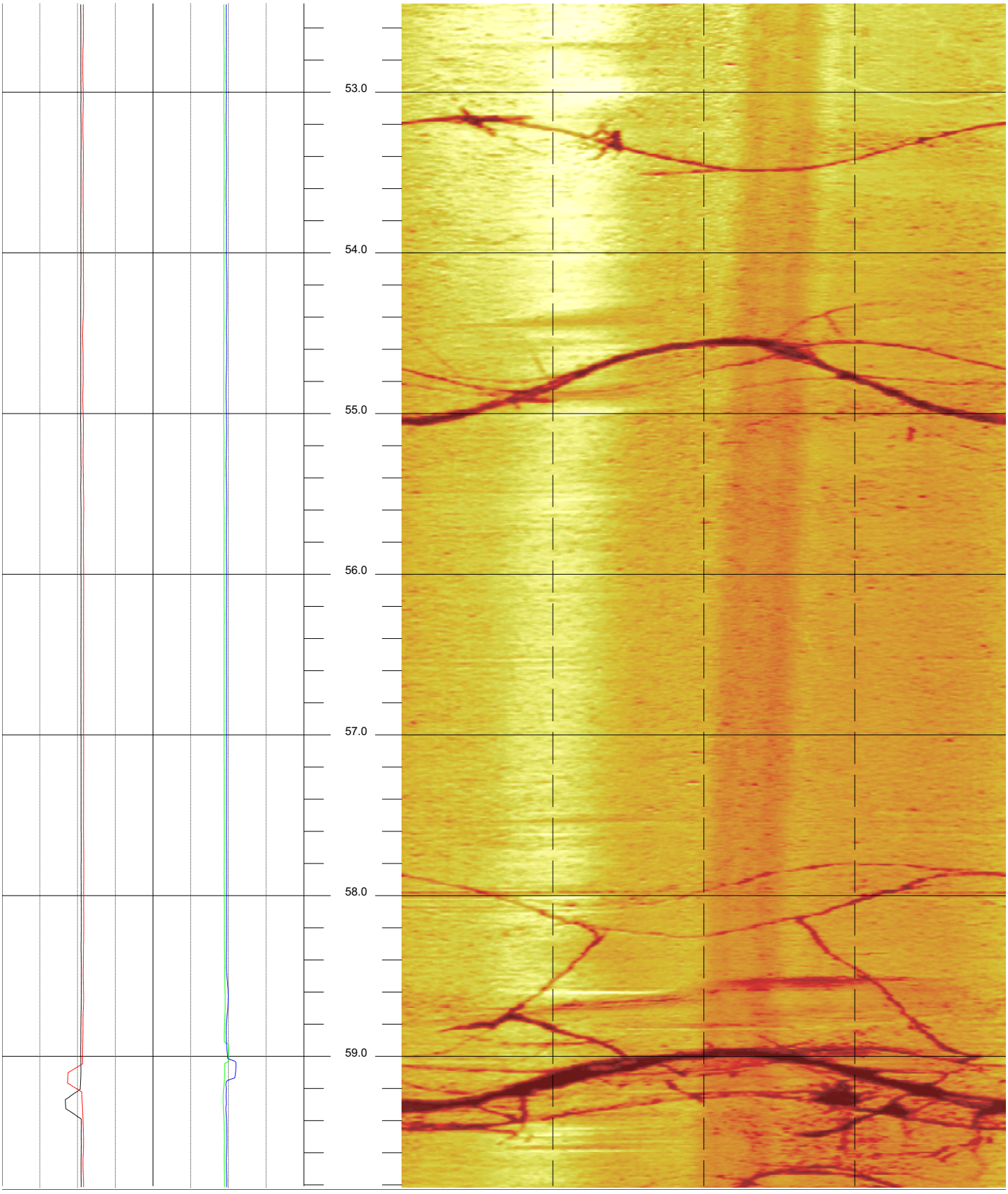
BTSB-R3 45.080 to 37.712ft 4

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 4 of 13



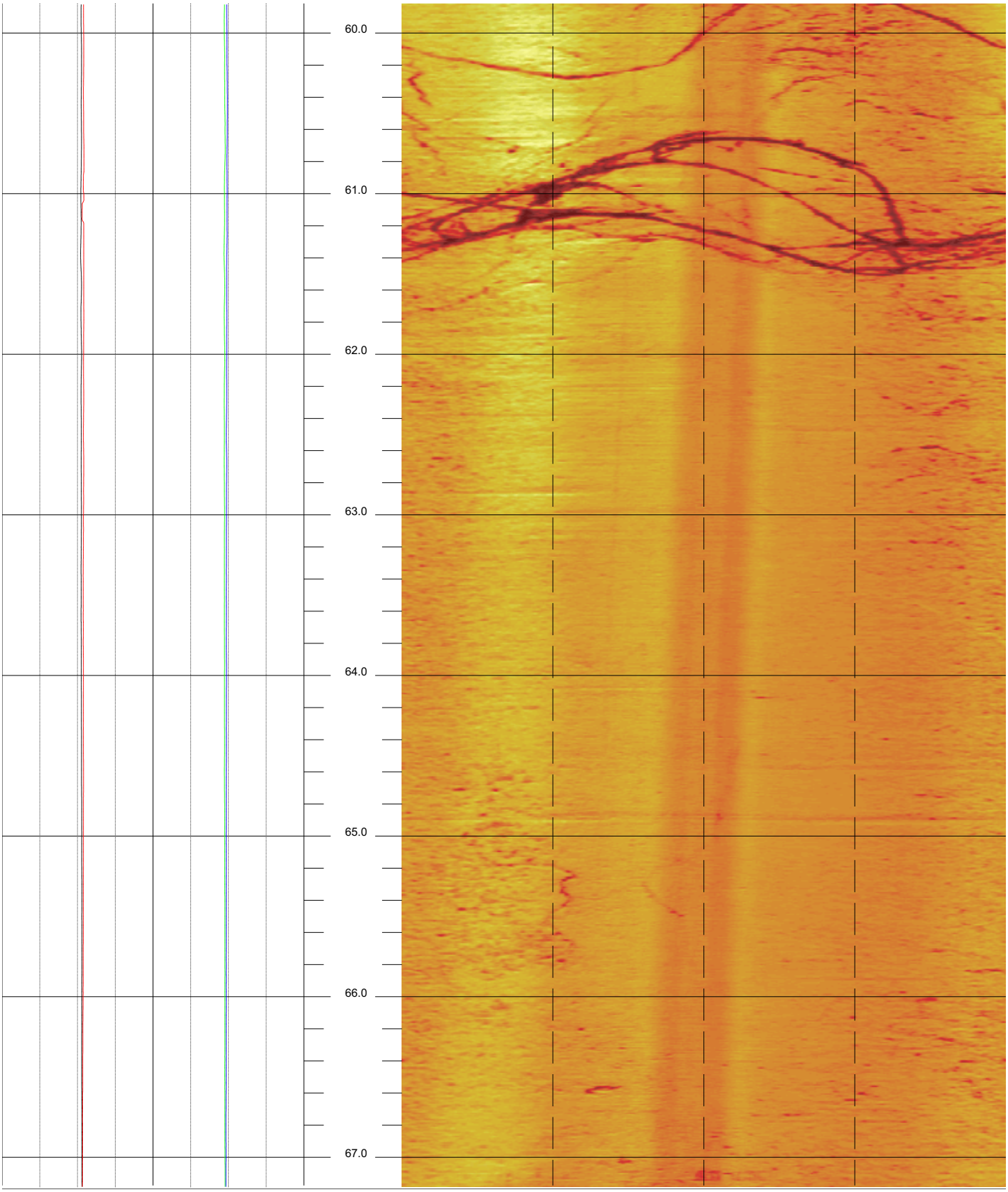
BTSB-R3 52.448 to 45.080ft 5

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 5 of 13



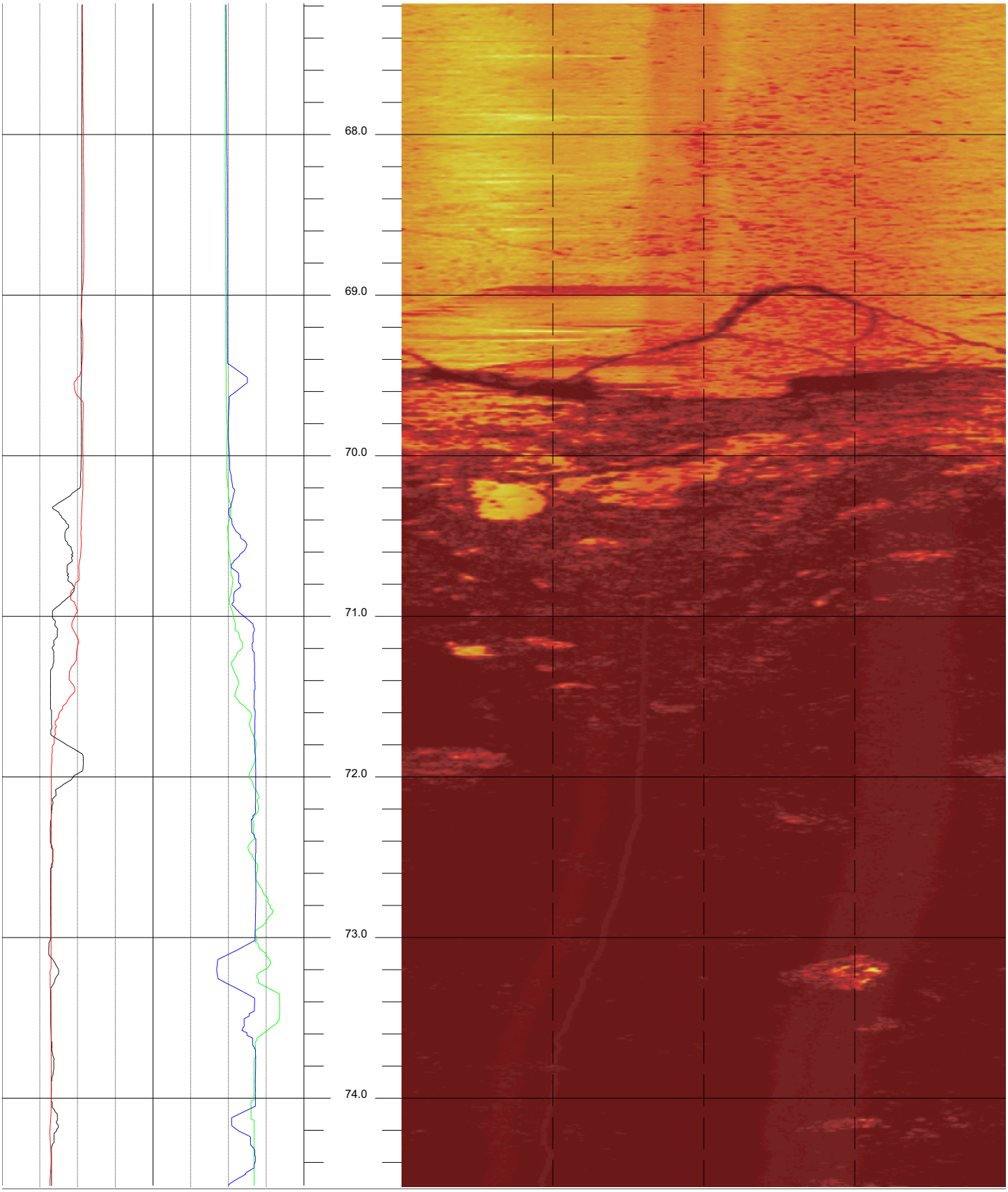
BTSB-R3 59.816 to 52.448ft 6

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 6 of 13



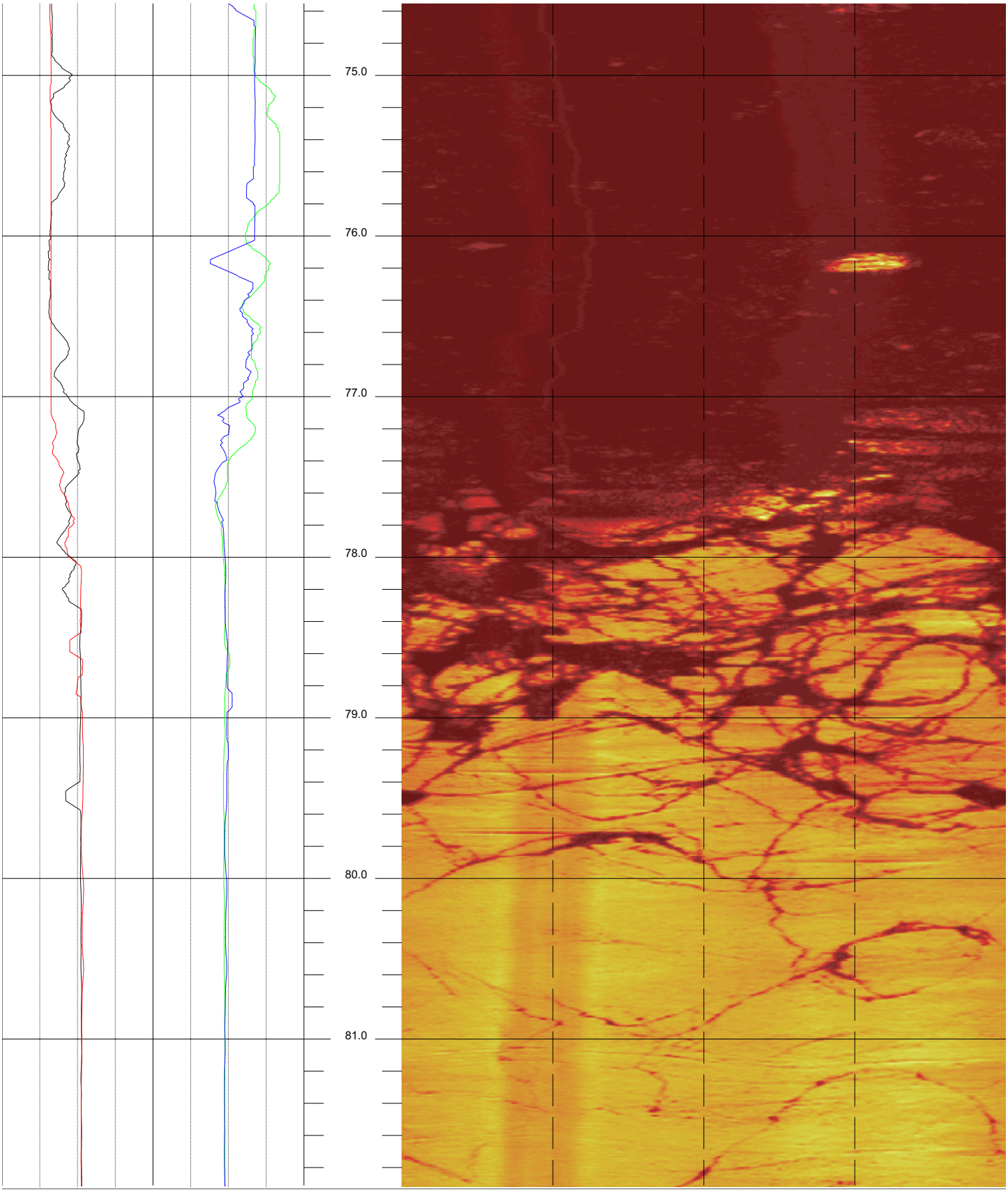
BTSB-R3 67.184 to 59.816ft 7

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 7 of 13



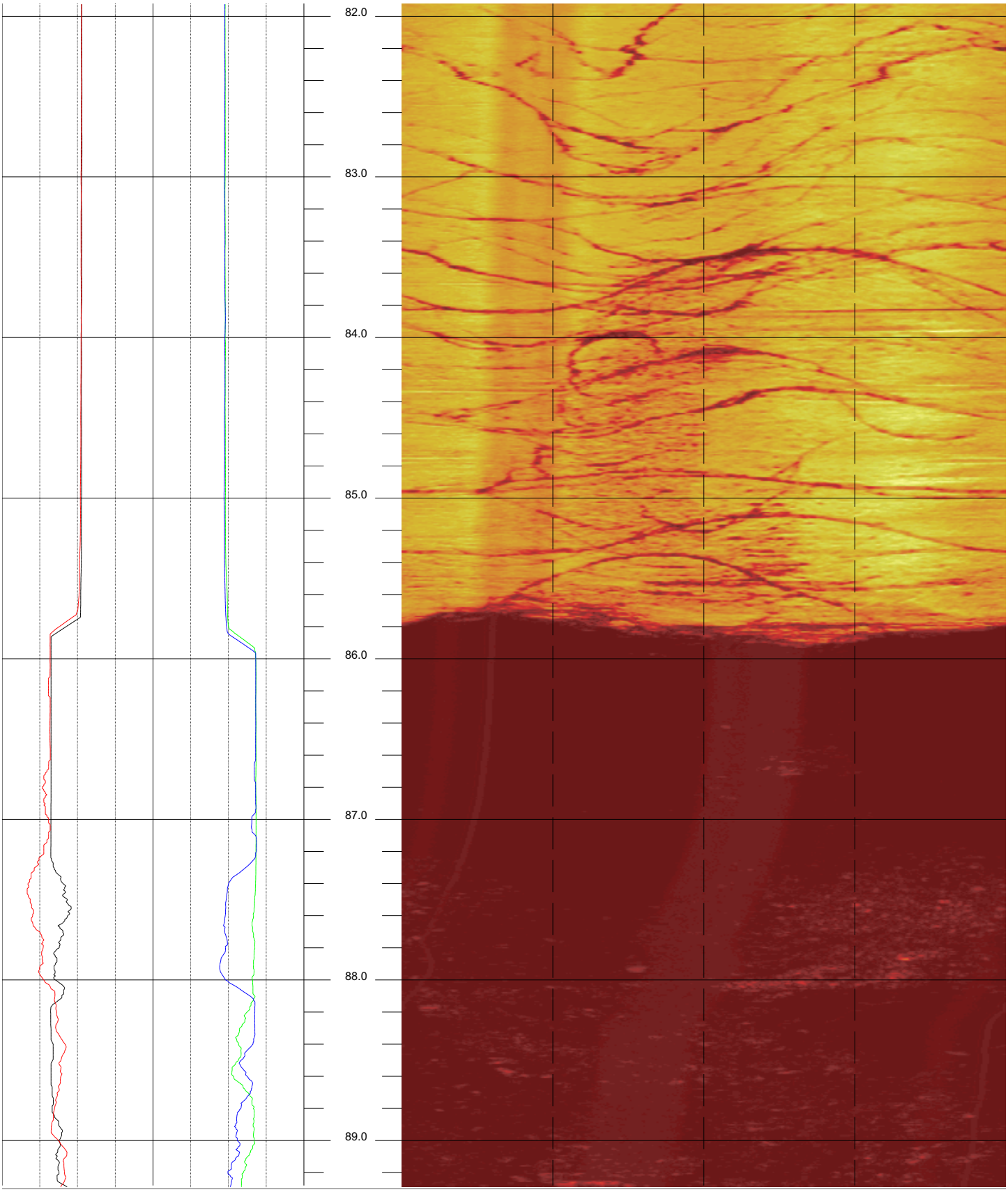
BTSB-R3 74.552 to 67.184ft 8

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 8 of 13



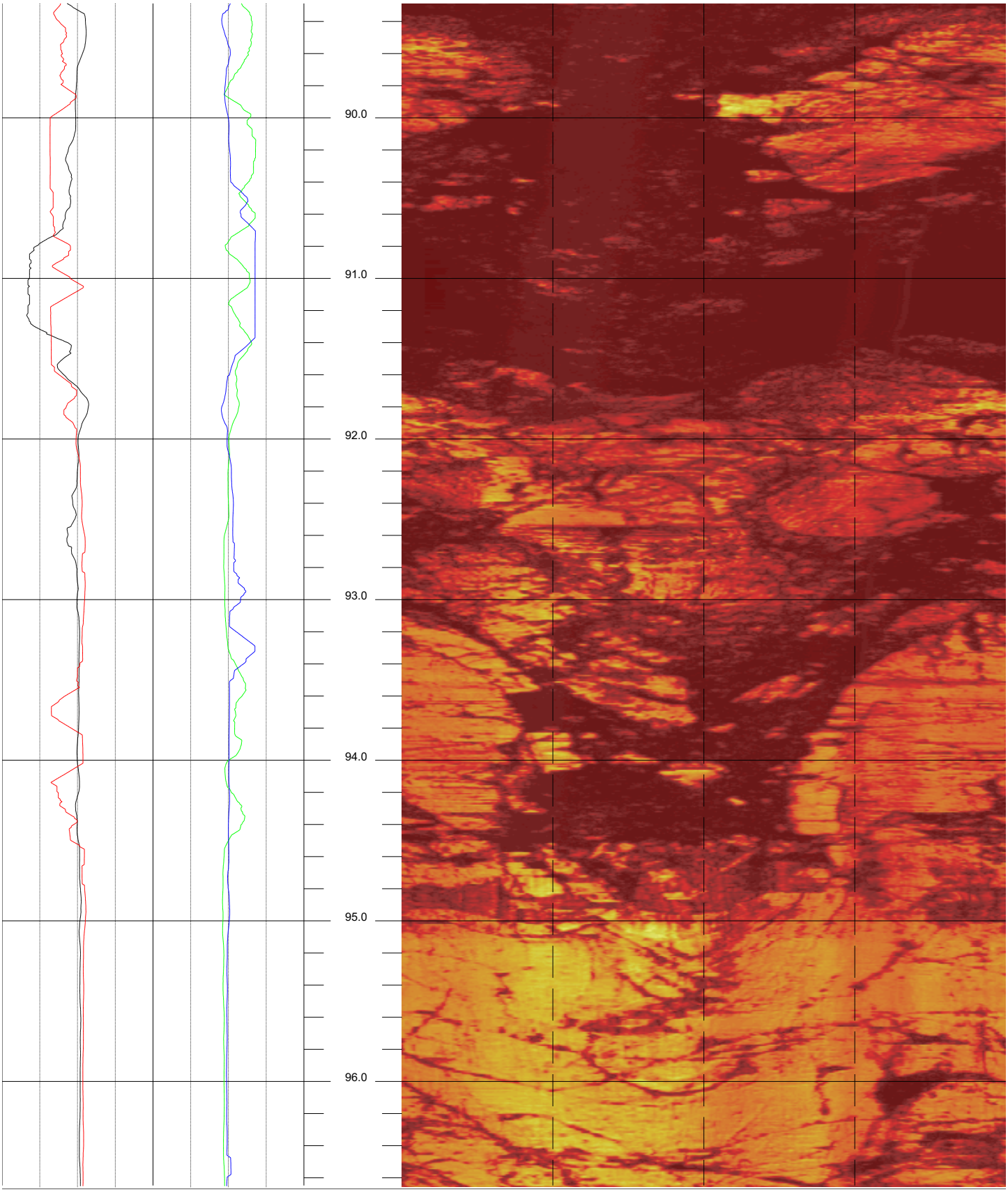
BTSB-R3 81.920 to 74.552ft 9

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 9 of 13



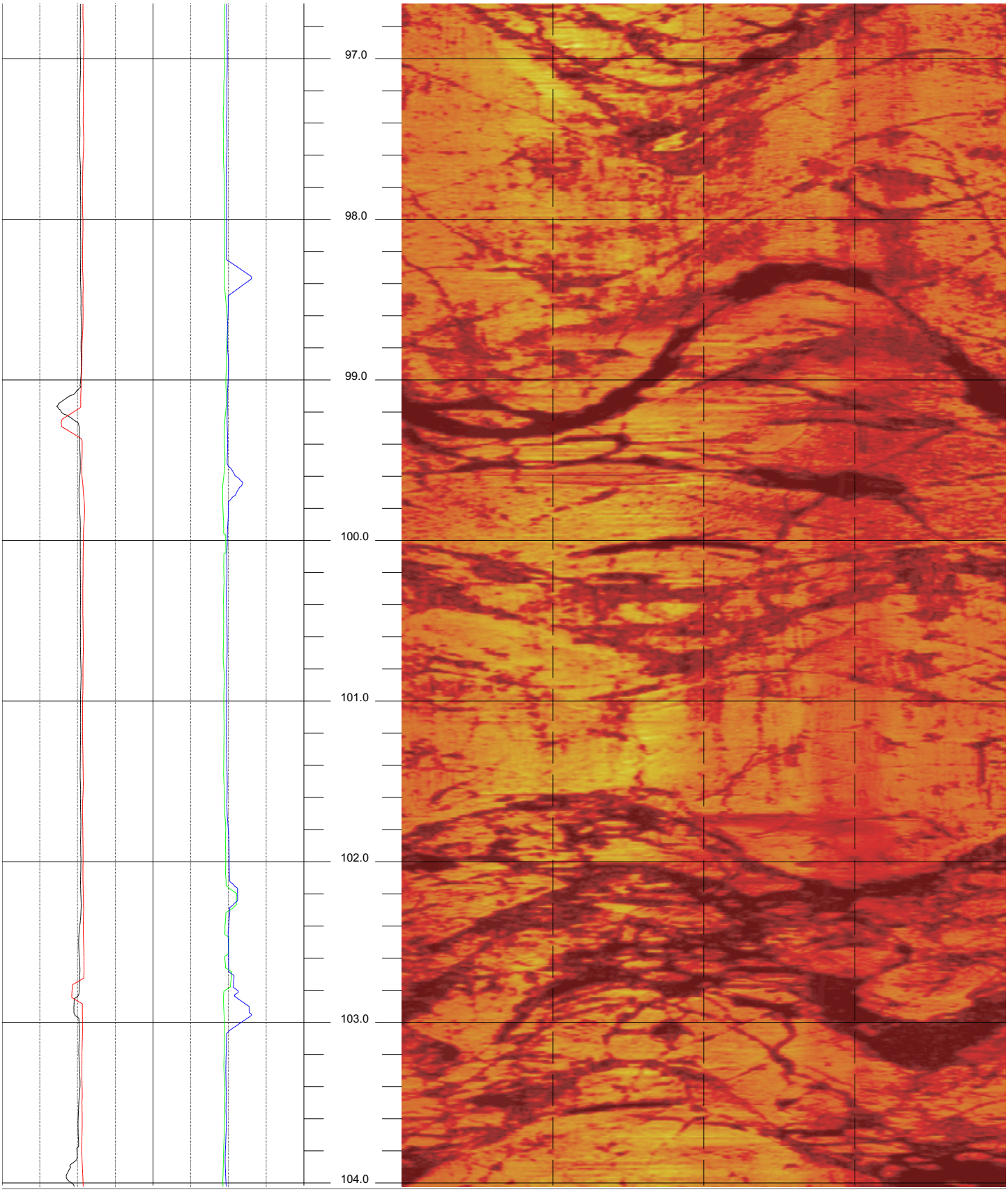
BTSB-R3 89.288 to 81.920ft 10

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 10 of 13



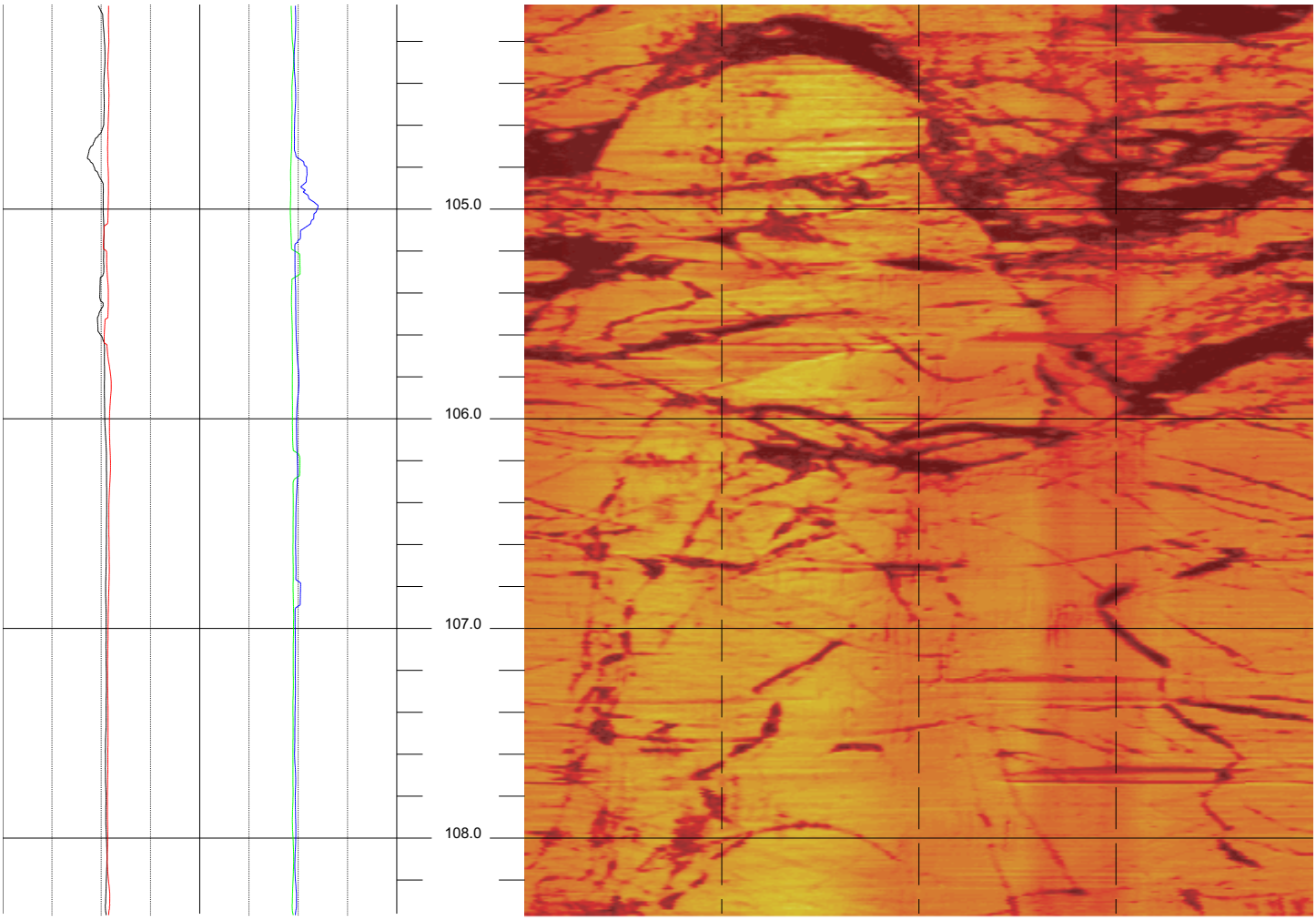
BTSB-R3 96.656 to 89.288ft 11

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 11 of 13



BTSB-R3 104.024 to 96.656fl 12

Doyle Drive BTSB-R3 Acoustic Televiewer derived Caliper Sheet 12 of 13


105.0
106.0
107.0
108.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

14 Jun 2008

ARUP

Borehole: RW6-R1

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

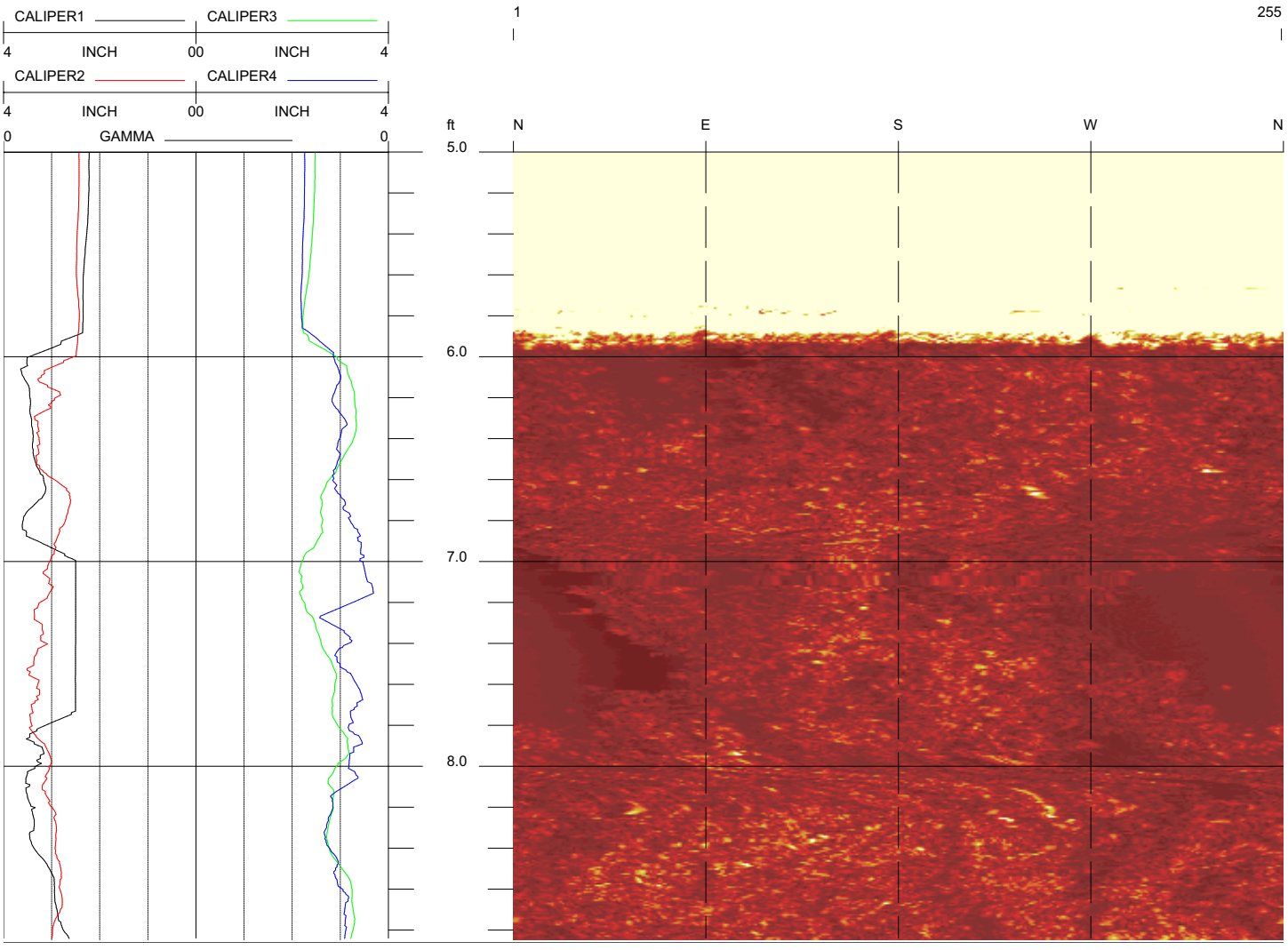
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 57.216 to 5.000ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

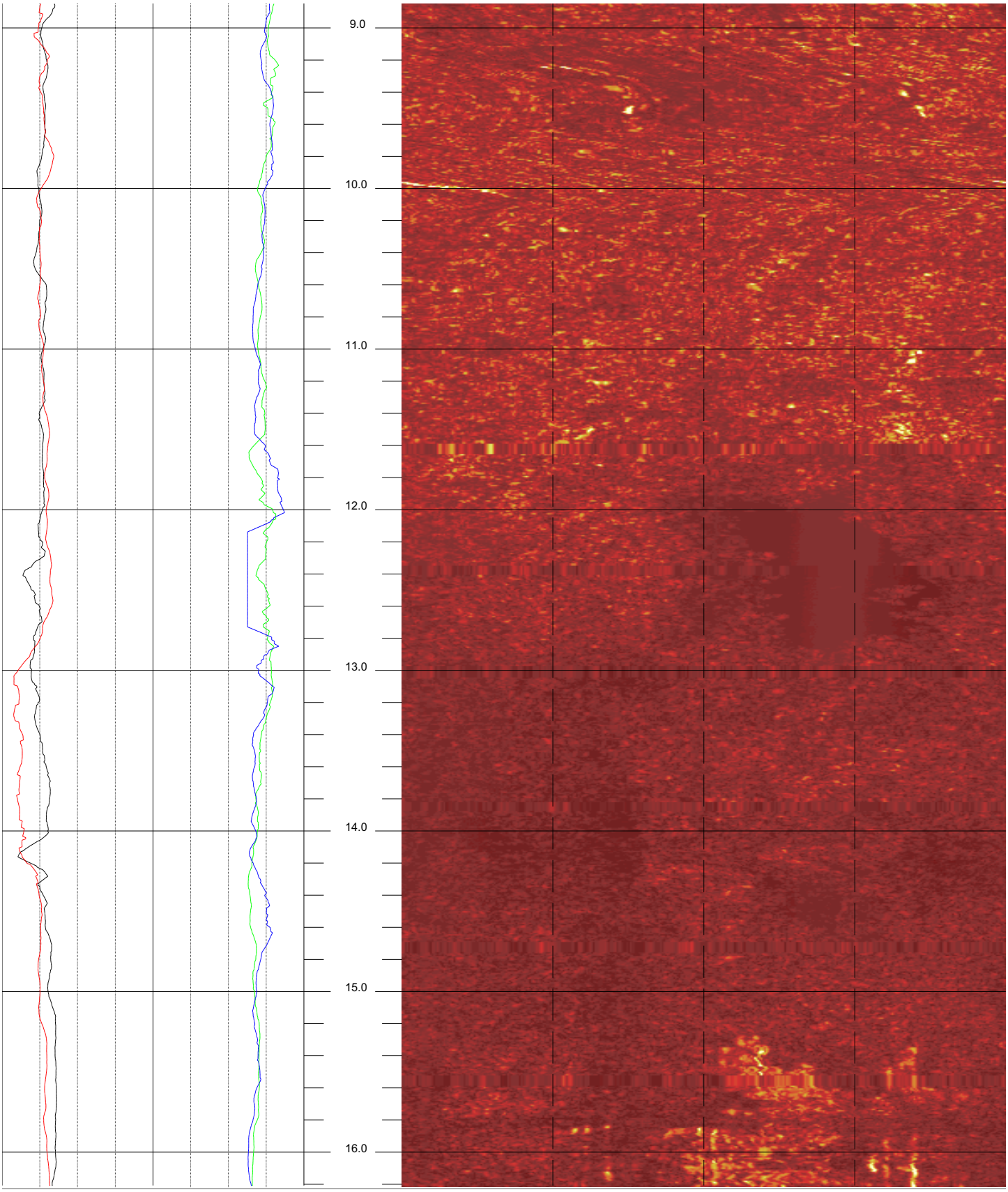
Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE

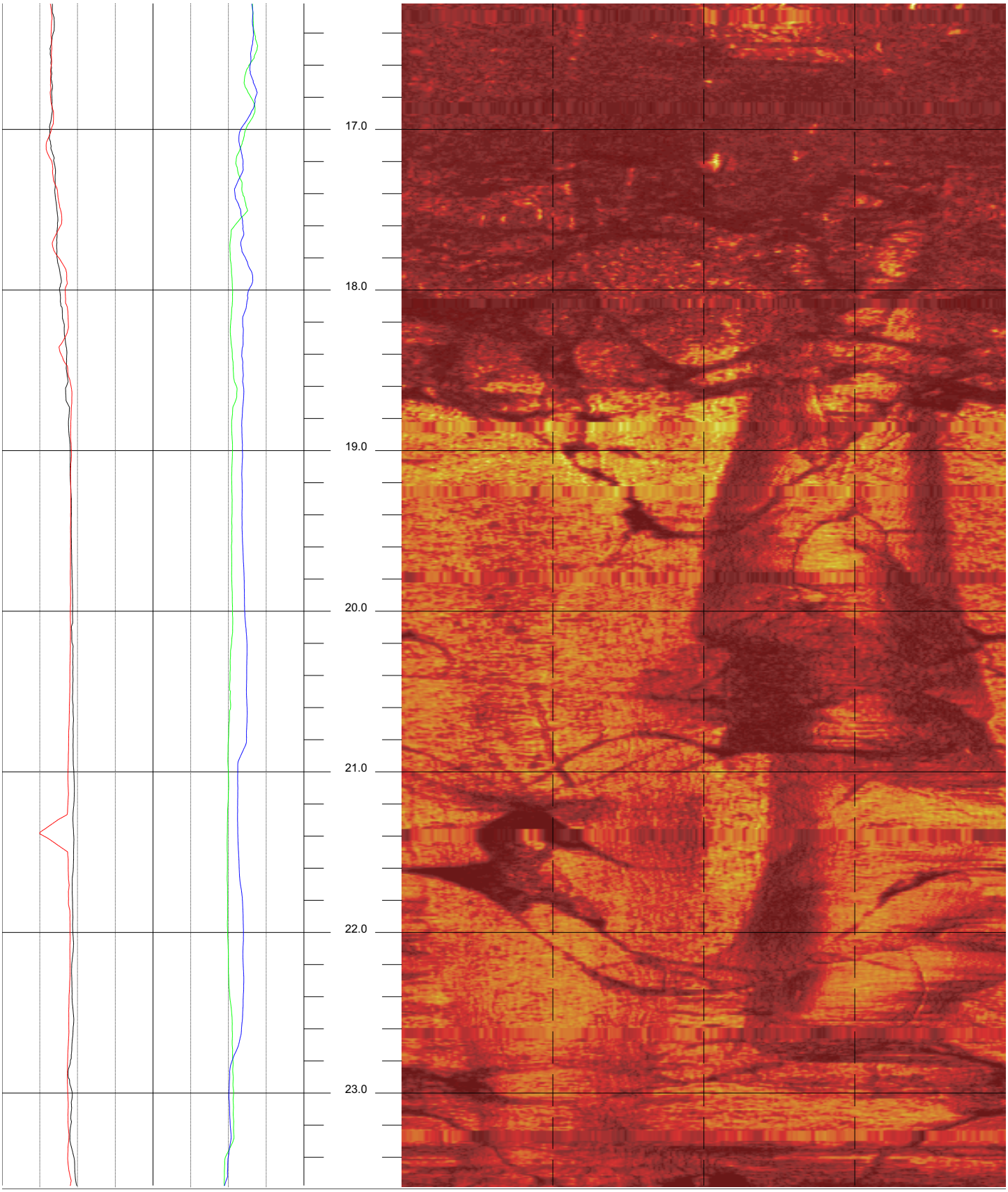


RW6-R1 8.848 to 5.000fl 1

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 1 of 8

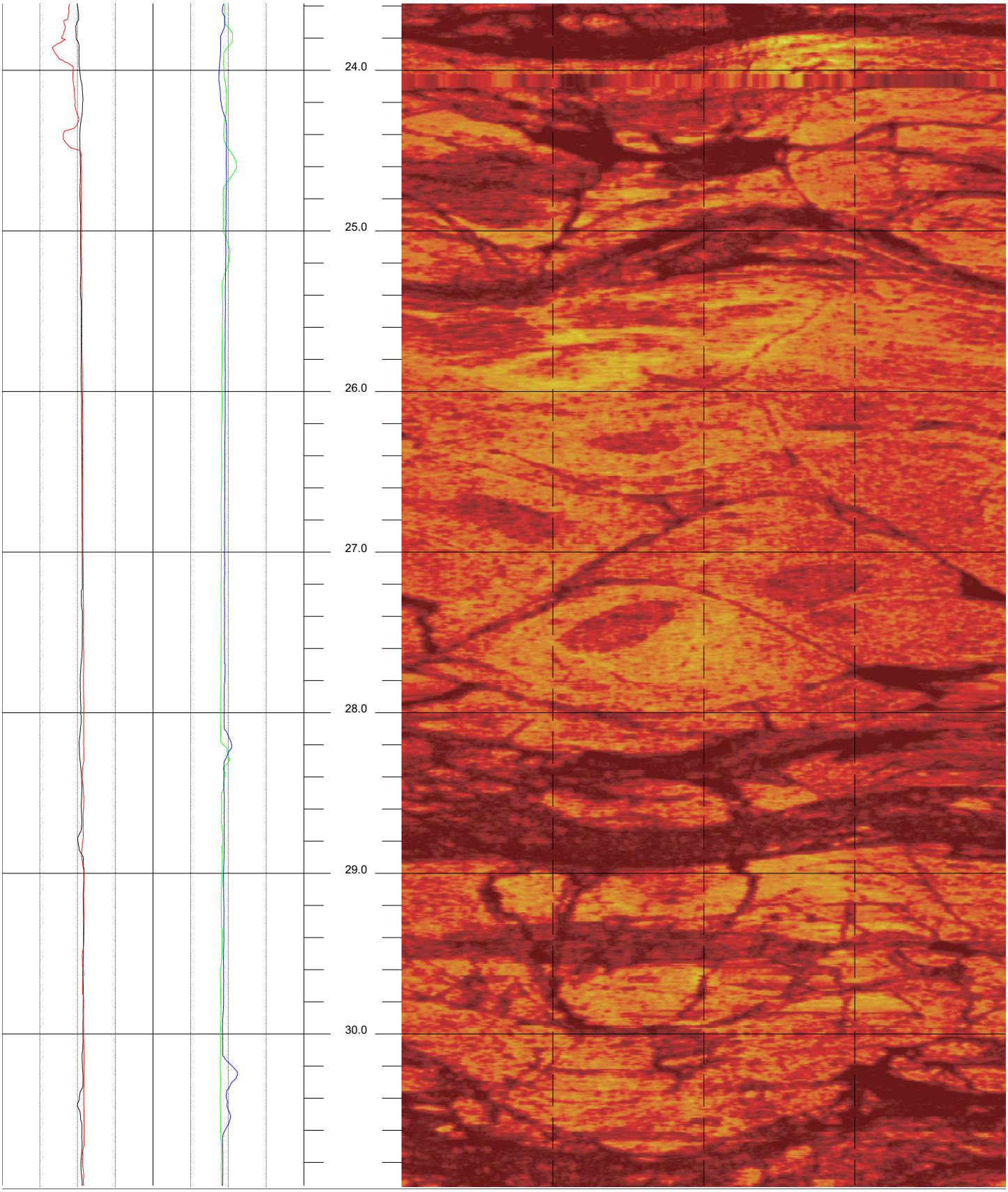


Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 2 of 8



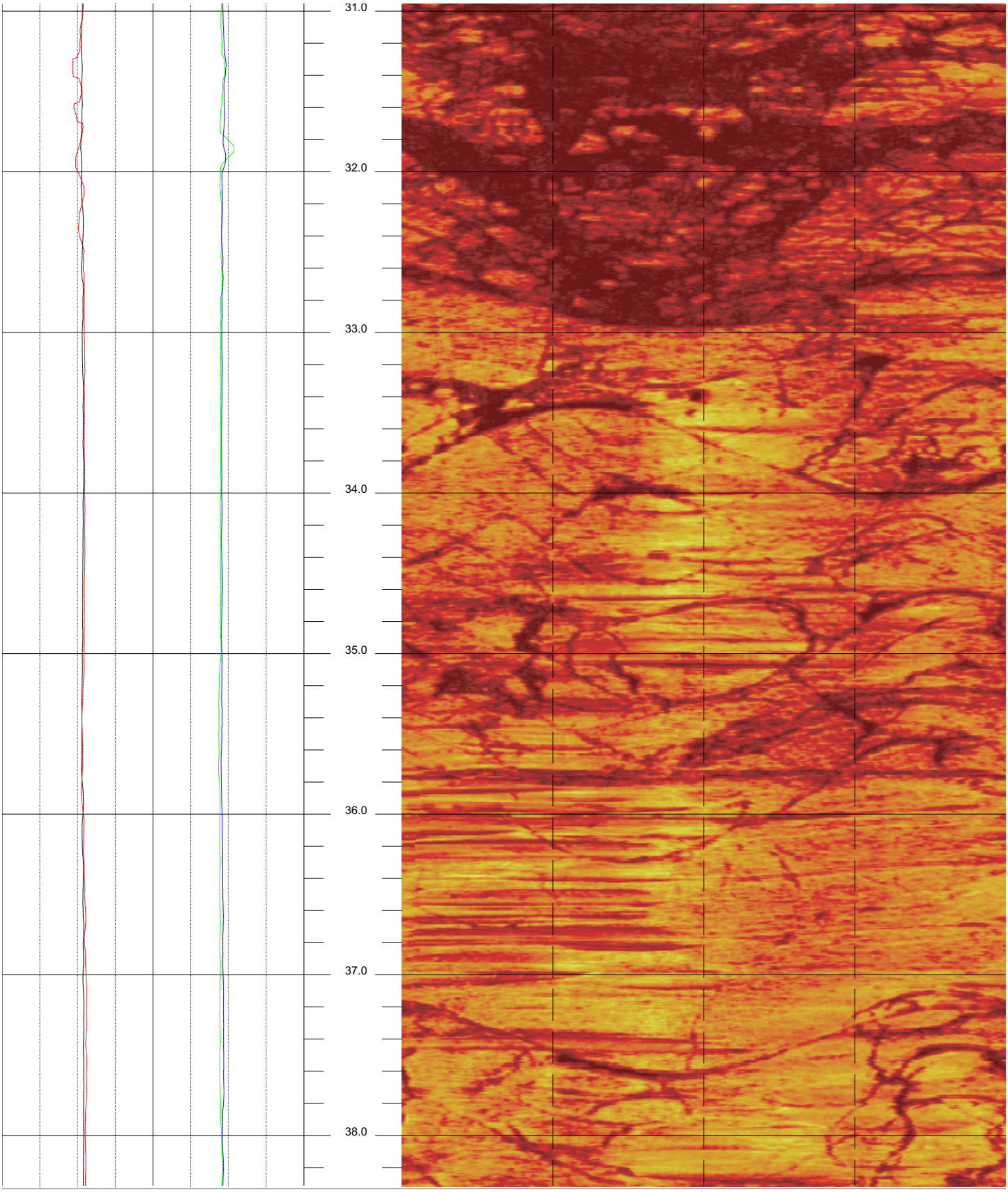
RW6-R1 23.584 to 16.216ft 3

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 3 of 8



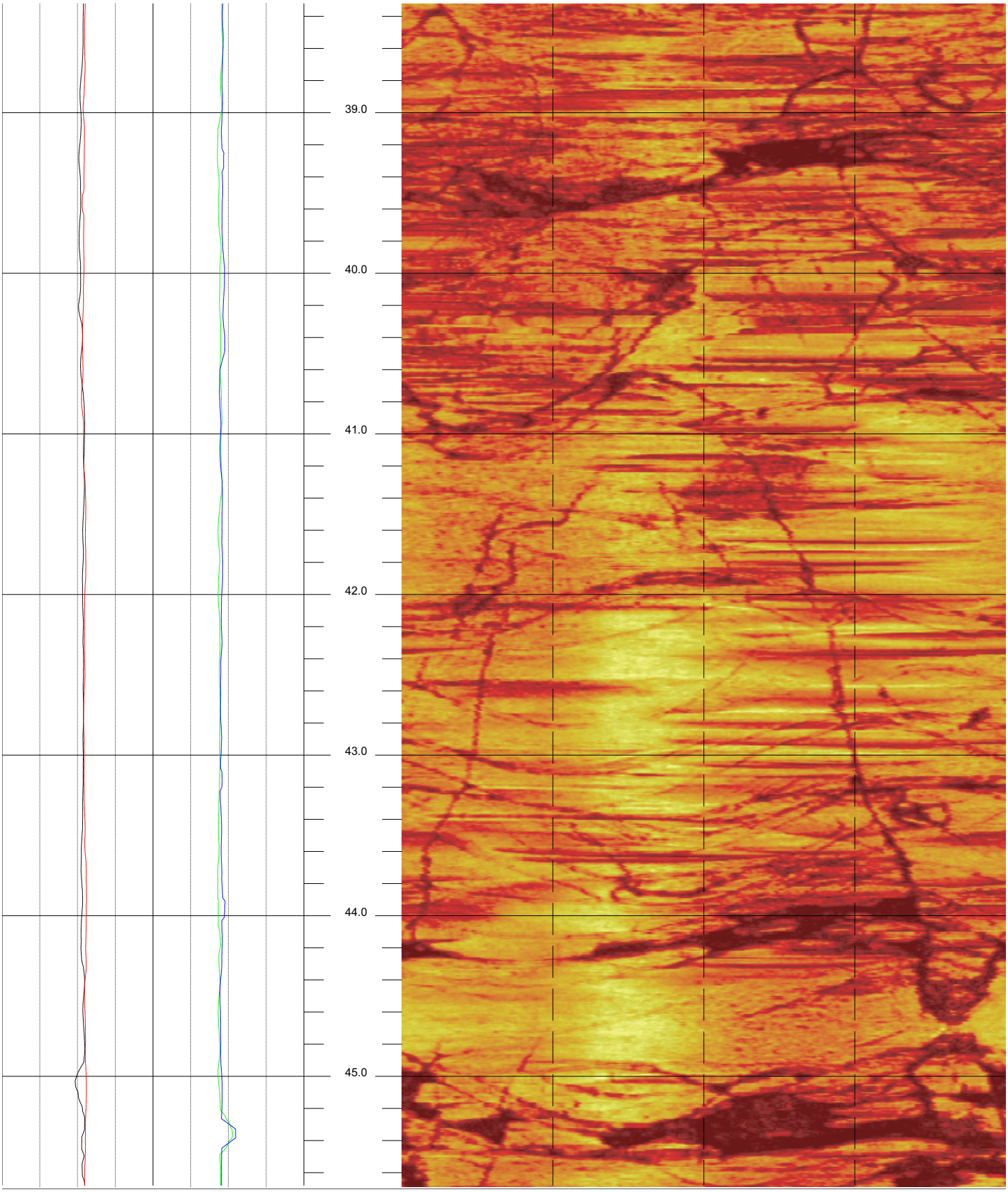
RW6-R1 30.952 to 23.584ft 4

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 4 of 8



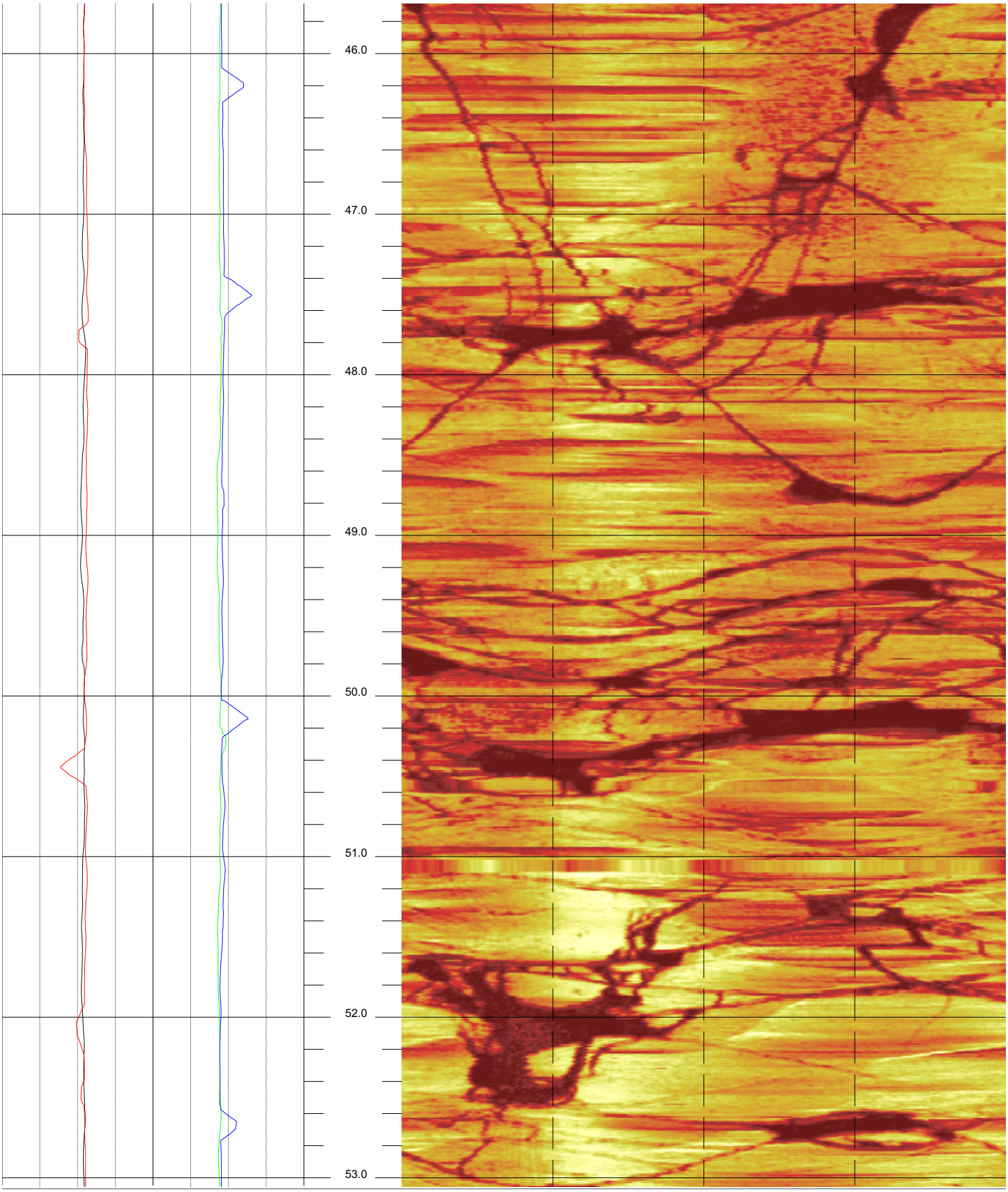
RW6-R1 38.320 to 30.952ft 5

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 5 of 8



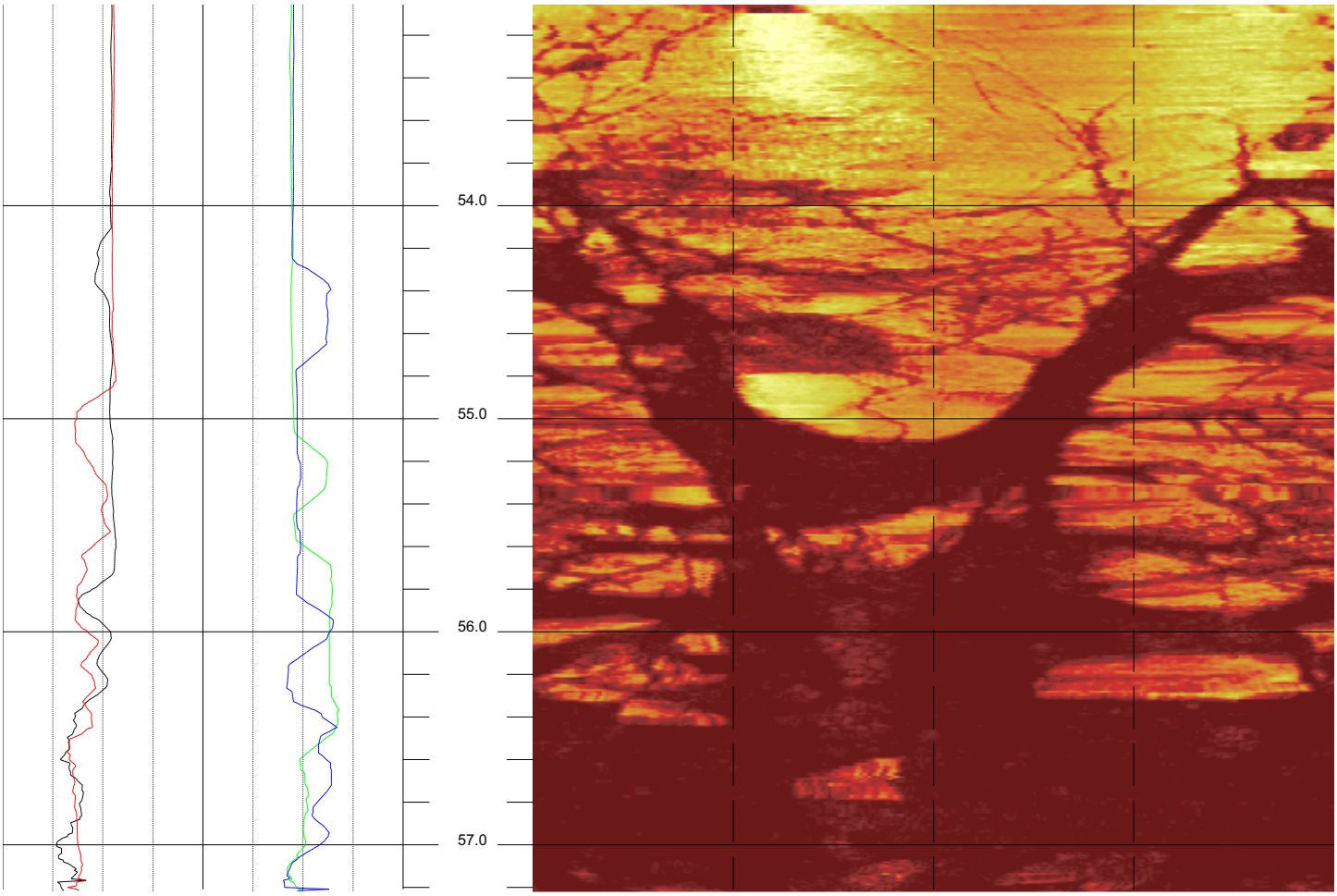
RW6-R1 45.688 to 38.320ft 6

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 6 of 8



RW6-R1 53.056 to 45.688ft 7

Doyle Drive RW6-R1 Acoustic Televiewer derived Caliper Sheet 7 of 8


54.0
55.0
56.0
57.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

15 Jun 2008

ARUP

Borehole: RW6-R2

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

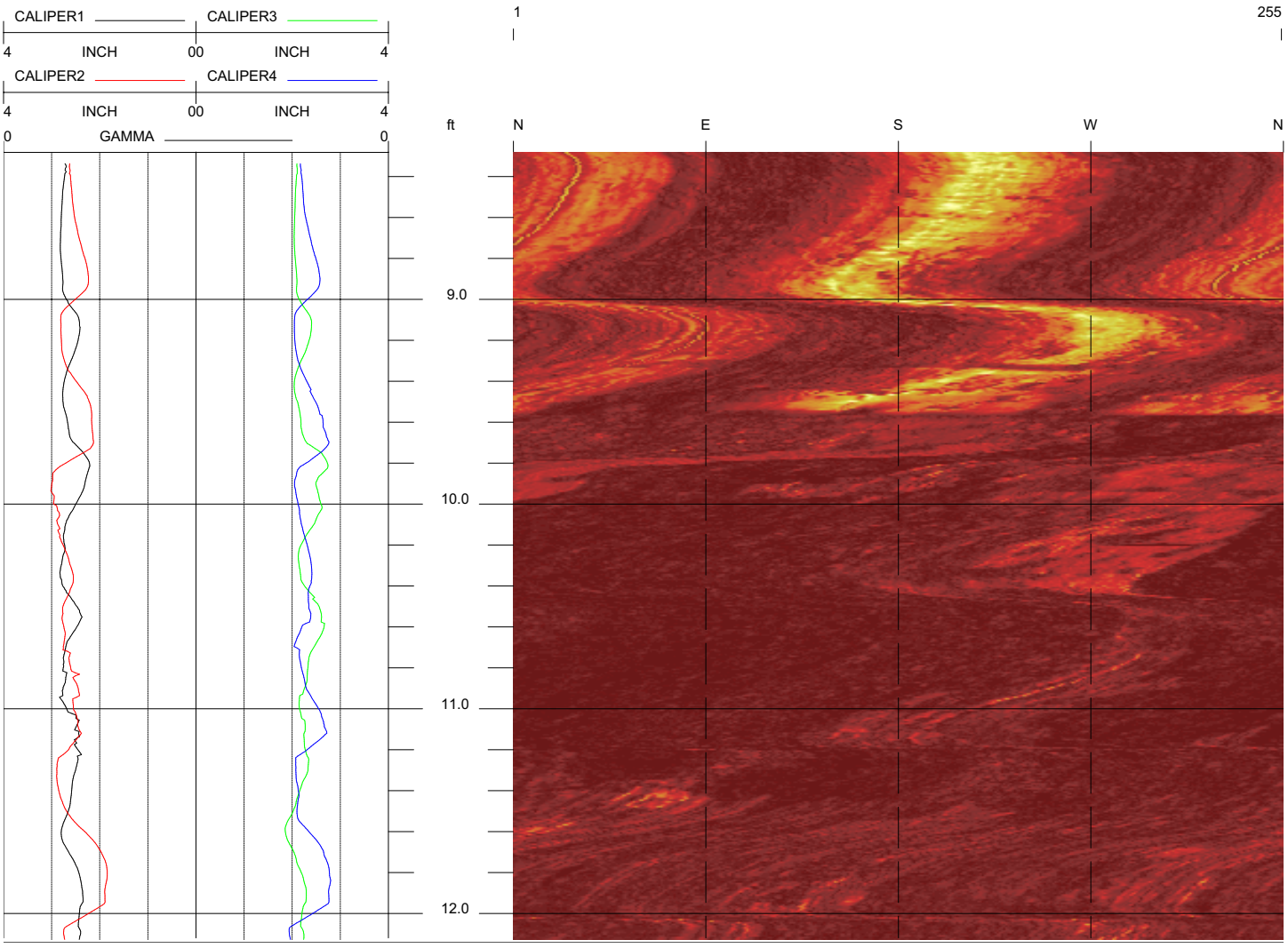
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 112.960 to 8.280ft

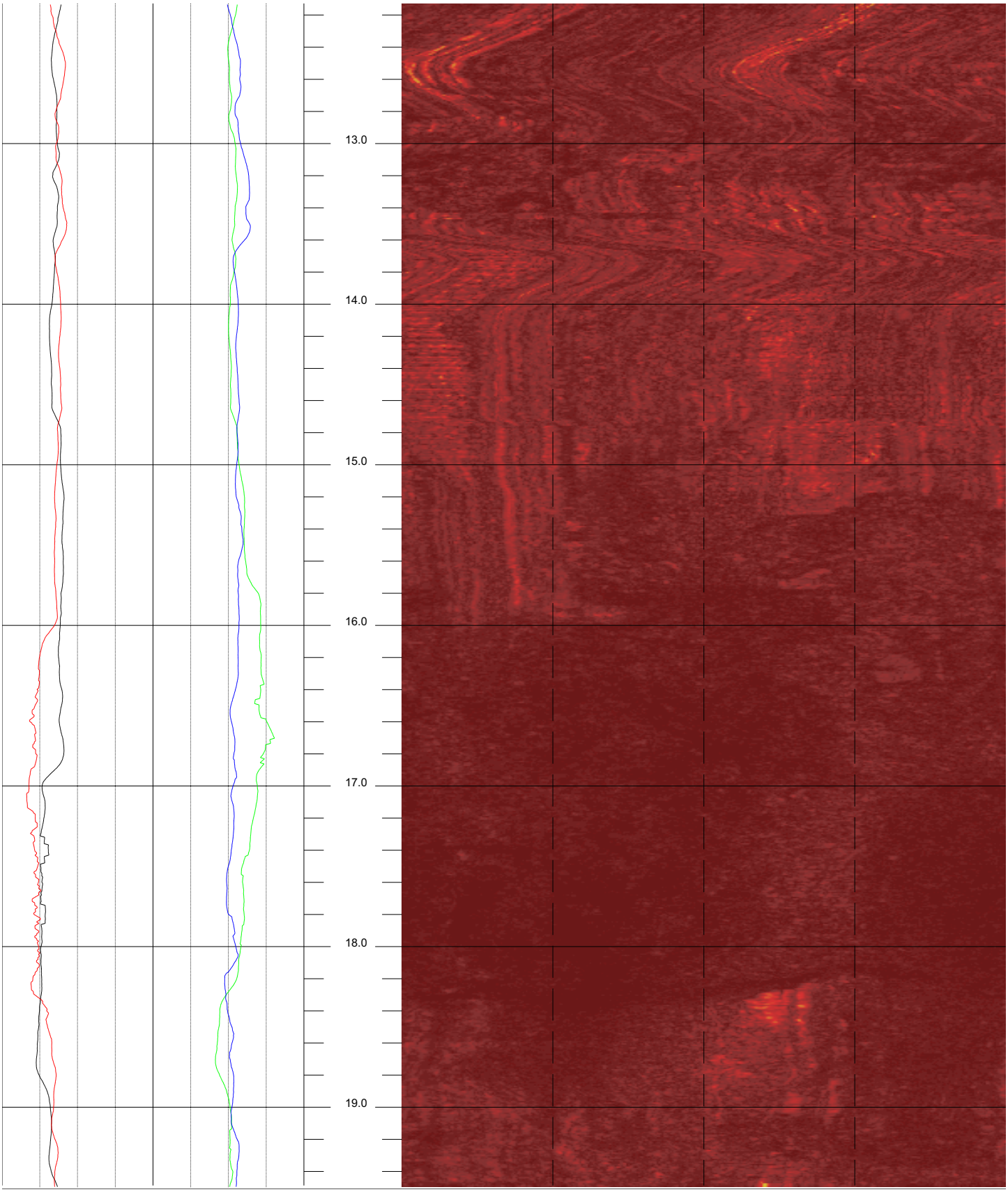
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE

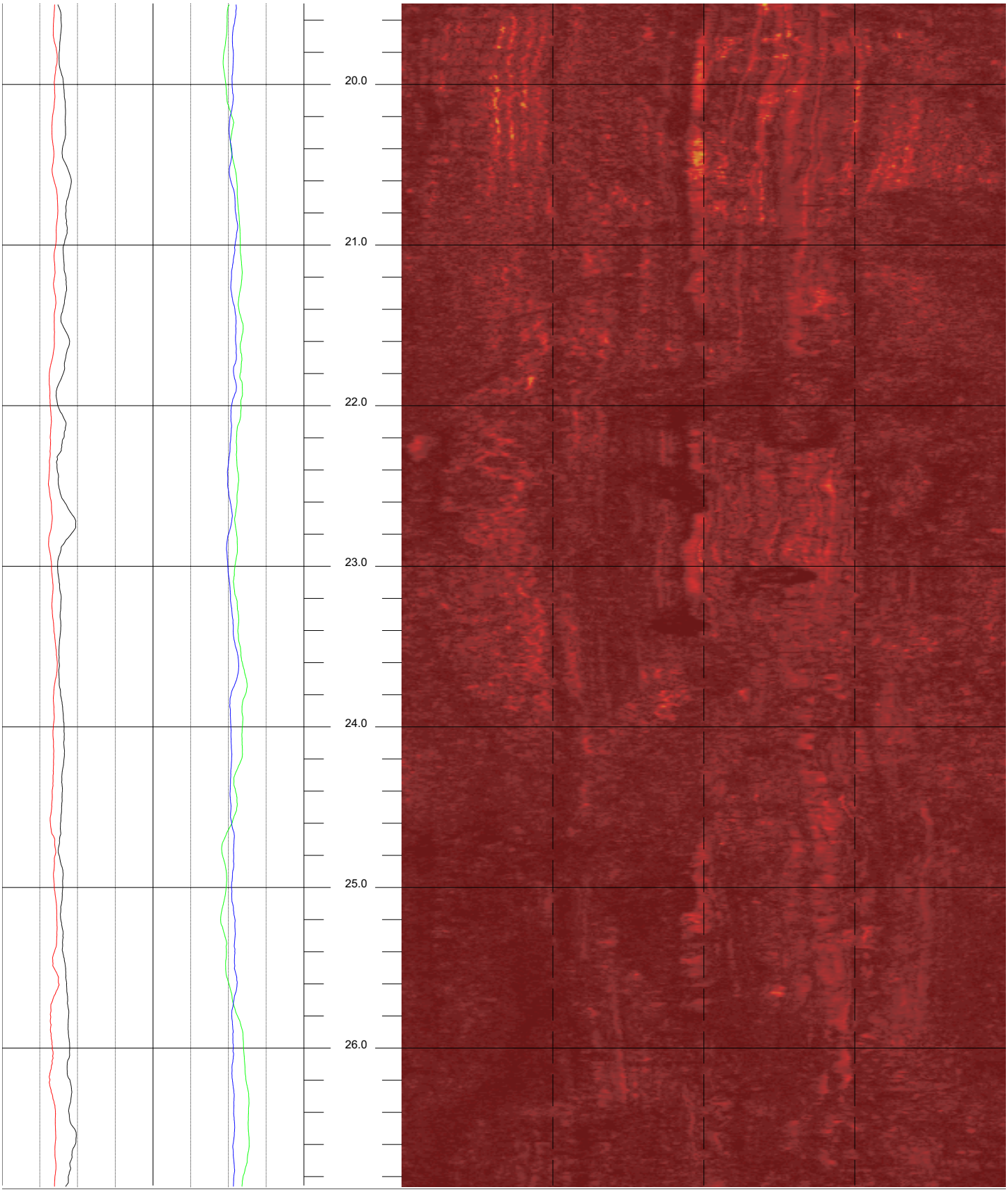


RW6-R2 12.128 to 8.280ft 1



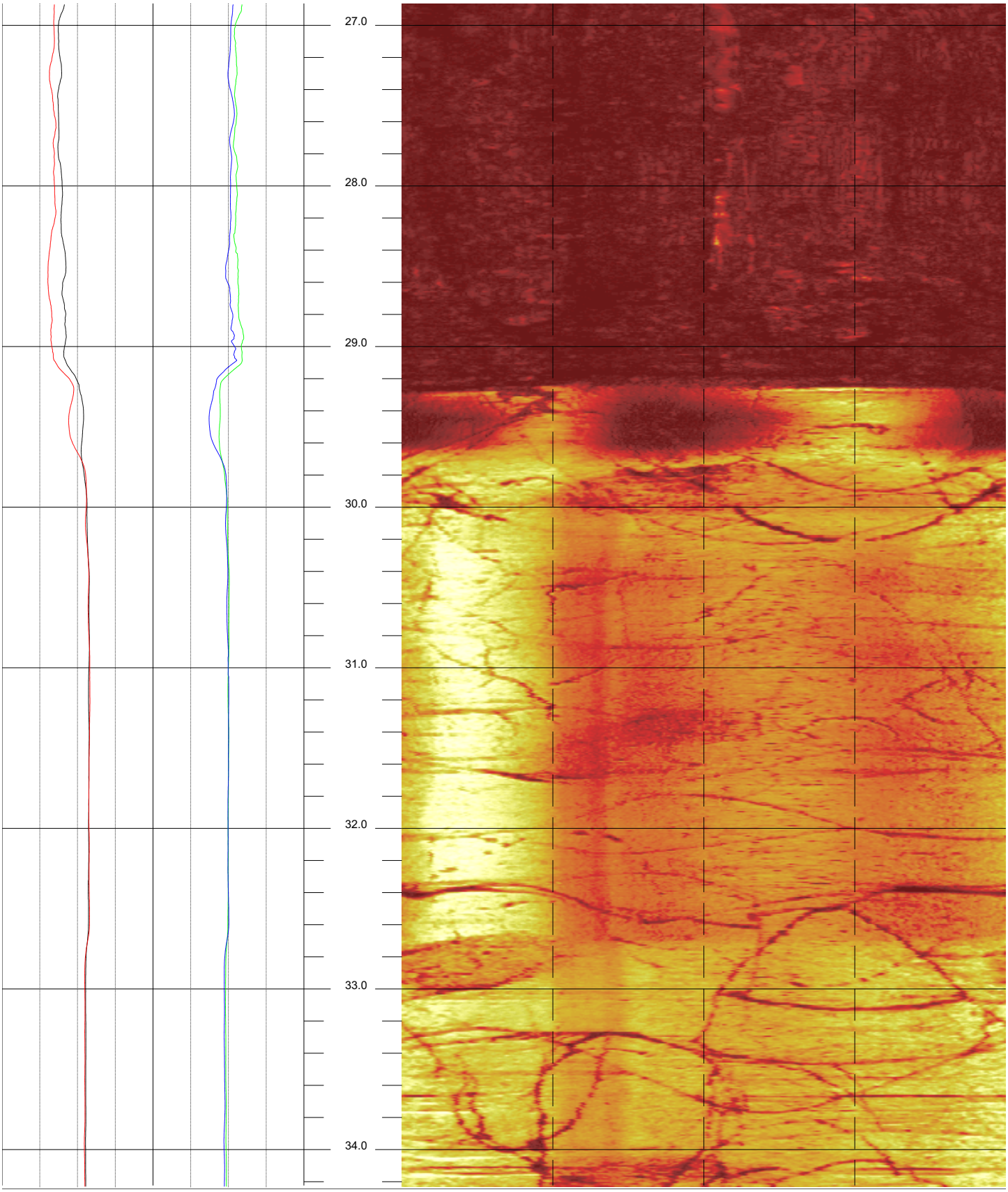
RW6-R2 19.496 to 12.128ft 2

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 2 of 15



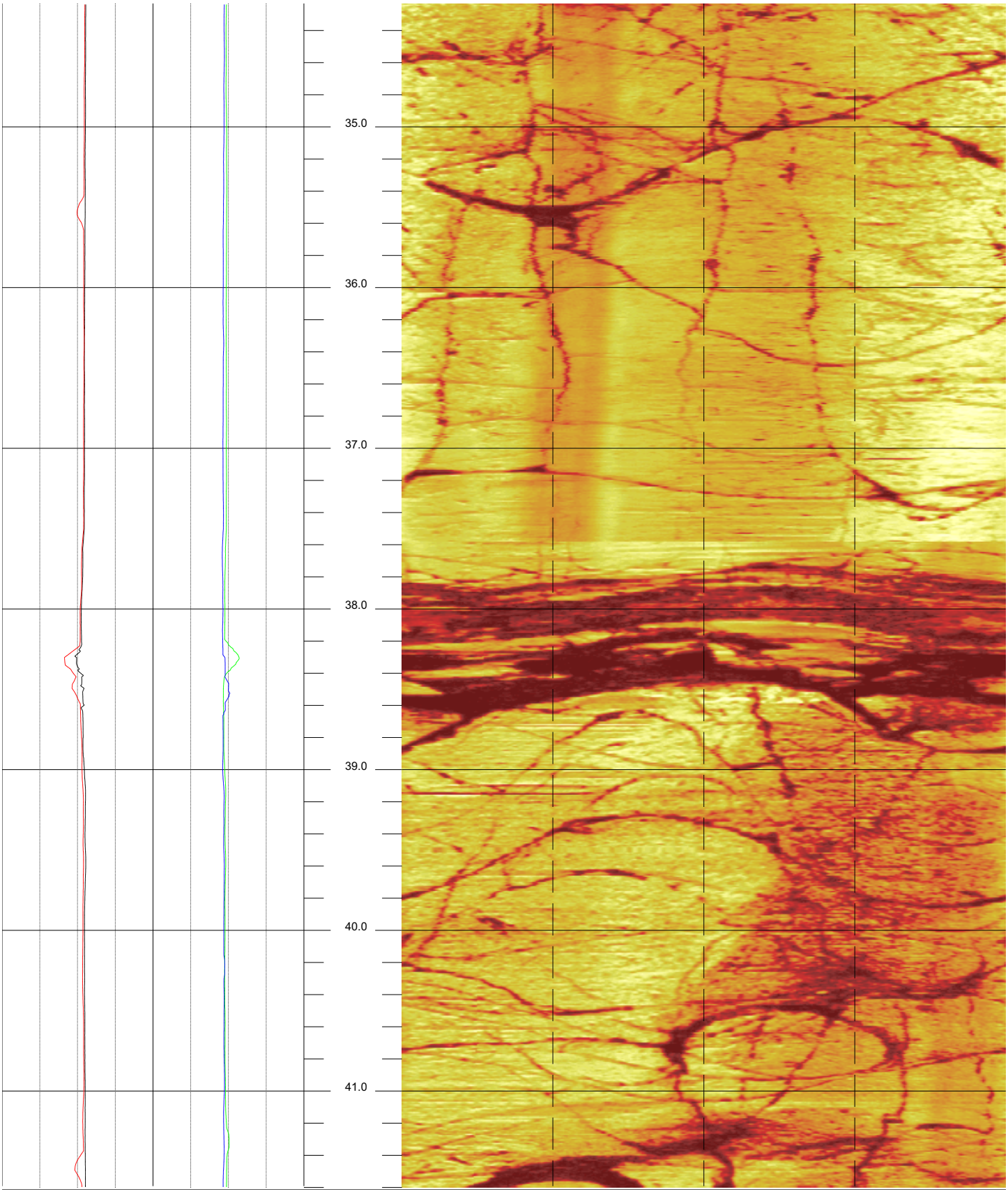
RW6-R2 26.864 to 19.496ft 3

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 3 of 15



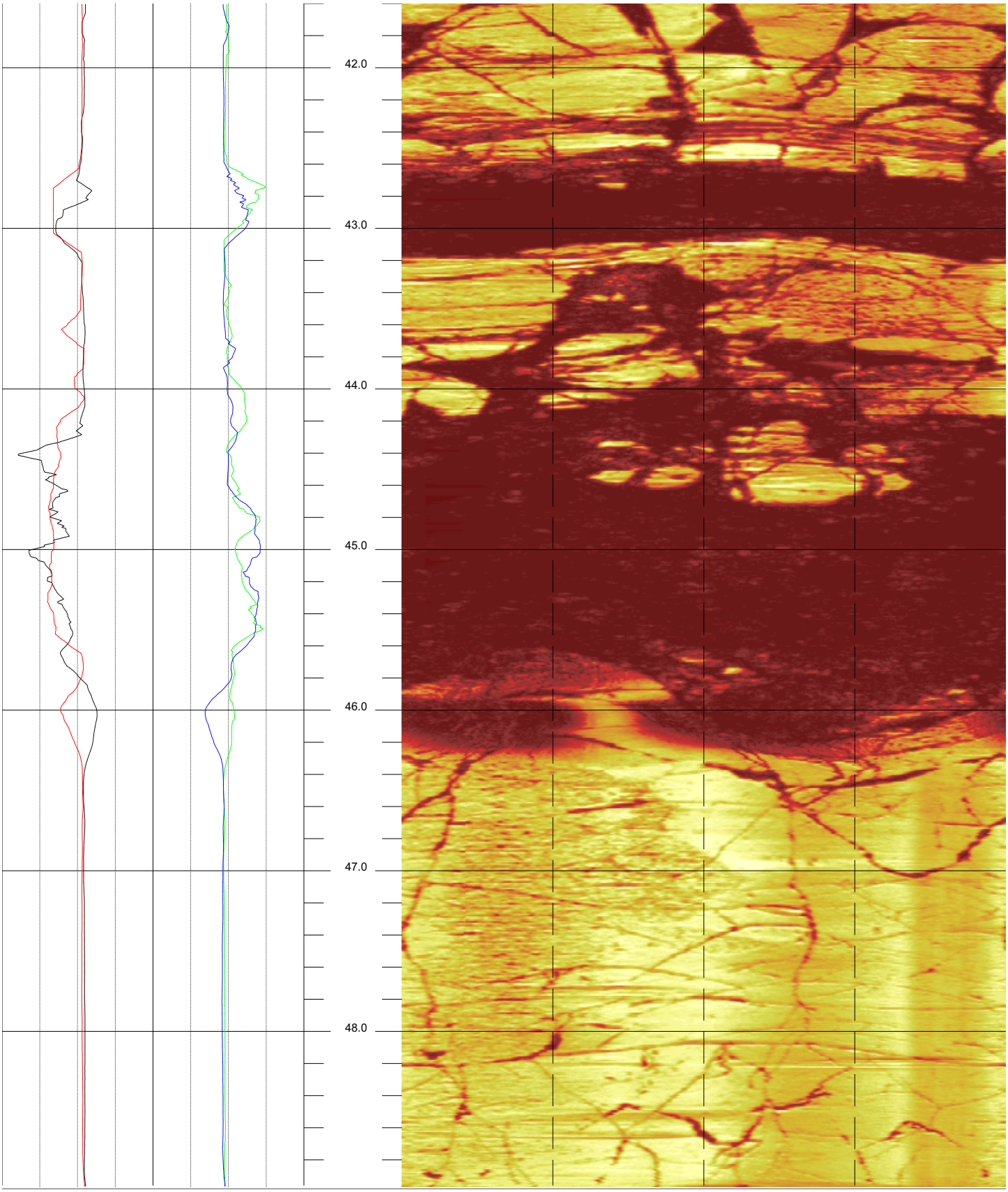
RW6-R2 34.232 to 26.864ft 4

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 4 of 15



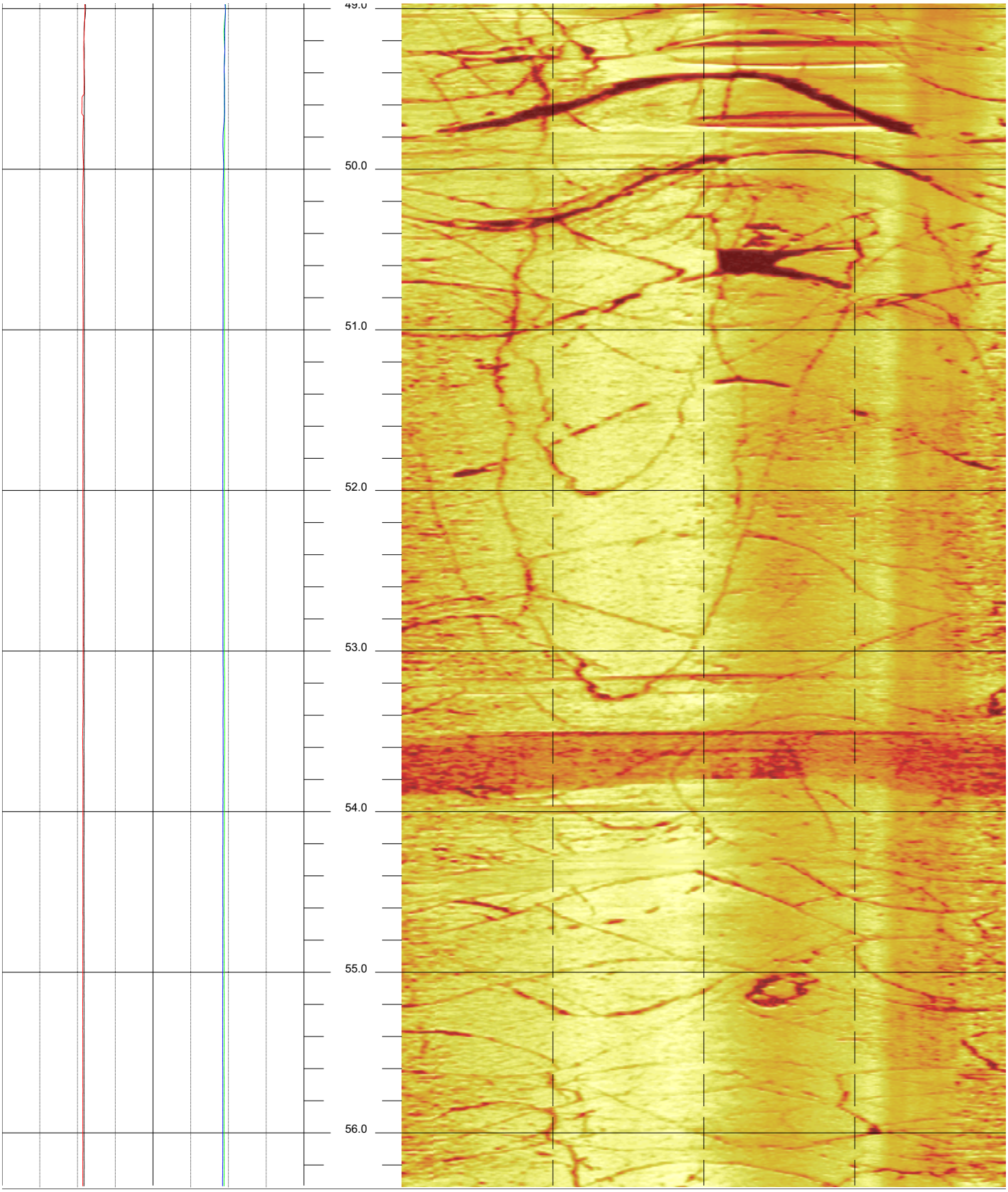
RW6-R2 41.600 to 34.232ft 5

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 5 of 15



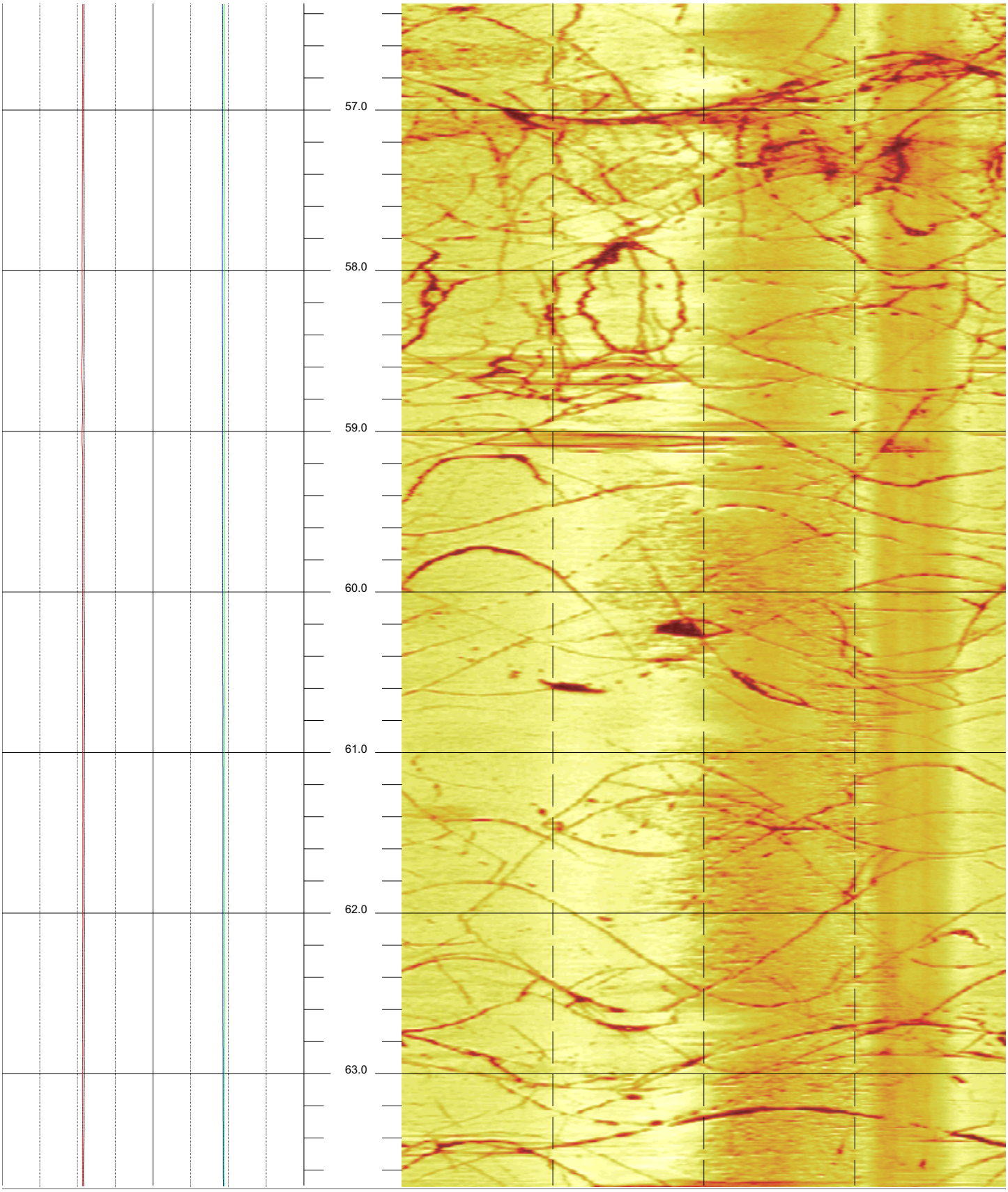
RW6-R2 48.968 to 41.600ft 6

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 6 of 15



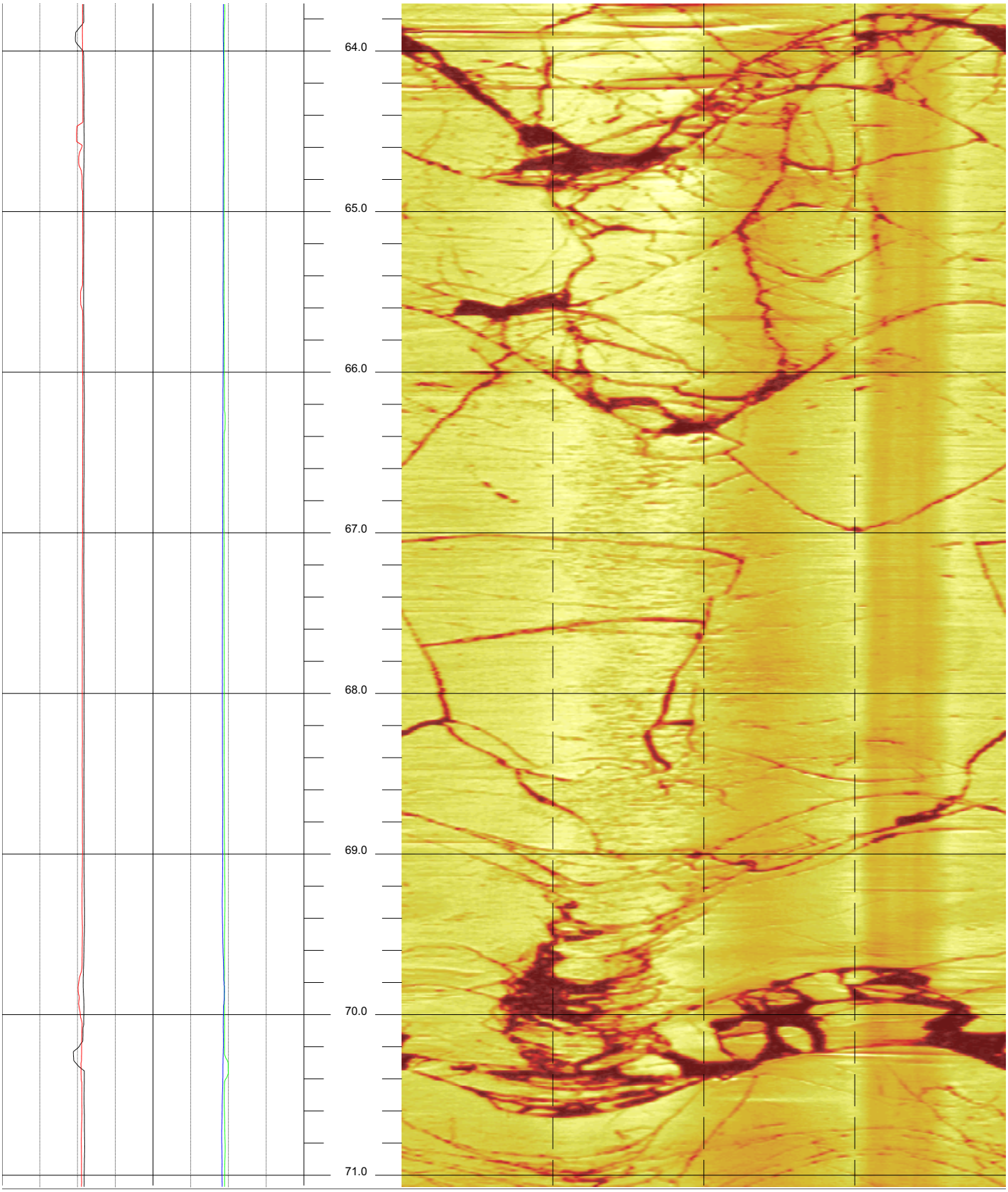
RW6-R2 56.336 to 48.968ft 7

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 7 of 15



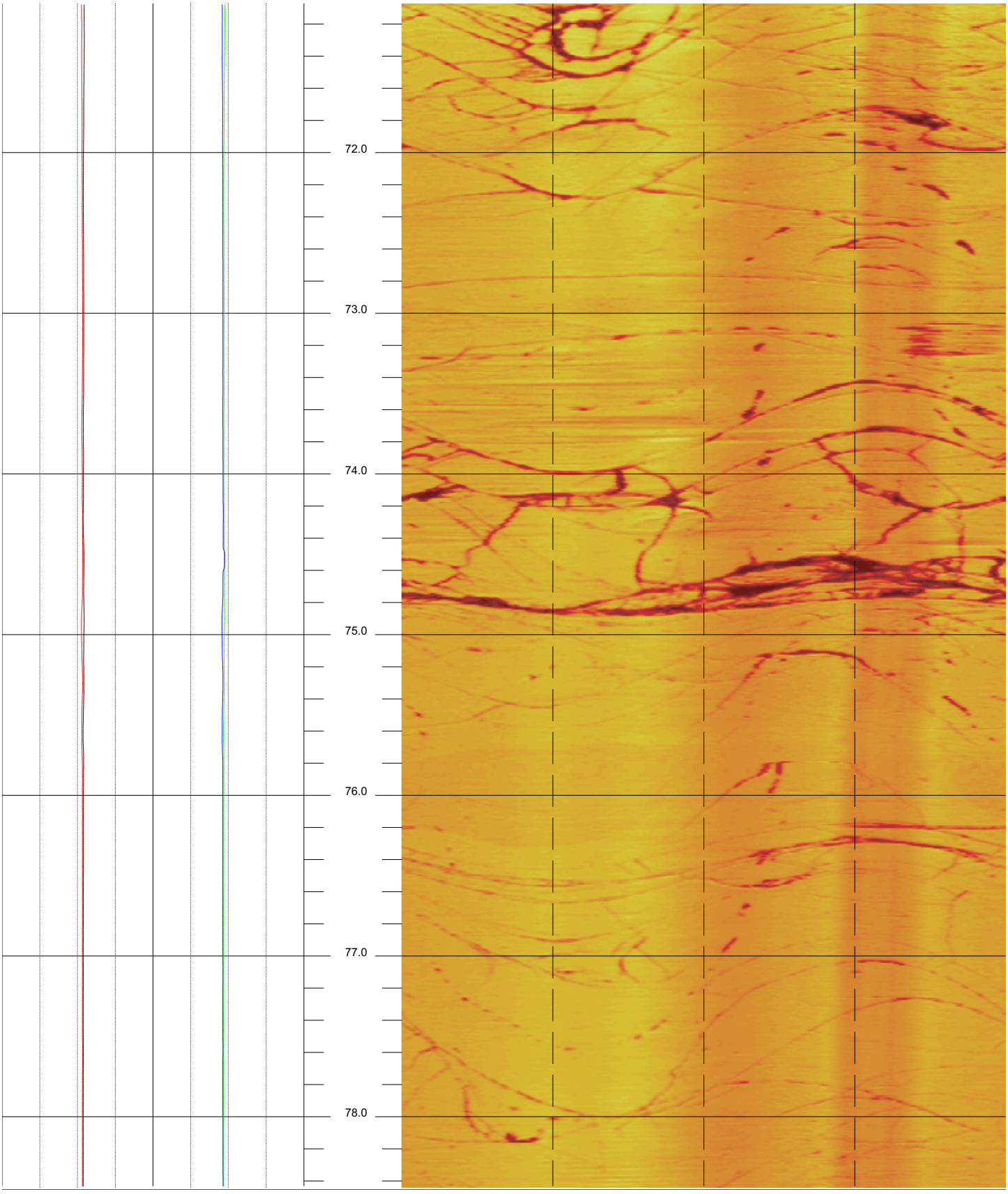
RW6-R2 63.704 to 56.336ft 8

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 8 of 15

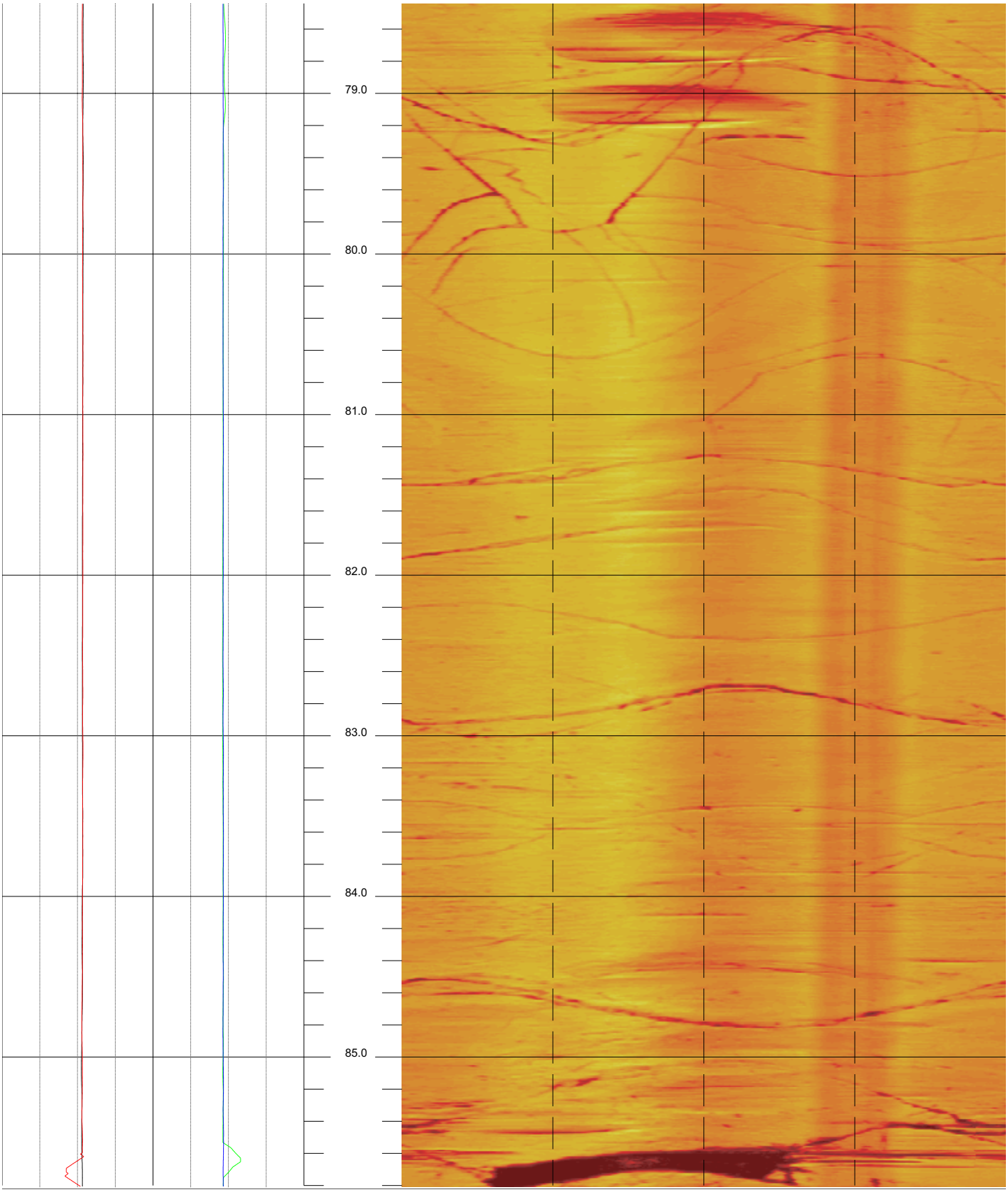


RW6-R2 71.072 to 63.704ft 9

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 9 of 15

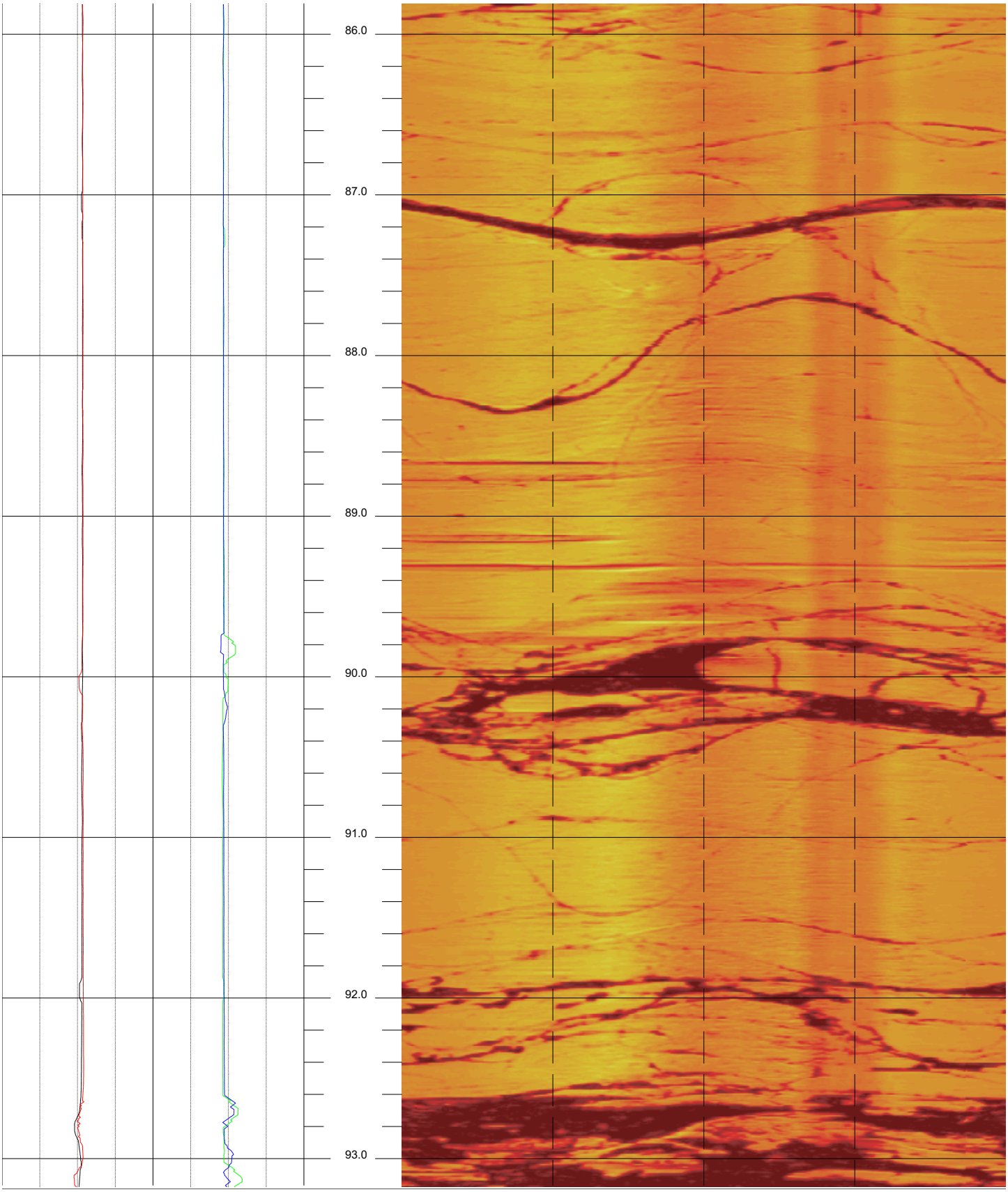


Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 10 of 15



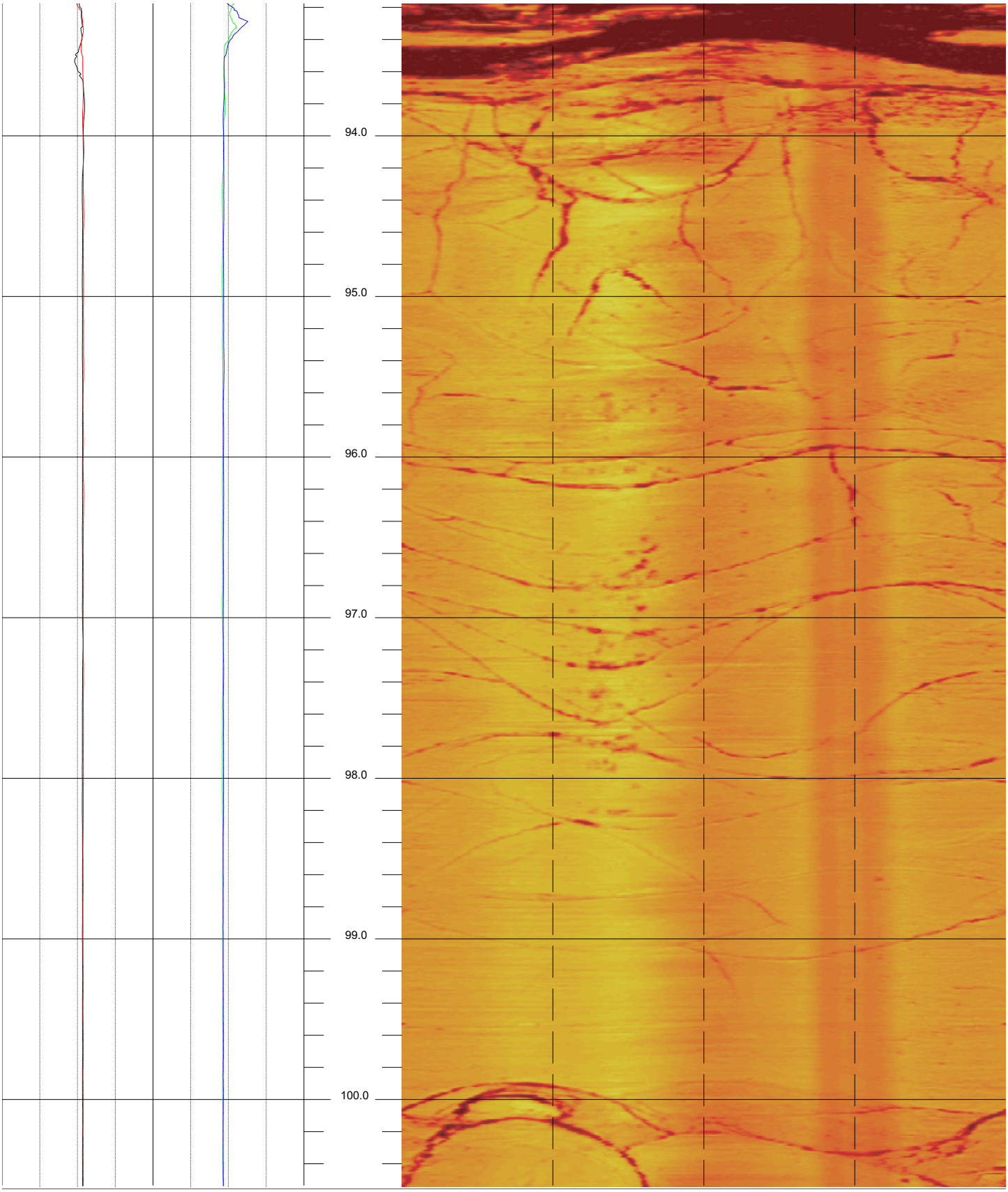
RW6-R2 85.808 to 78.440ft 11

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 11 of 15



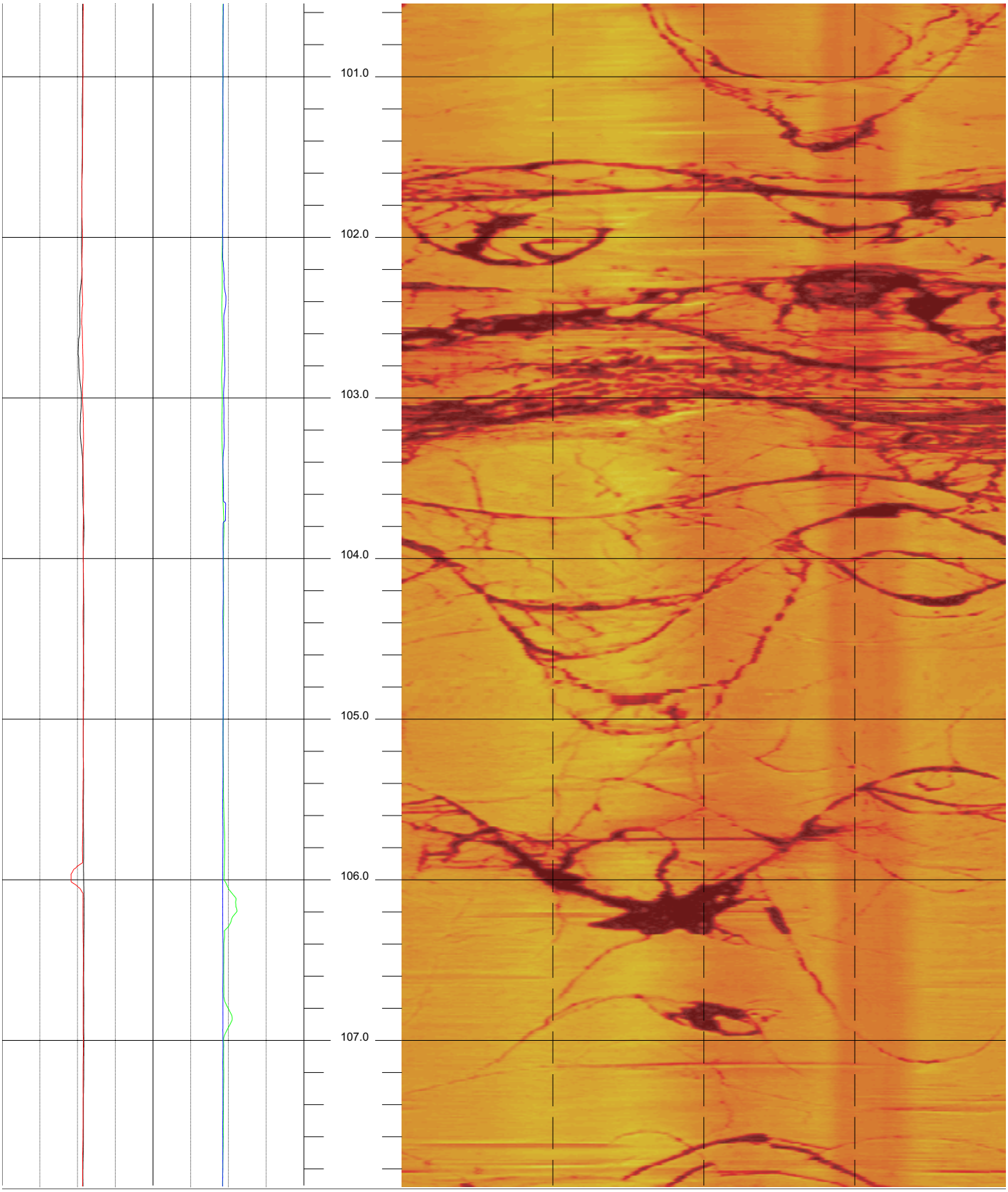
RW6-R2 93.176 to 85.808ft 12

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 12 of 15



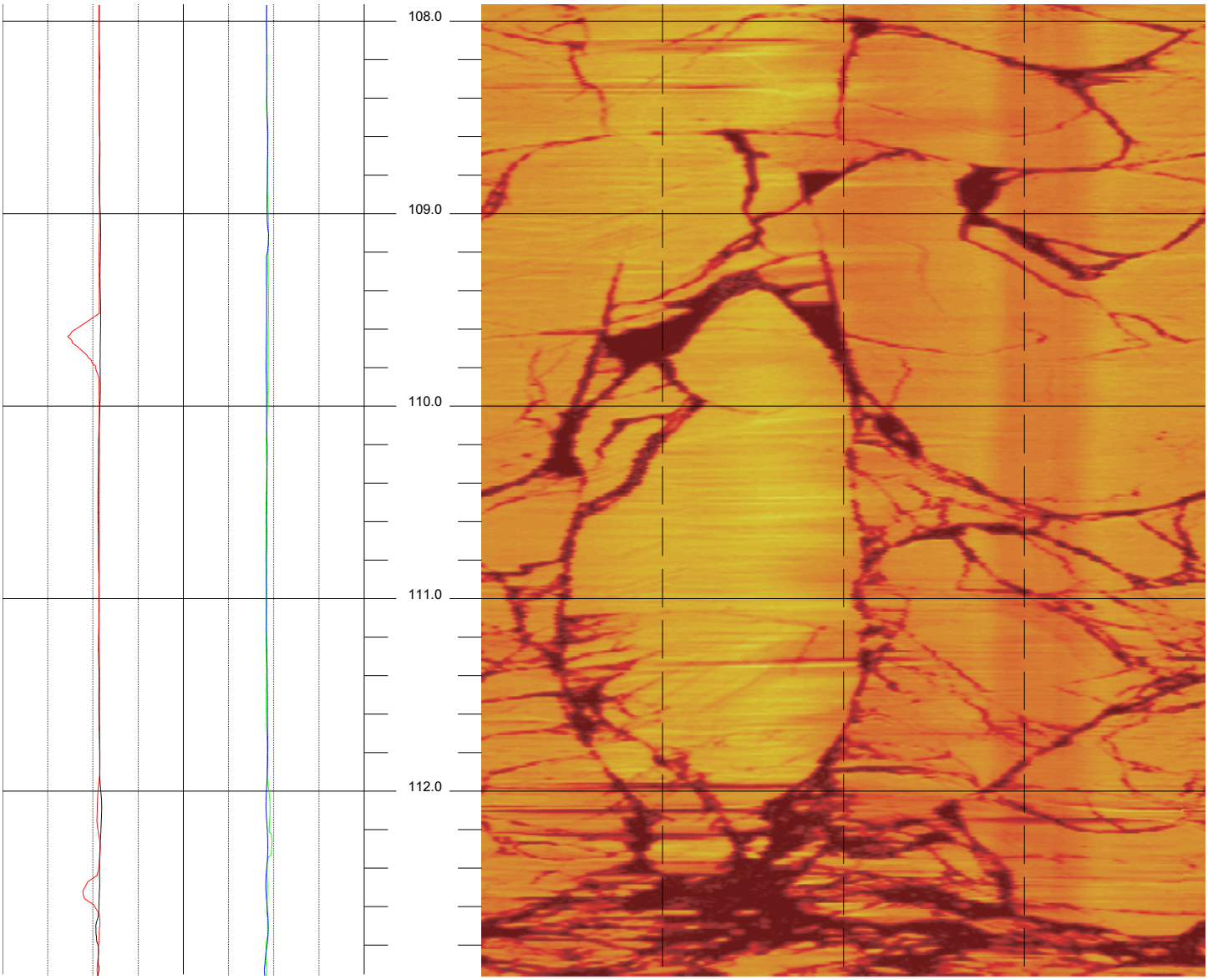
RW6-R2 100.544 to 93.176fl 13

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 13 of 15



RW6-R2 107.912 to 100.544ft 14

Doyle Drive RW6-R2 Acoustic Televiewer based Caliper Sheet 14 of 15


108.0
109.0
110.0
111.0
112.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
ACOUSTIC CALIPER LOG

16 Jun 2008

ARUP

Borehole: RW8-R1

DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

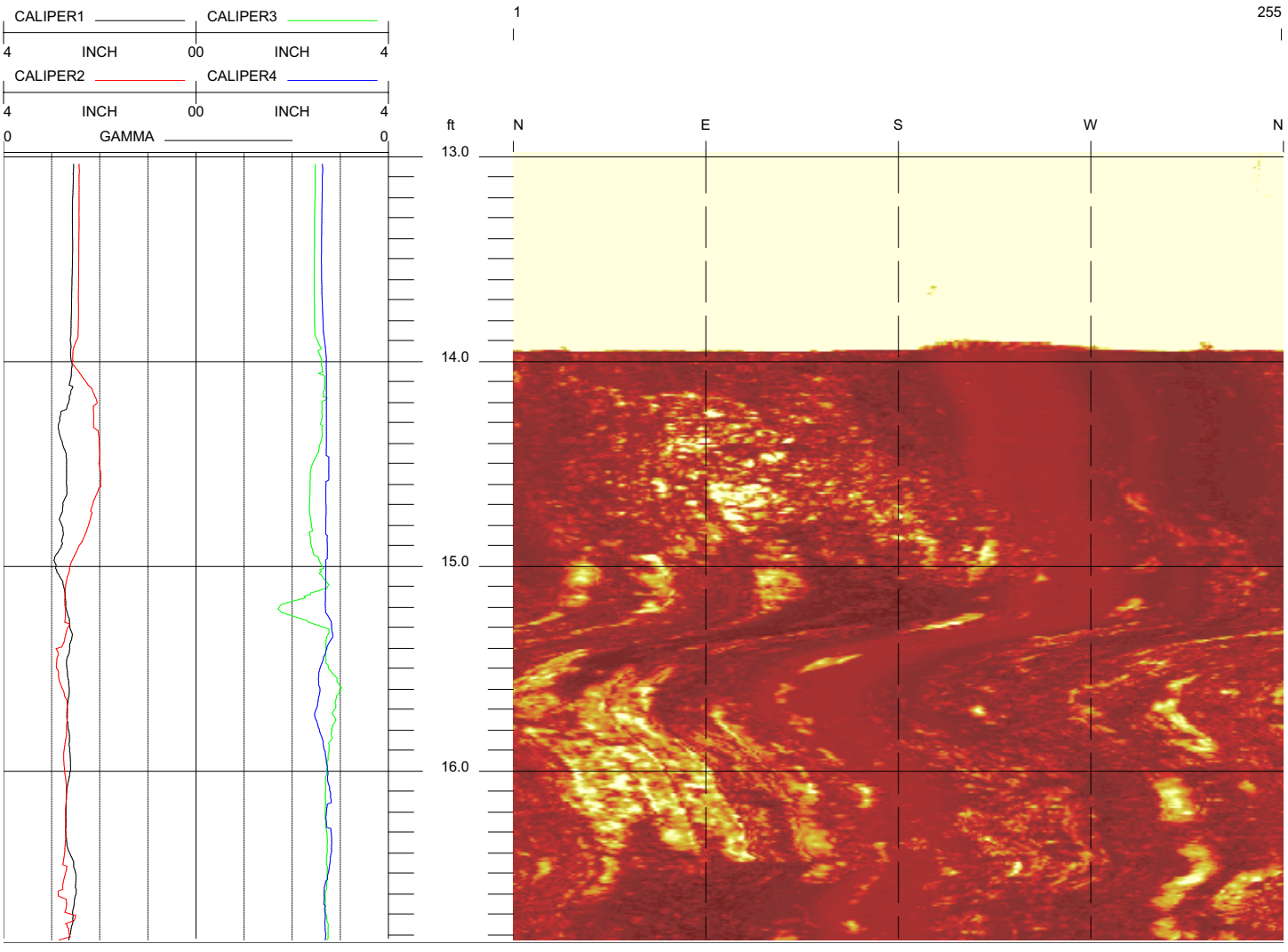
North ref. is true
Depth units are feet
Vertical scale: 1/10

Zone from 140.050 to 12.978ft

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

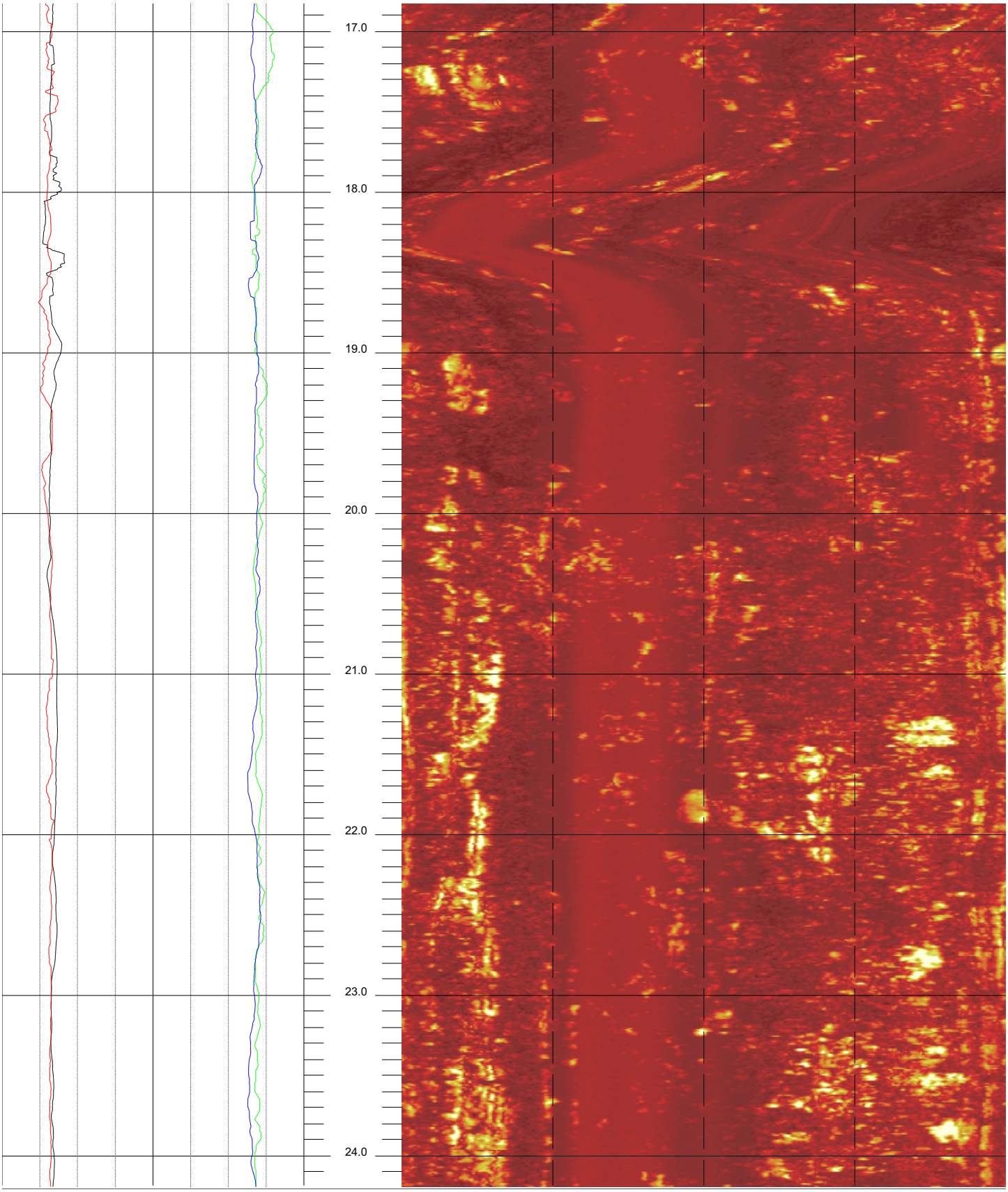
Depth interval 0.008ft, Filter length 0.120ft

REFLECTANCE



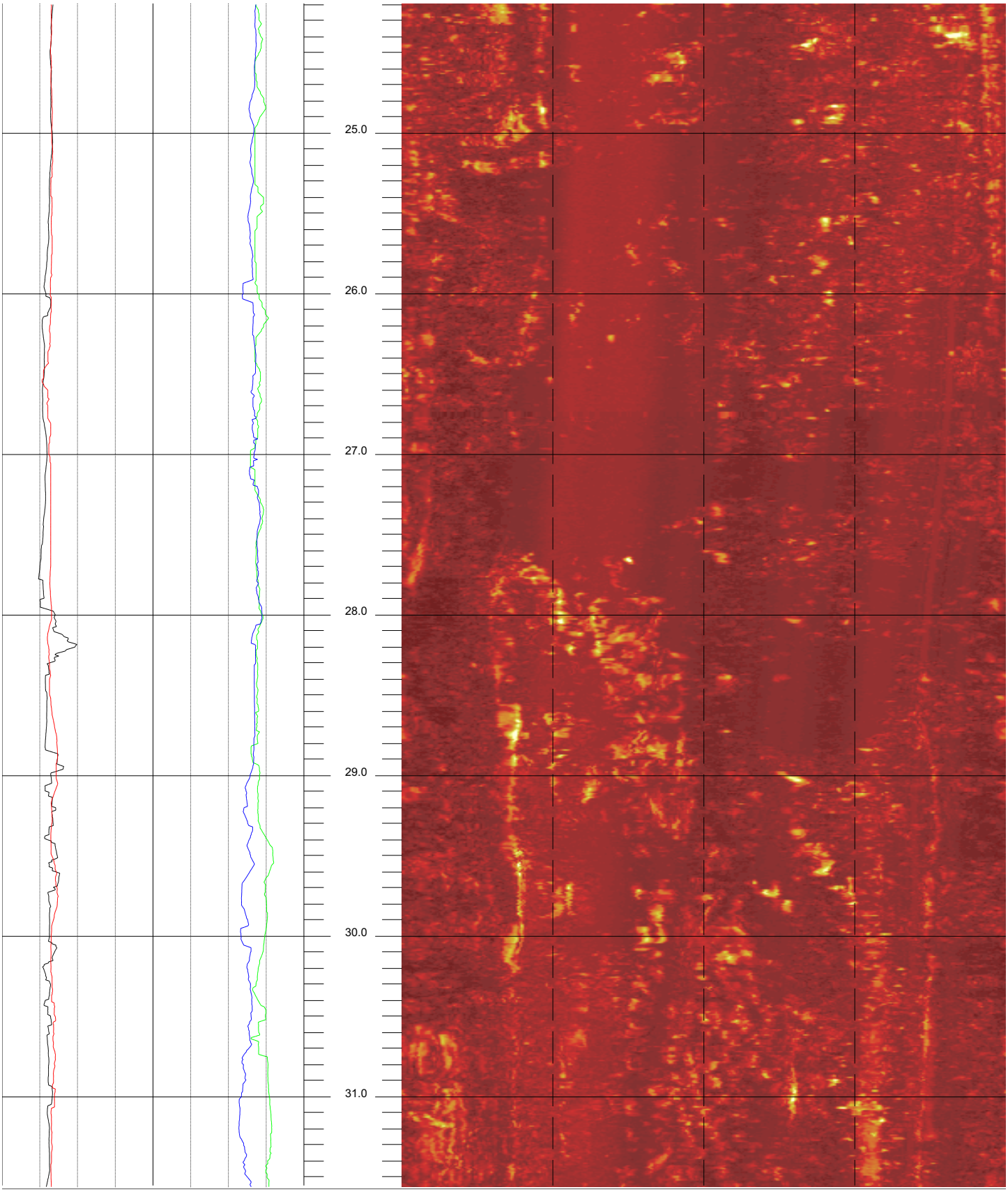
RW8-R1 16.826 to 12.978ft 1

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 1 of 18



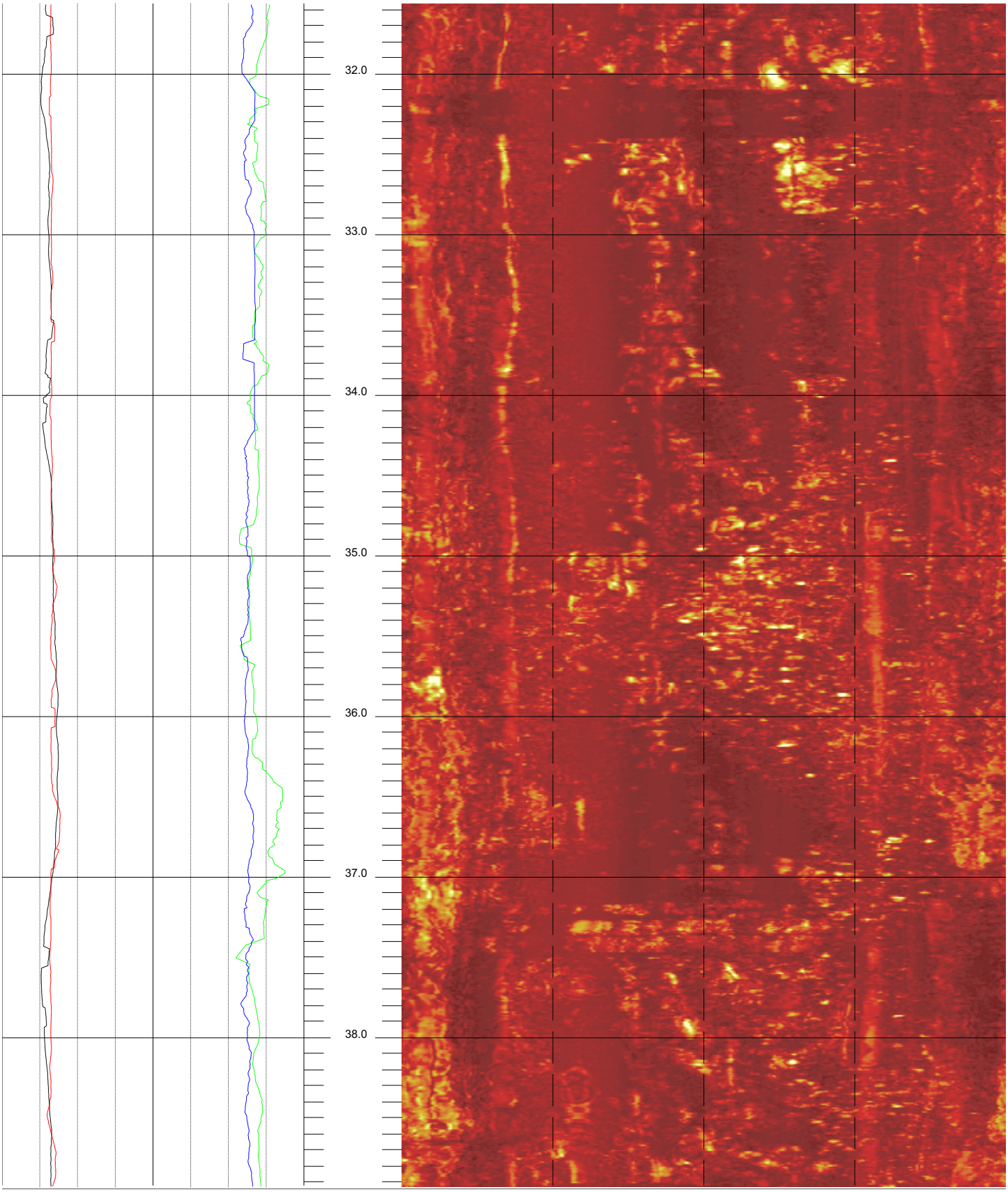
RW8-R1 24.194 to 16.826ft 2

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 2 of 18



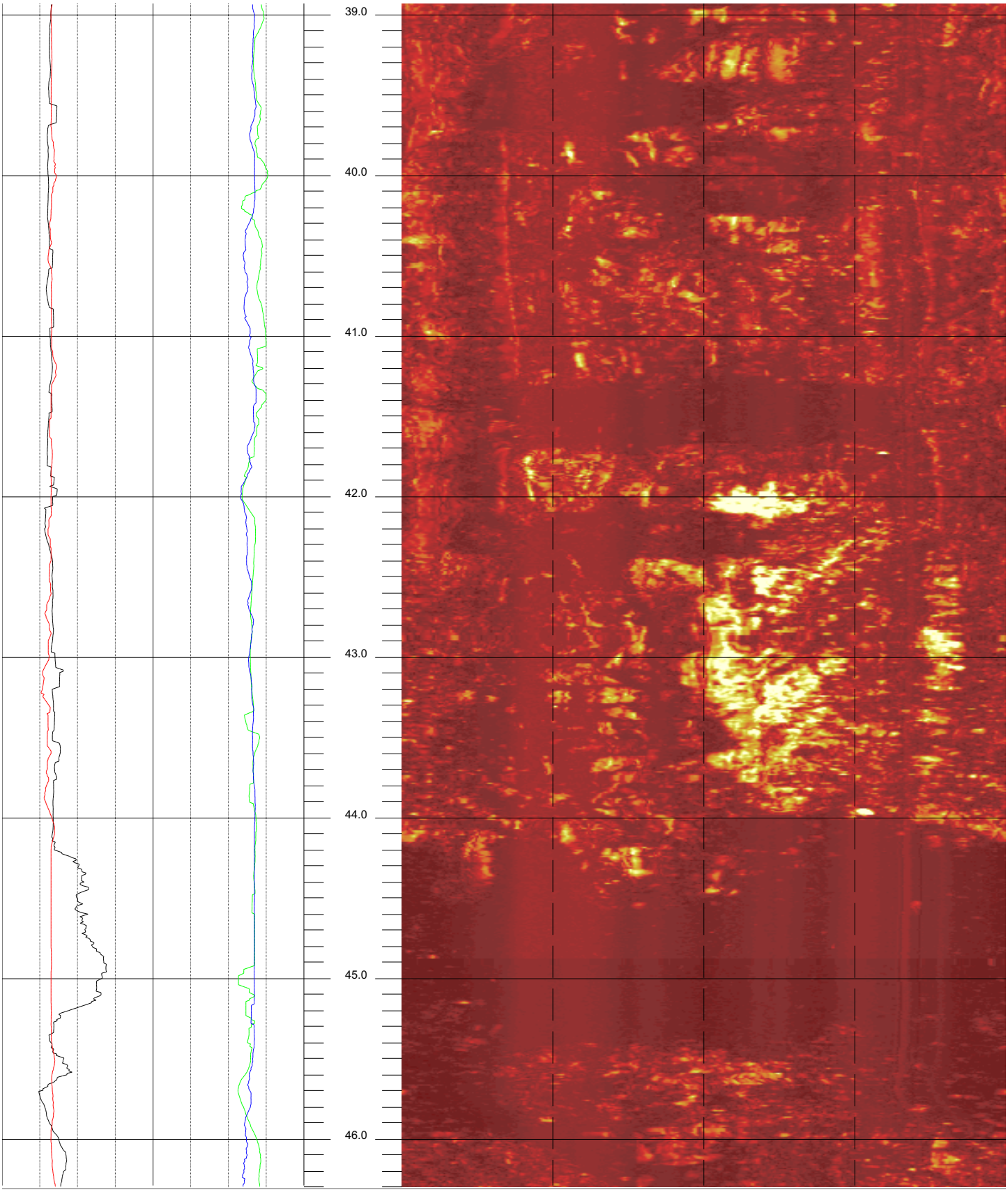
RW8-R1 31.562 to 24.194ft 3

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 3 of 18



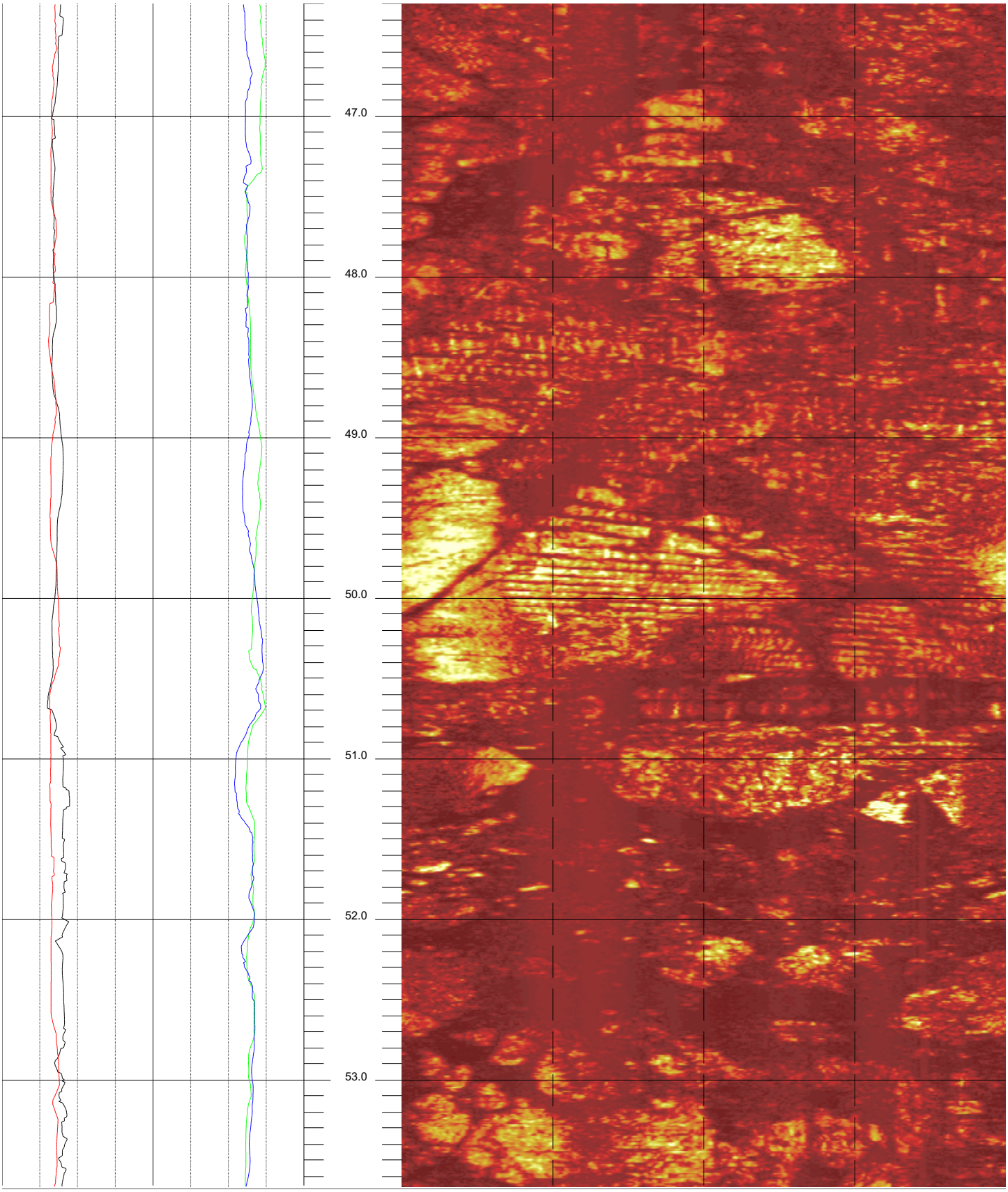
RW8-R1 38.930 to 31.562ft 4

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 4 of 18



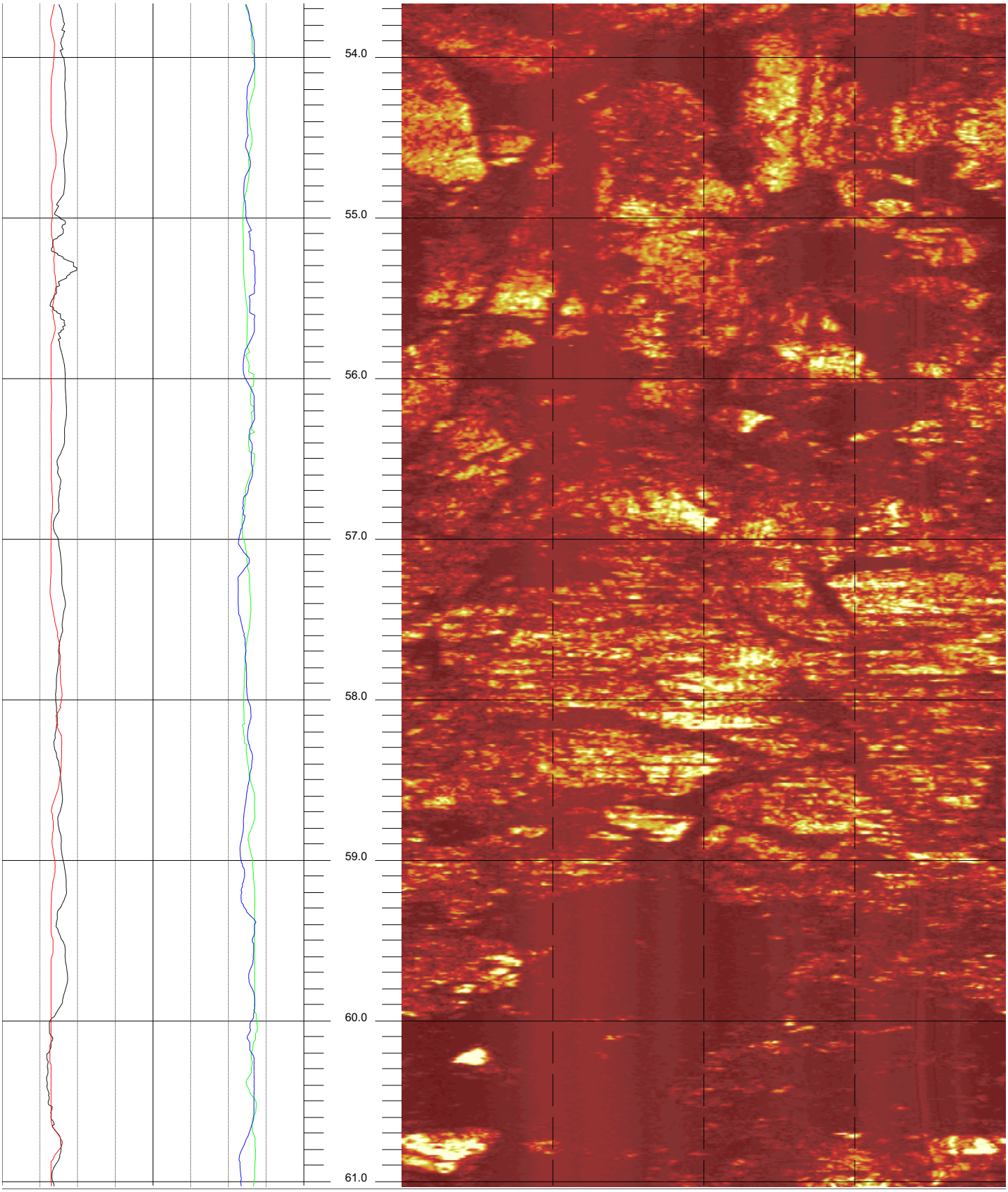
RW8-R1 46.298 to 38.930ft 5

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 5 of 18



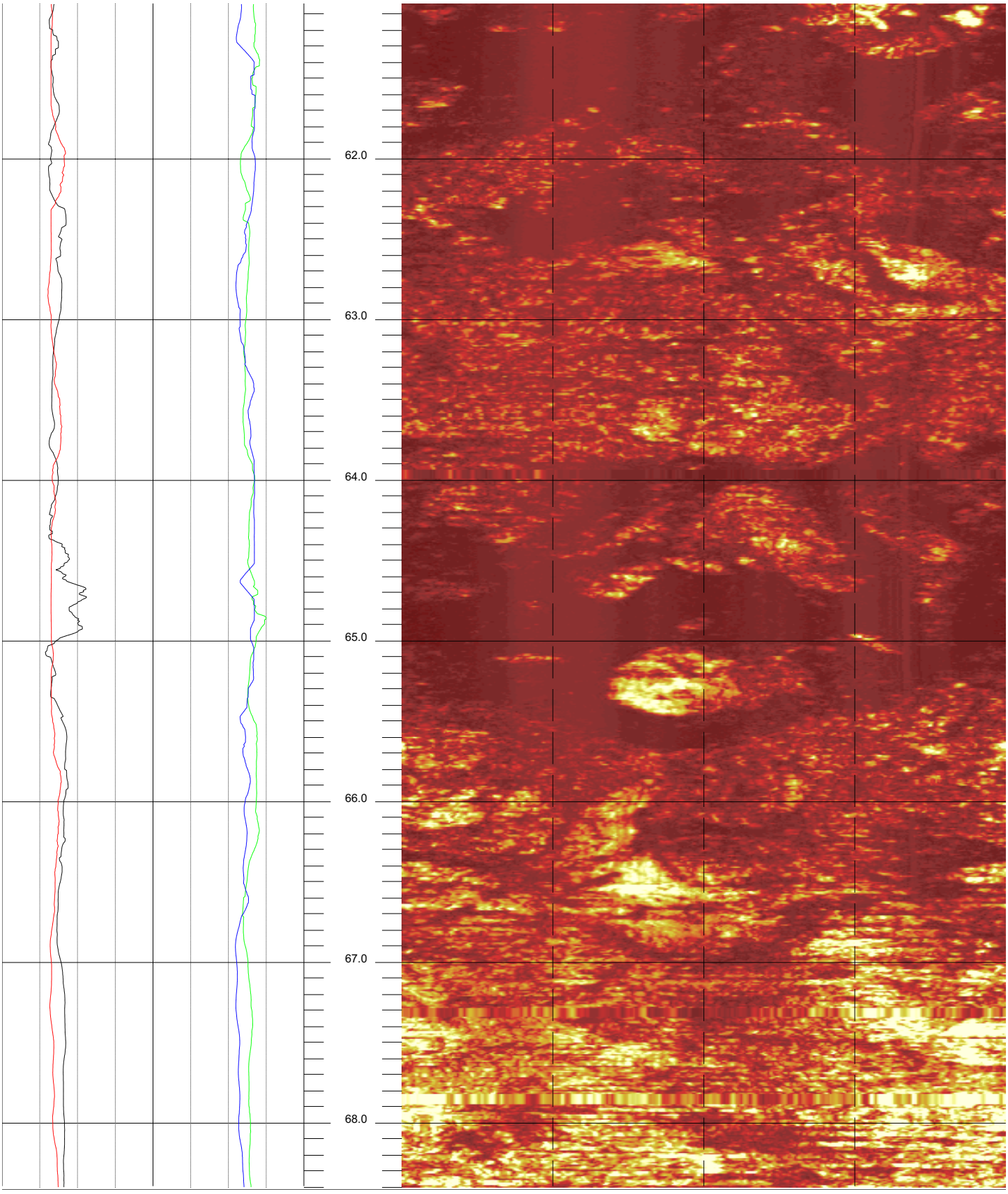
RW8-R1 53.666 to 46.298ft 6

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 6 of 18



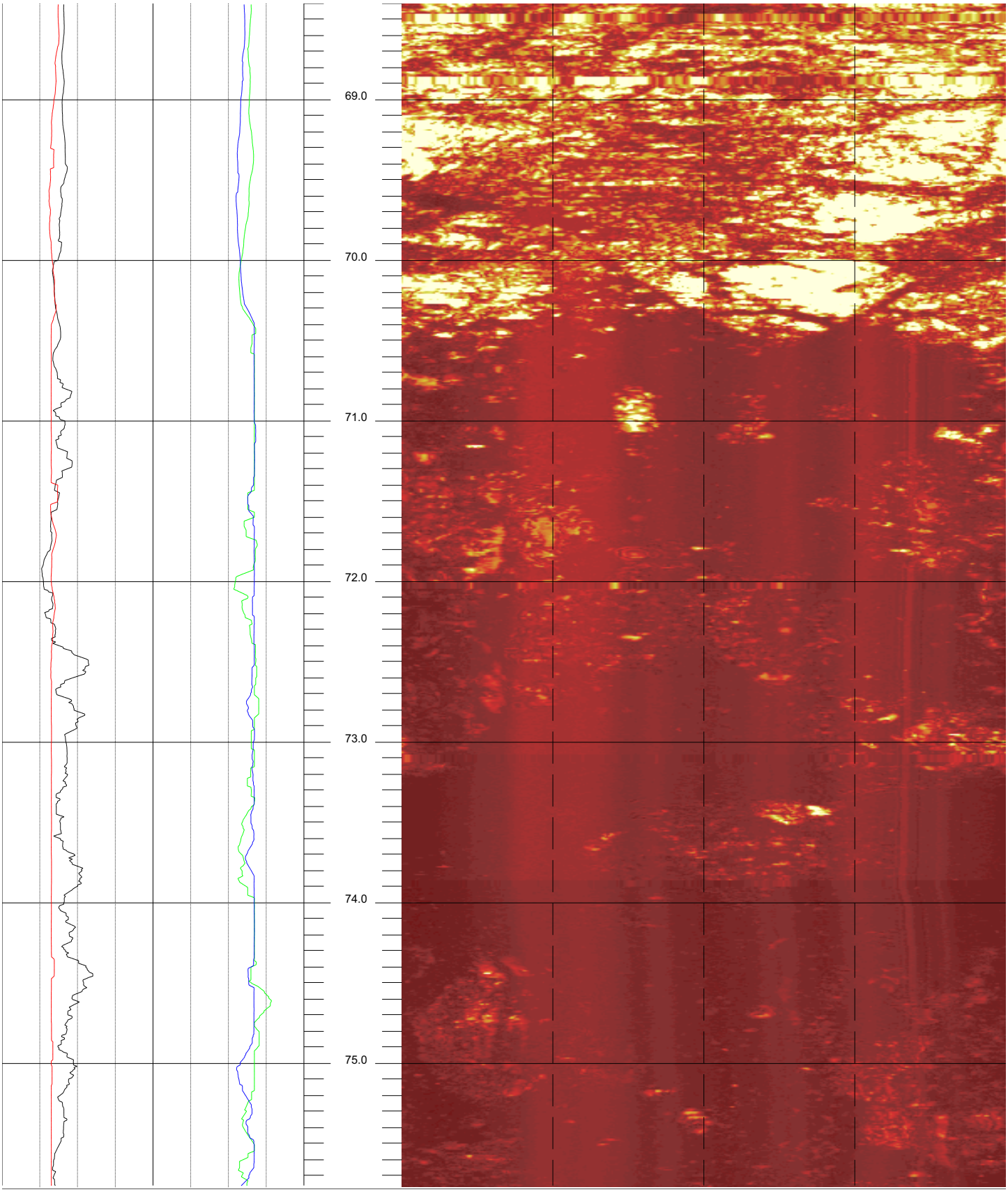
RW8-R1 61.034 to 53.666ft 7

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 7 of 18



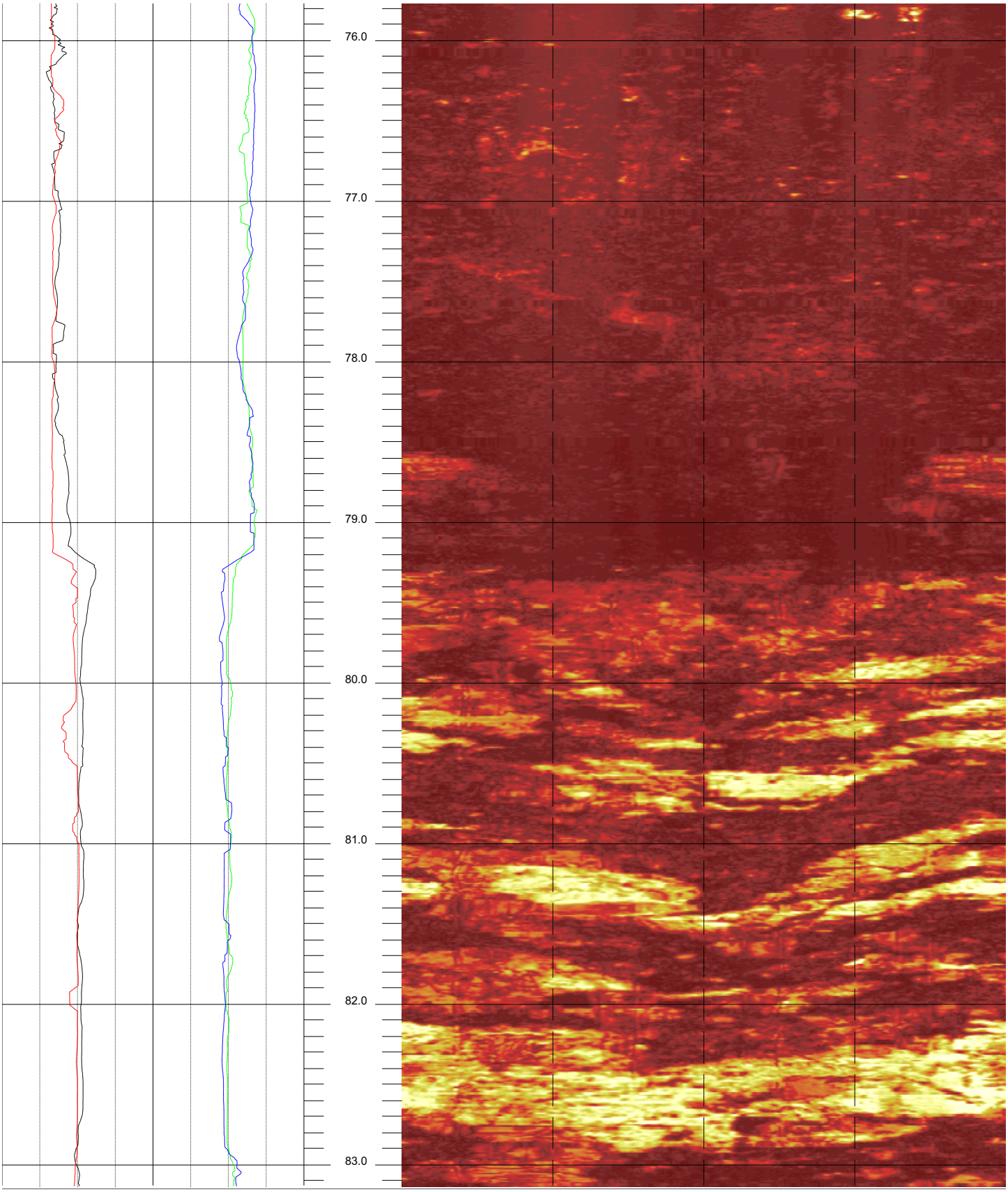
RW8-R1 68.402 to 61.034ft 8

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 8 of 18



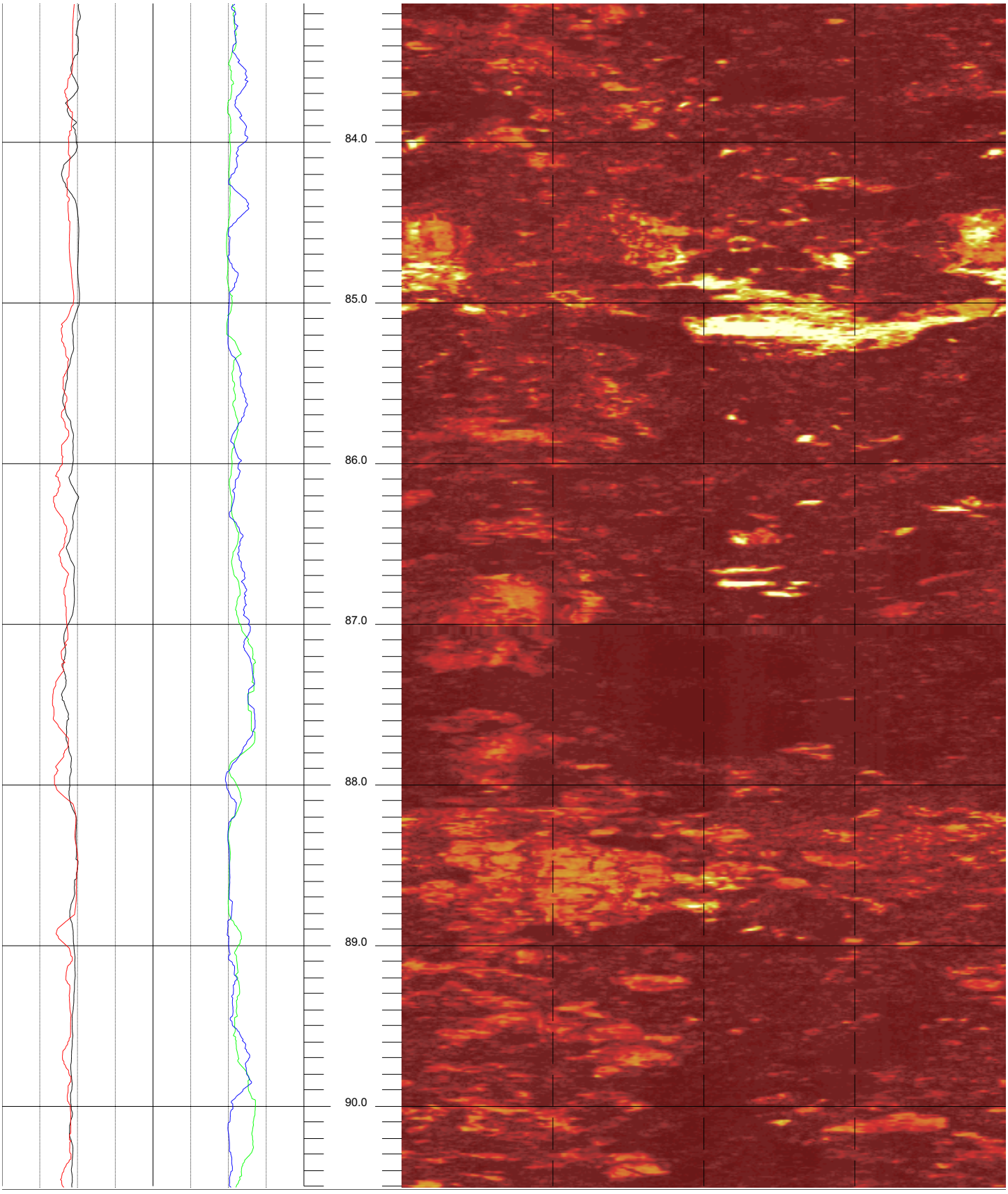
RW8-R1 75.770 to 68.402ft 9

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 9 of 18



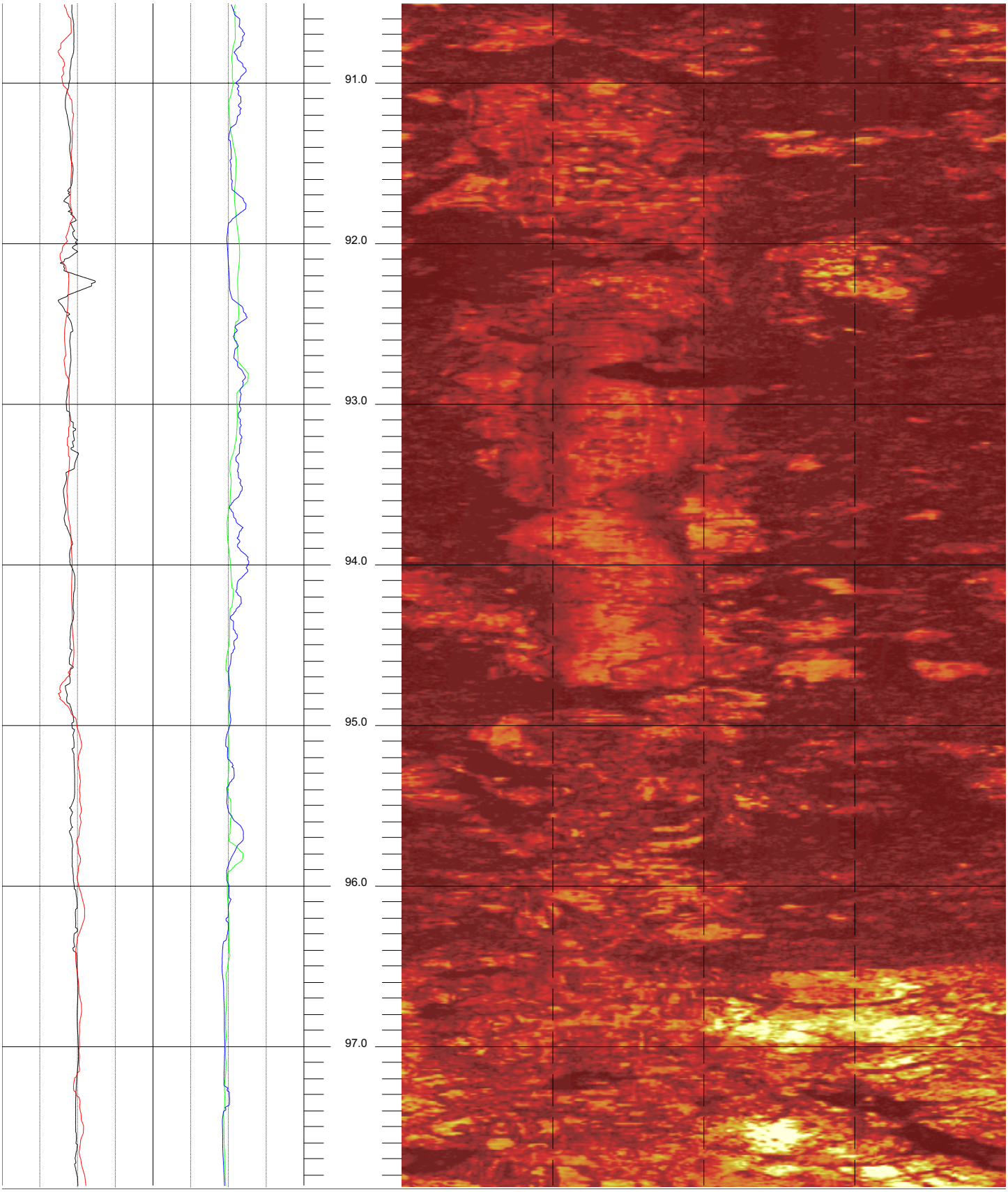
RW8-R1 83.138 to 75.770ft 10

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 10 of 18



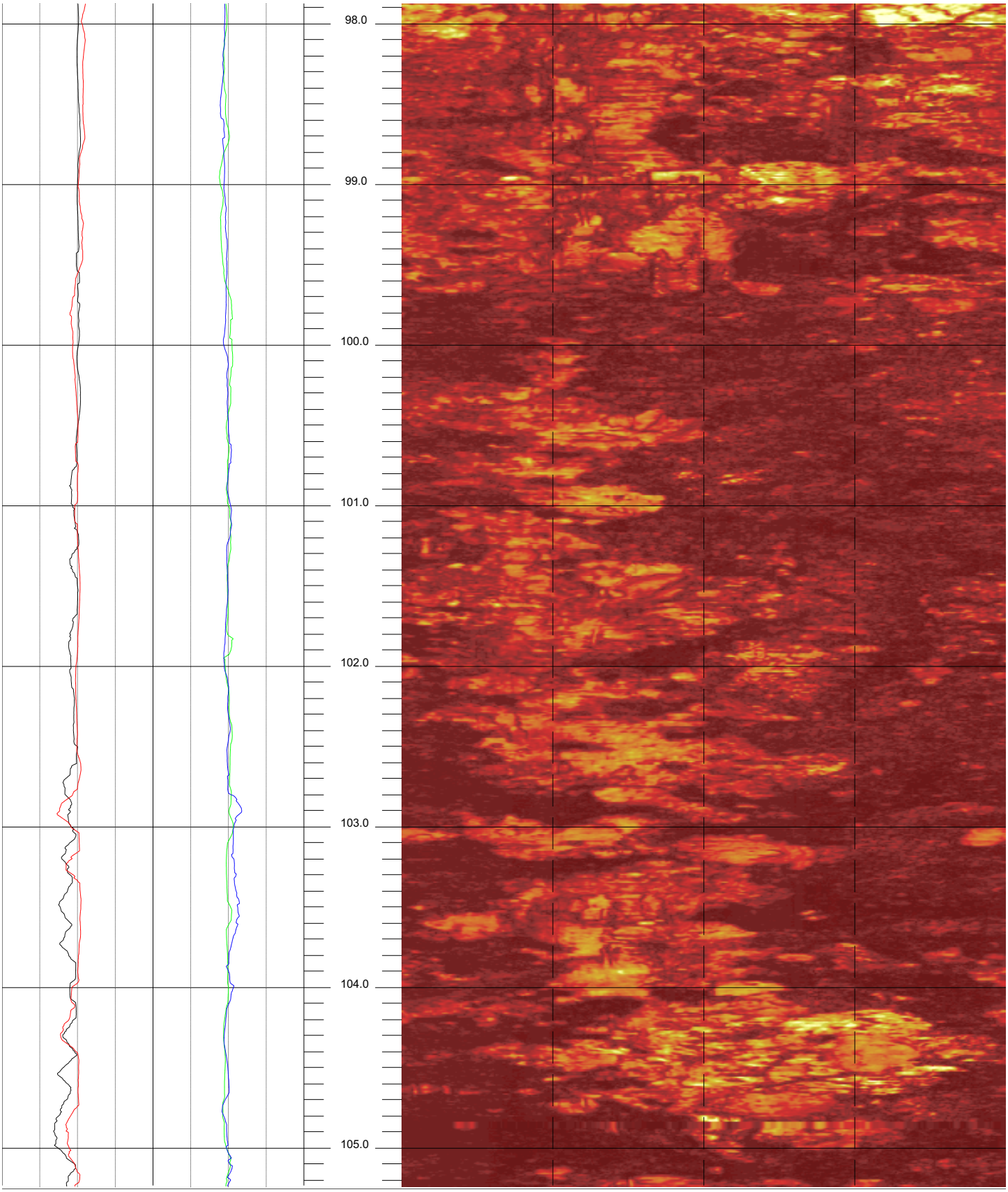
RW8-R1 90.506 to 83.138ft 11

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 11 of 18



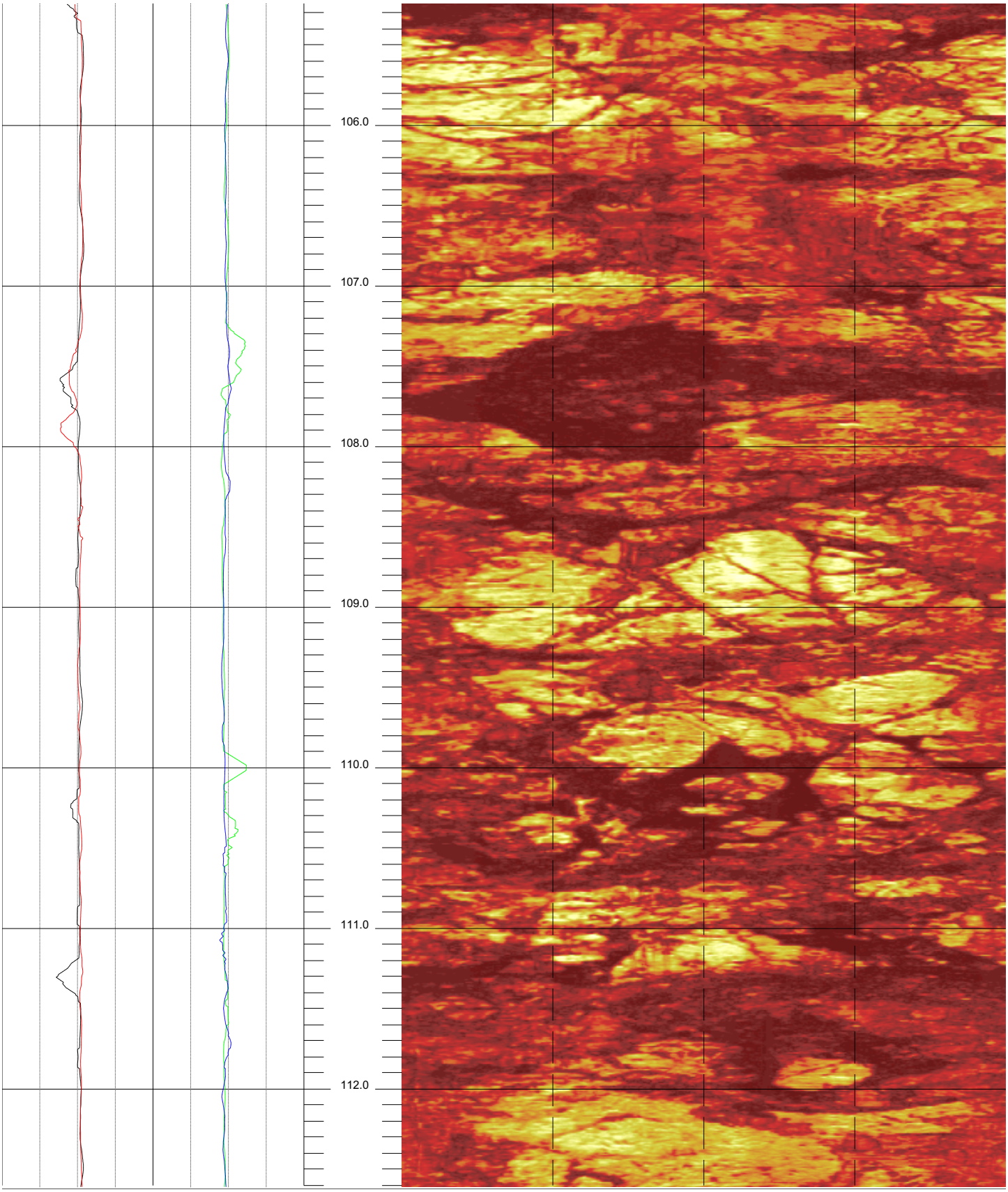
RW8-R1 97.874 to 90.506ft 12

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 12 of 18

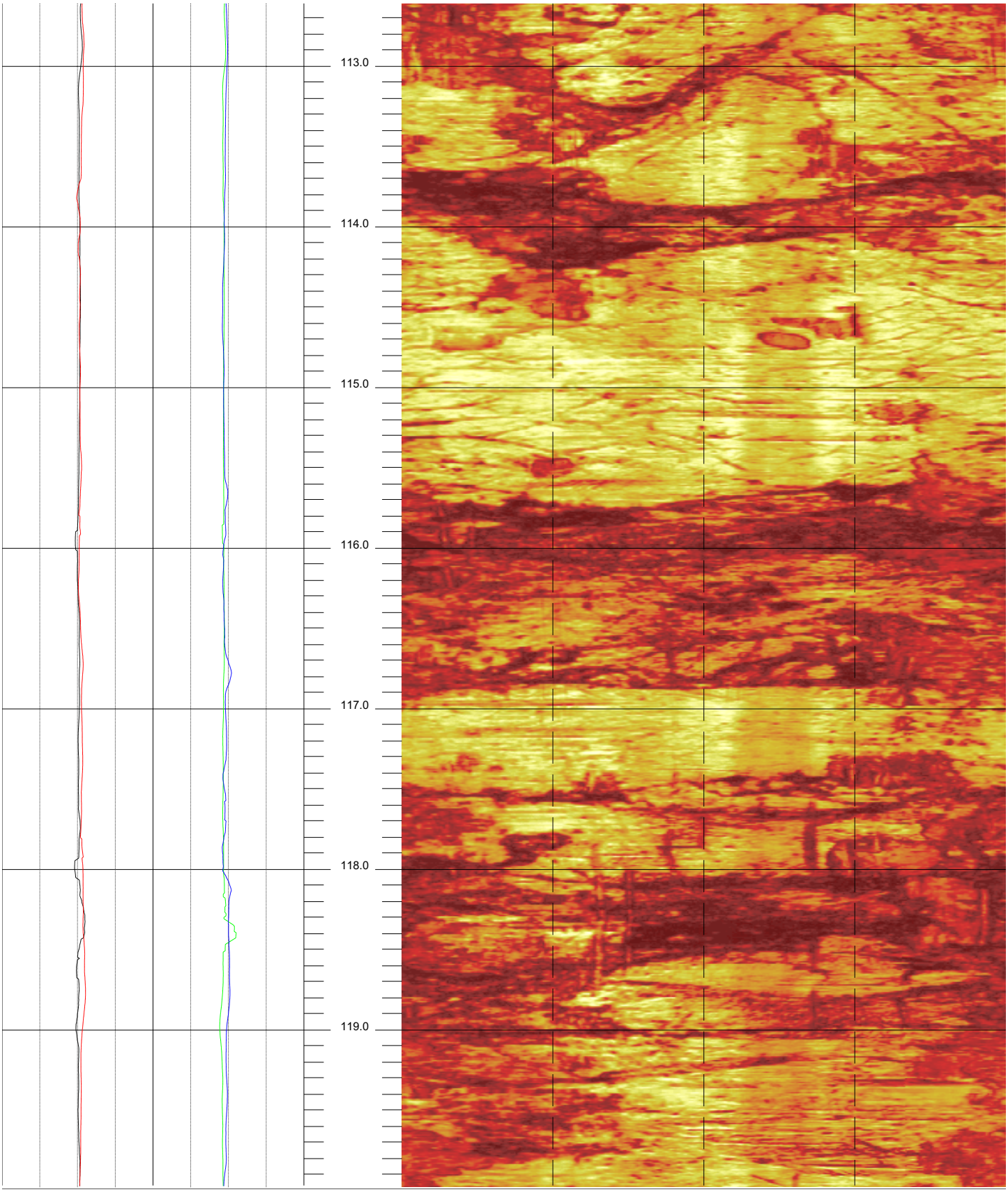


RW8-R1 105.242 to 97.874ft 13

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 13 of 18

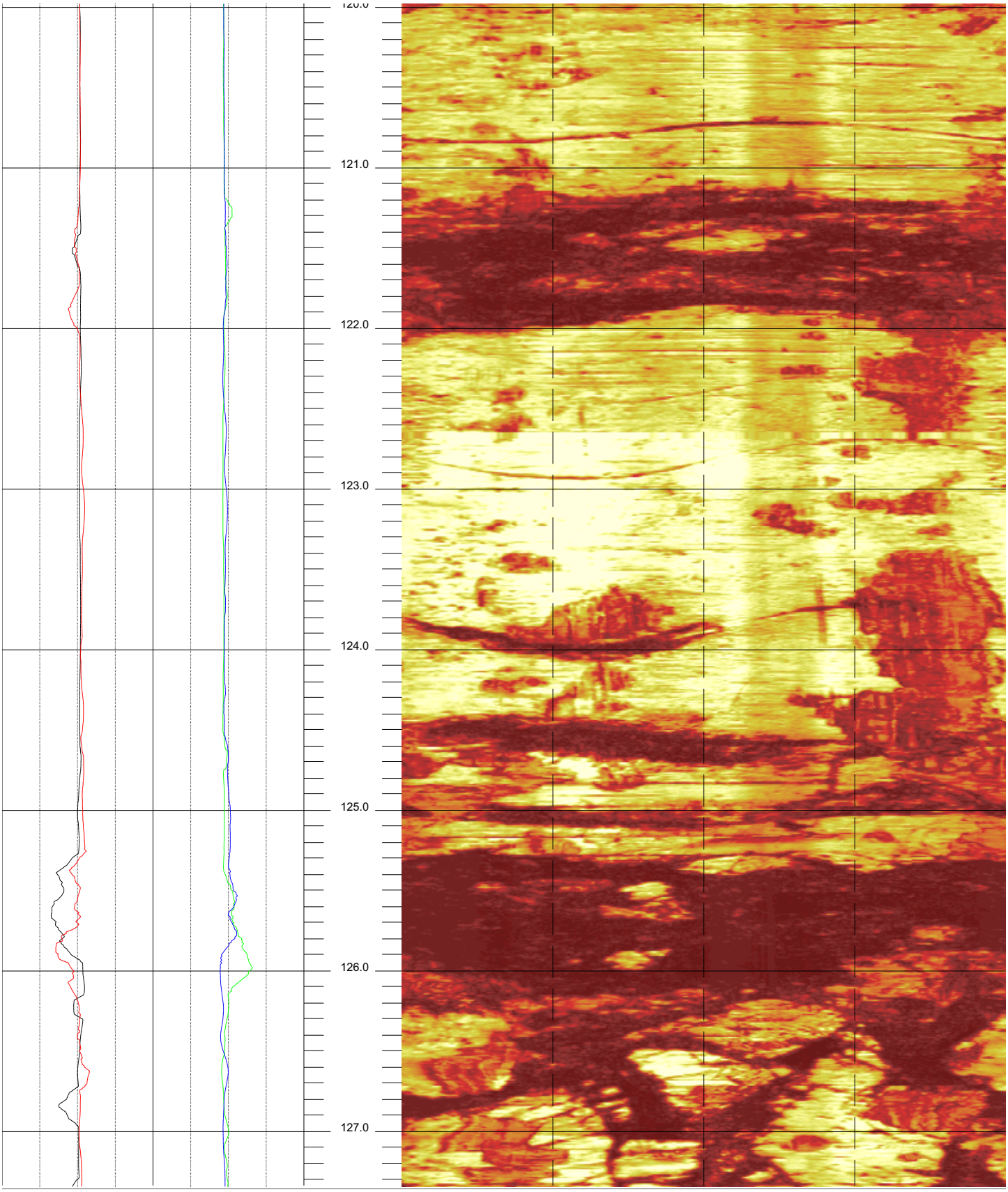


Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 14 of 18



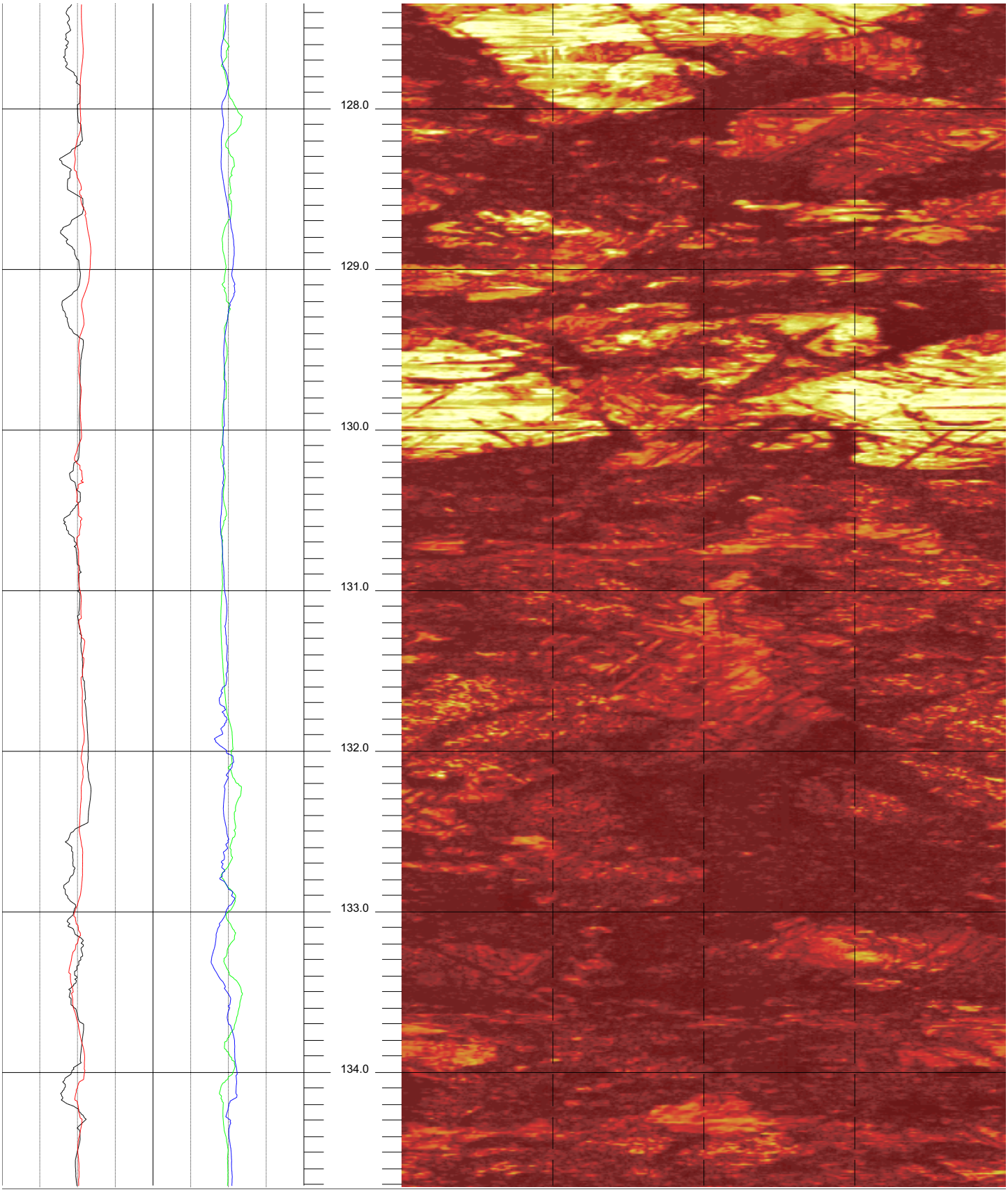
RW8-R1 119.978 to 112.610fl 15

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 15 of 18

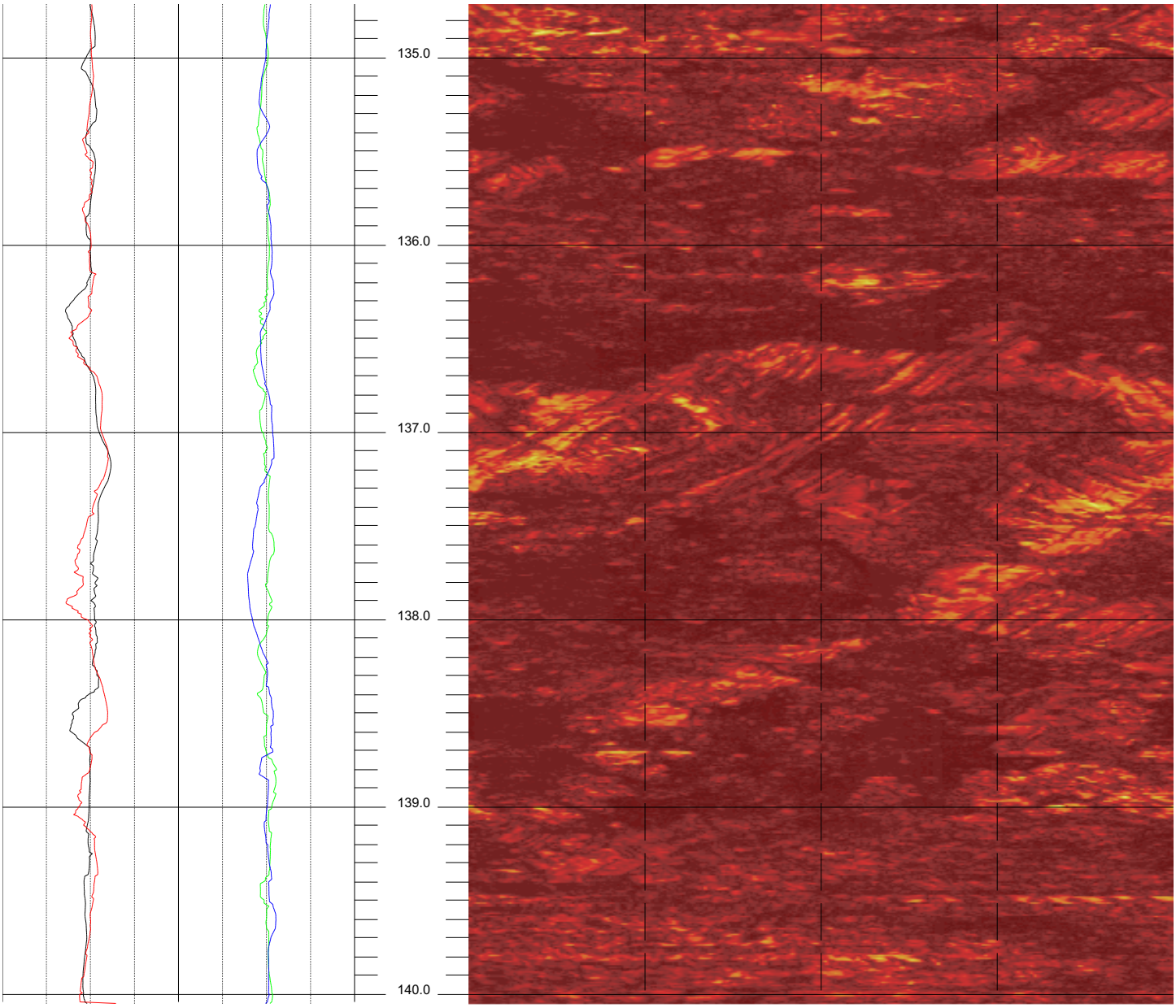


RW8-R1 127.346 to 119.978fl 16

Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 16 of 18



Doyle Drive RW8-R1 Acoustic Televiewer based Caliper Sheet 17 of 18


135.0
136.0
137.0
138.0
139.0
140.0

APPENDIX C

PROCESSED TELEVIEWER LOGS WITH FRACTURE AND BEDDING DEPTHS, DIPS AND DIP AZIMUTHS

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

14 Jun 2008

ARUP

Borehole: BTNB-R4

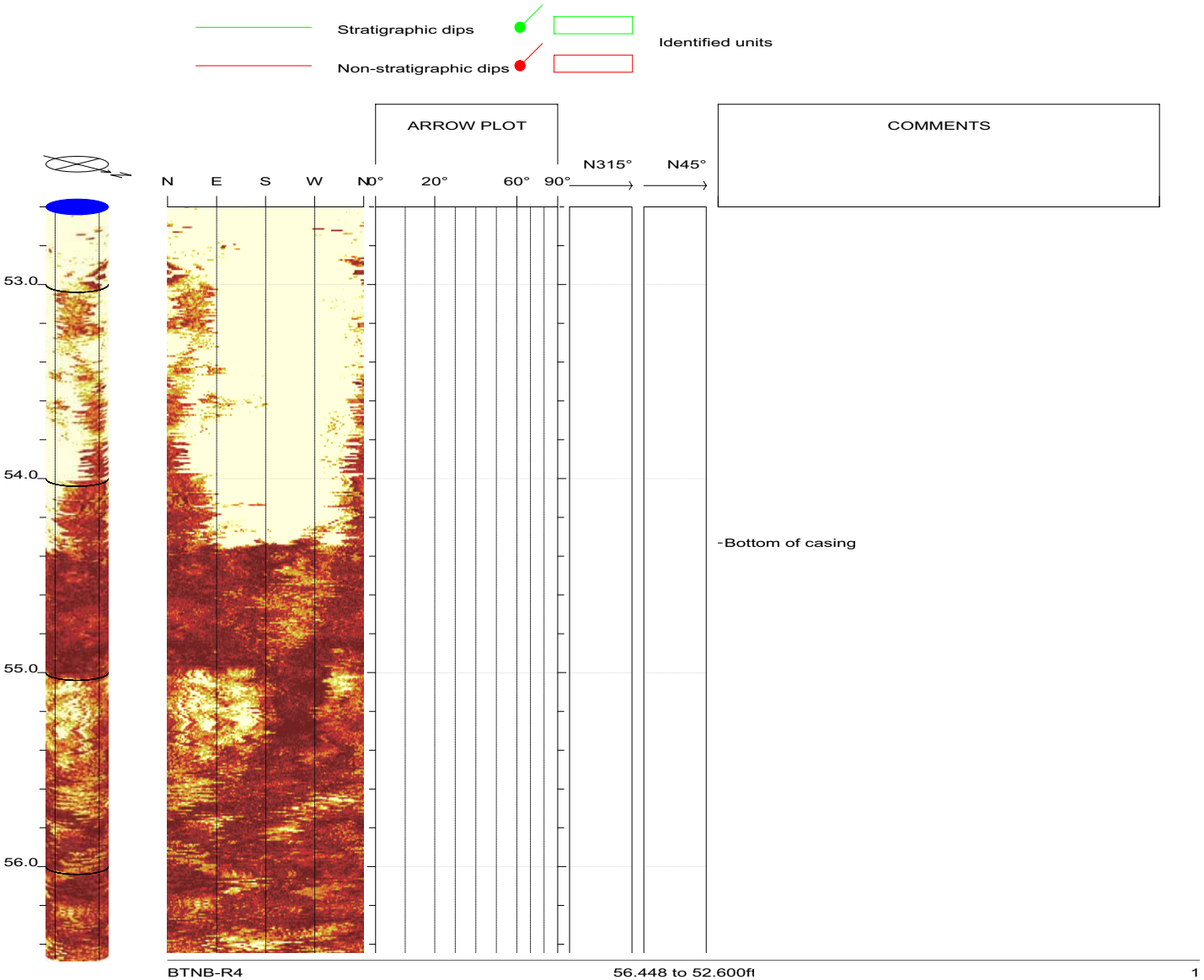
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

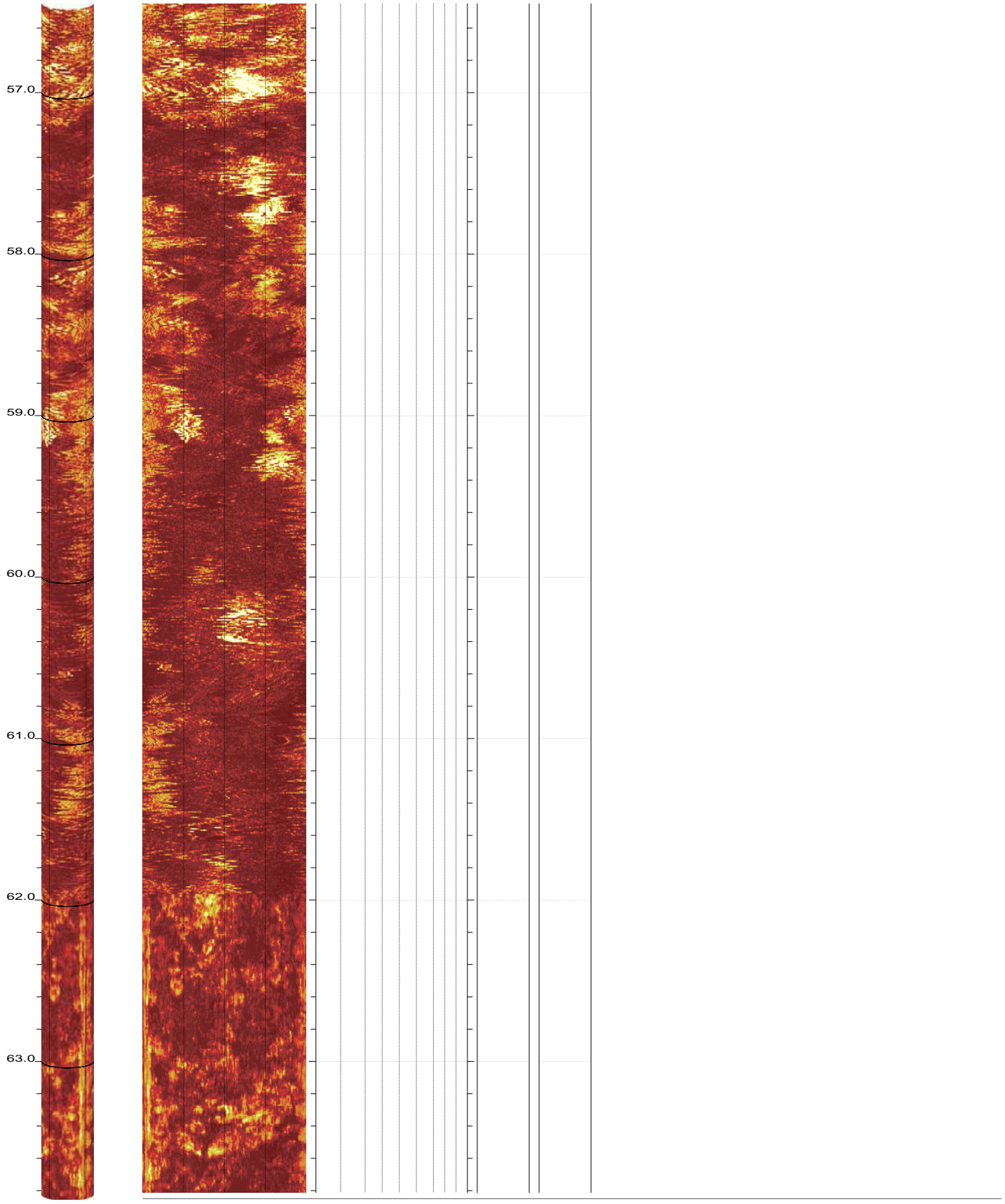
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 123.060 to 52.600ft
Format: BHTV-NESWN

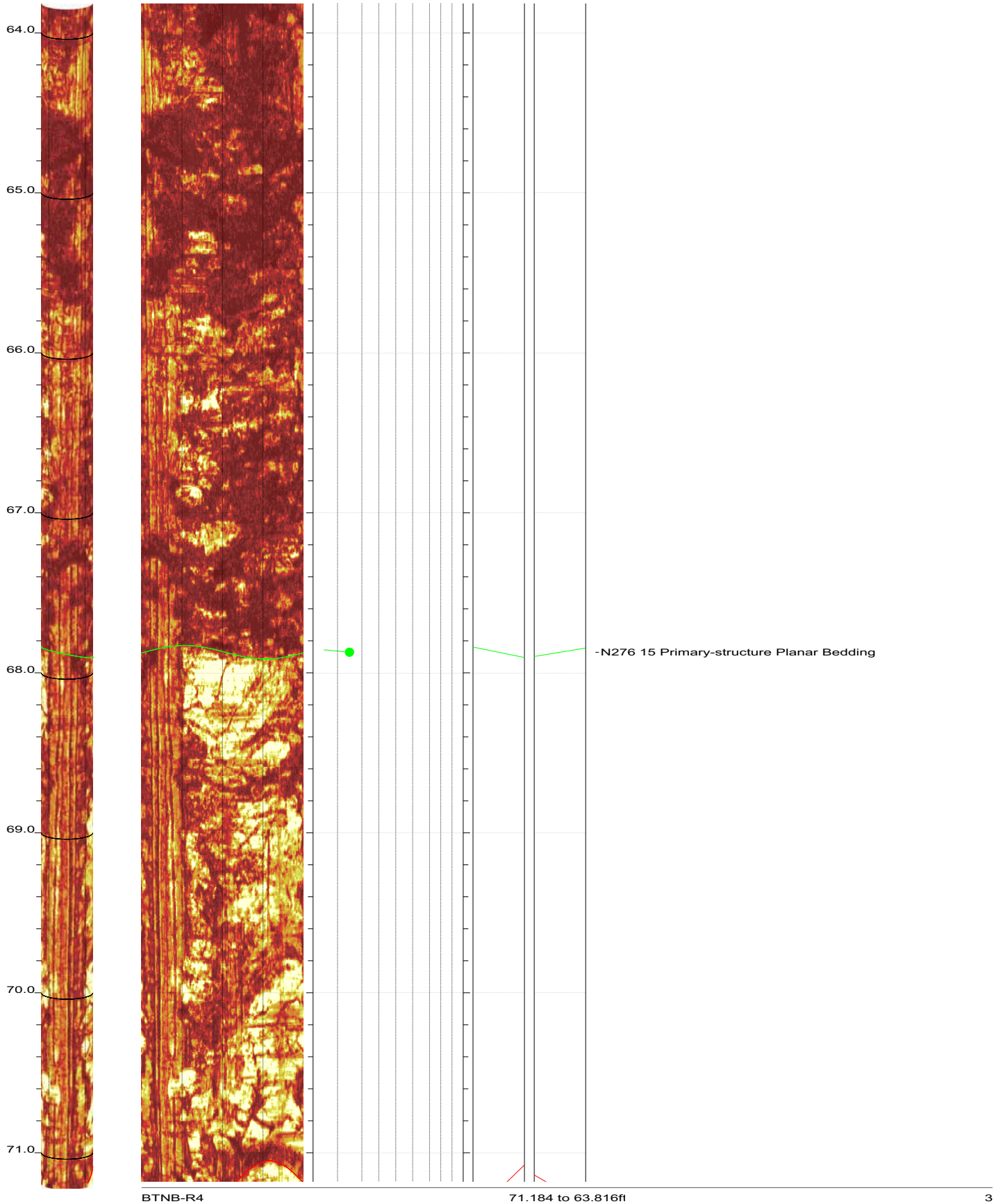
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



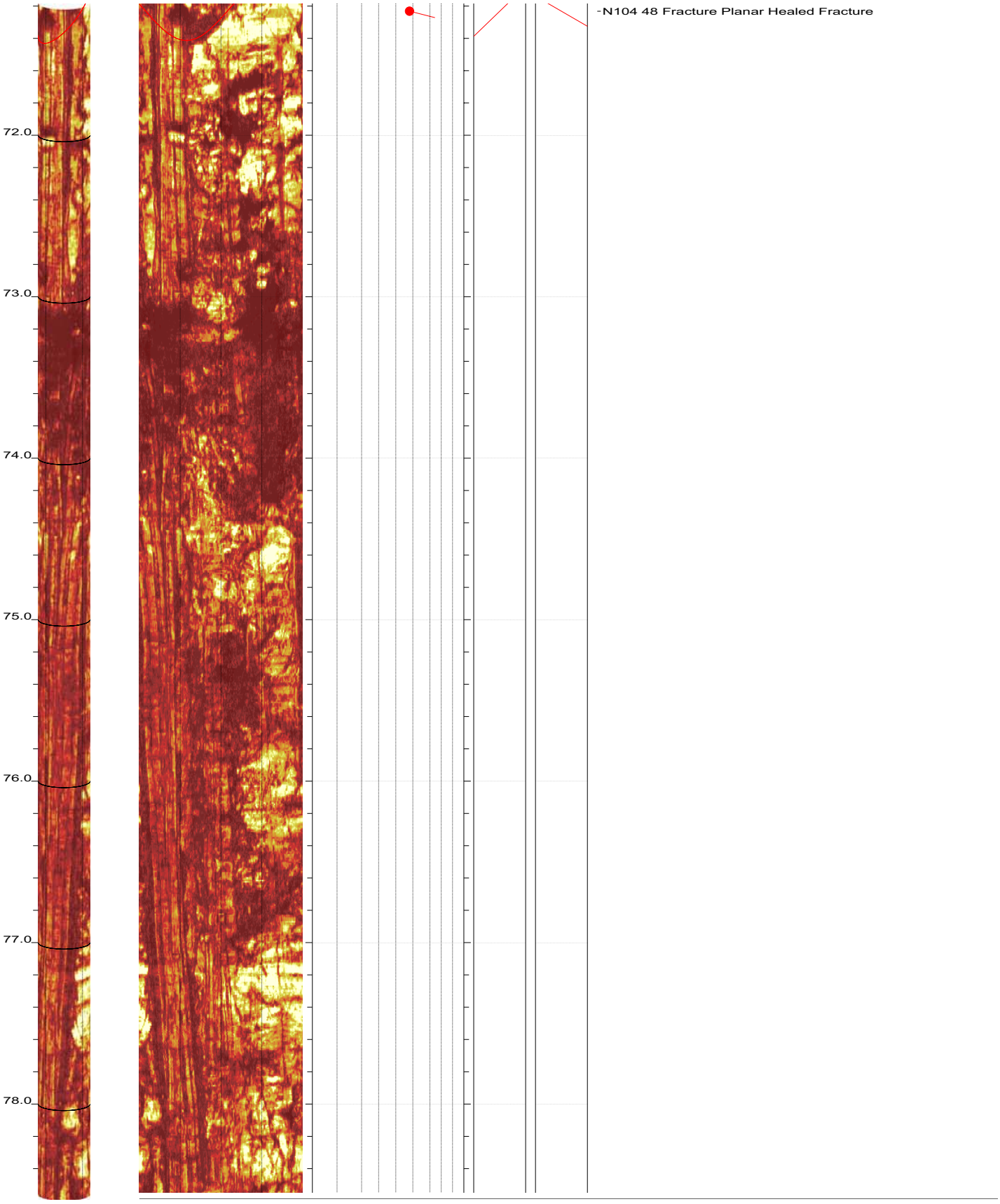
Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 1 of 11



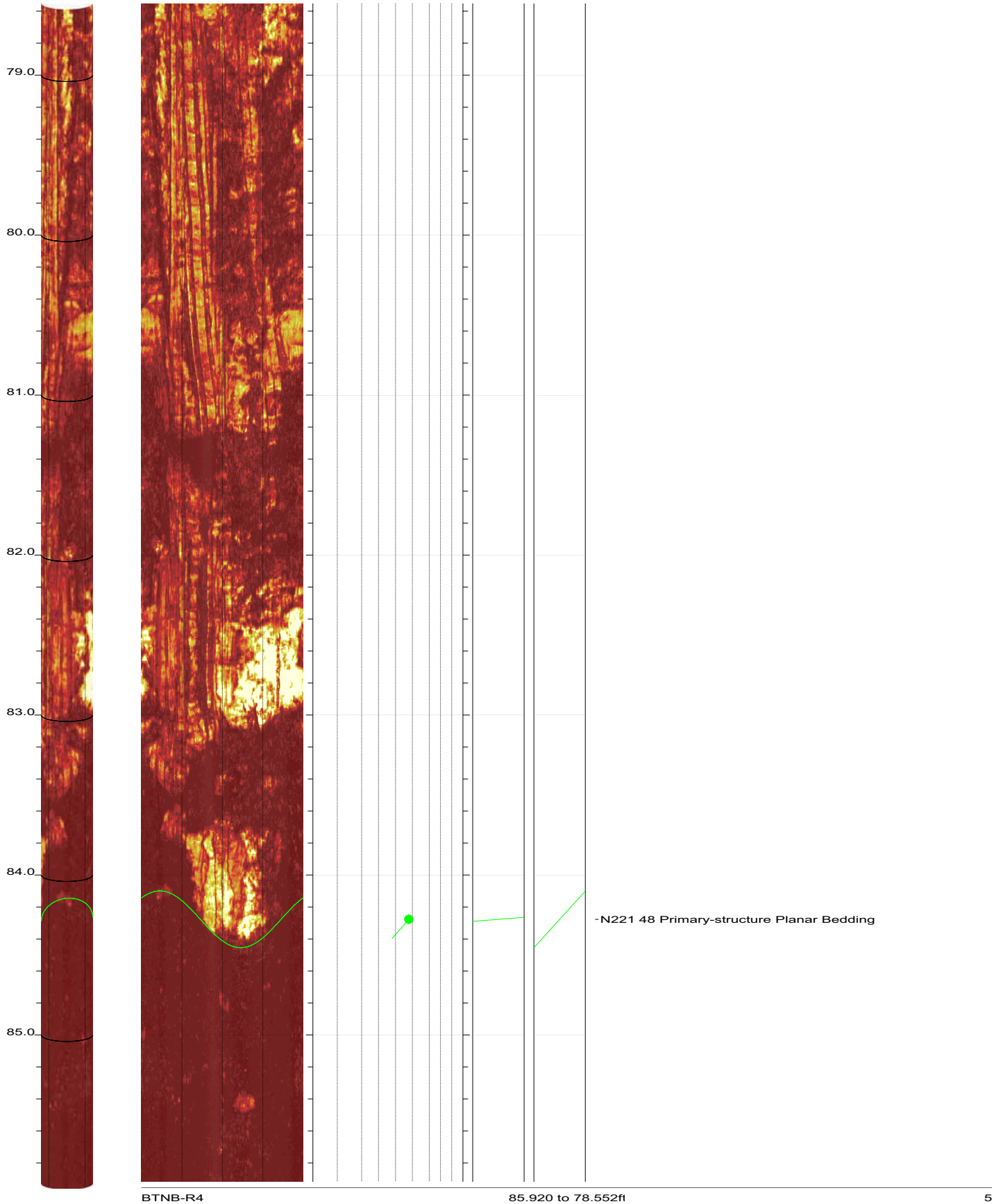
Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 2 of 11



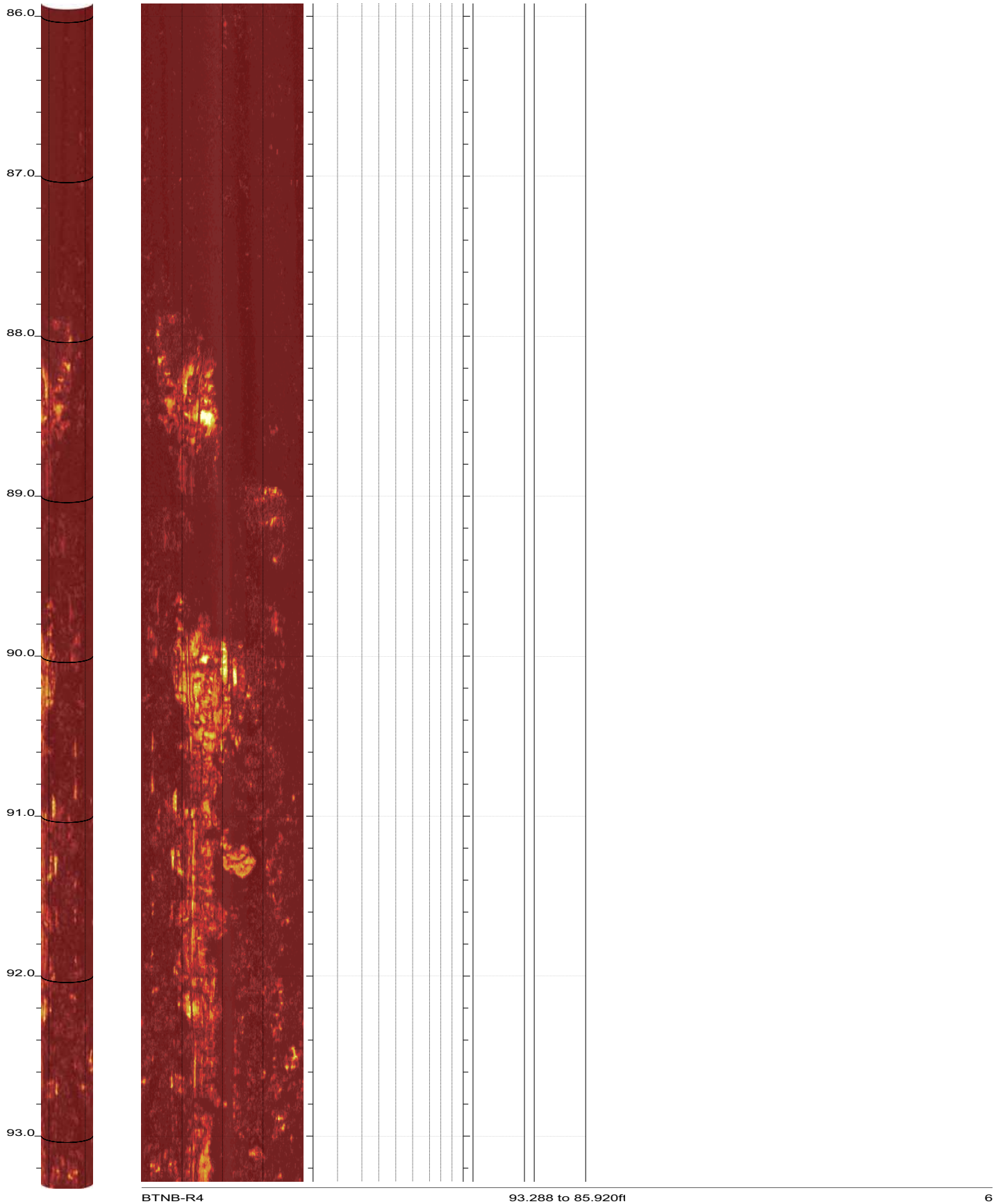
Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 3 of 11



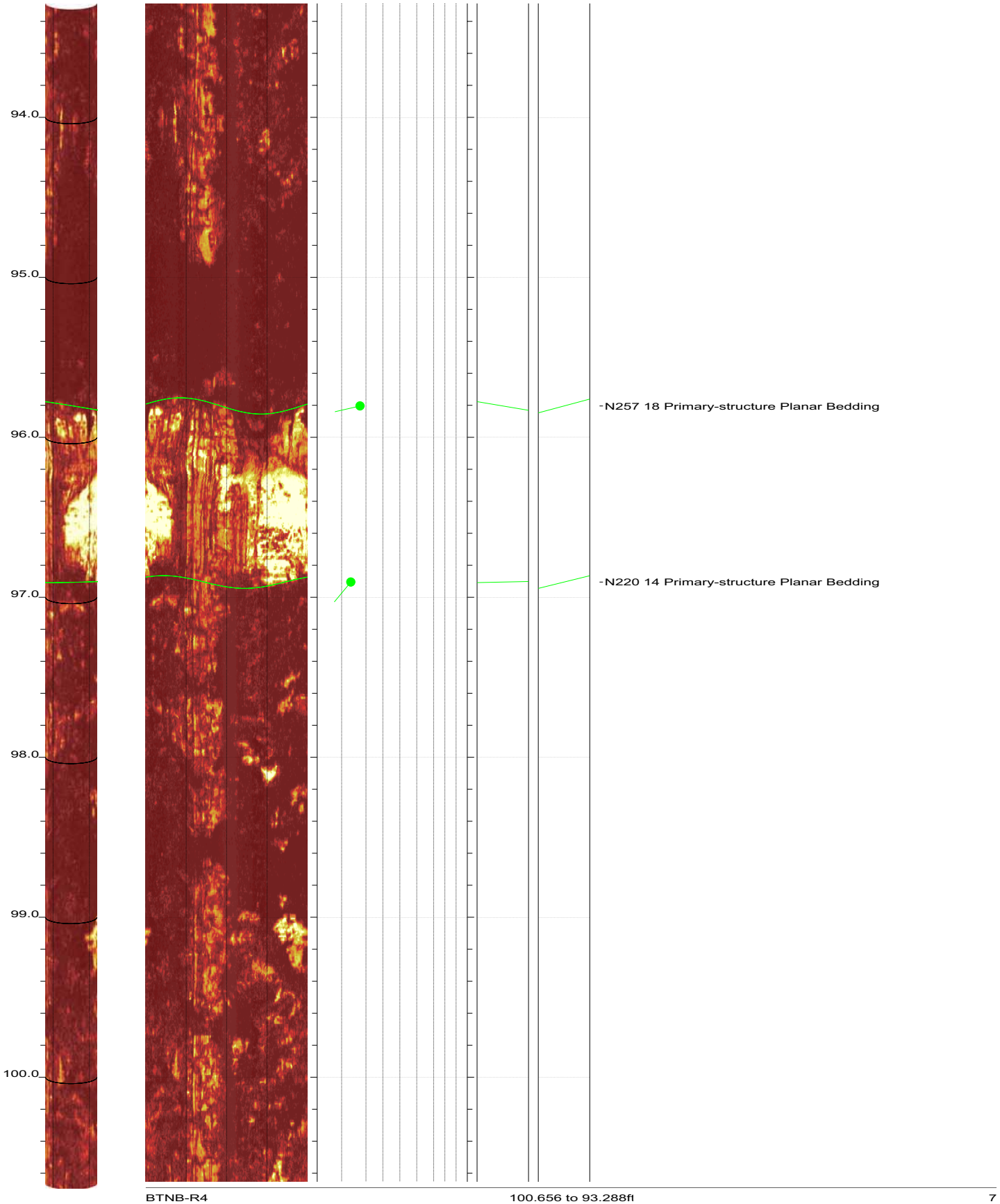
Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 4 of 11



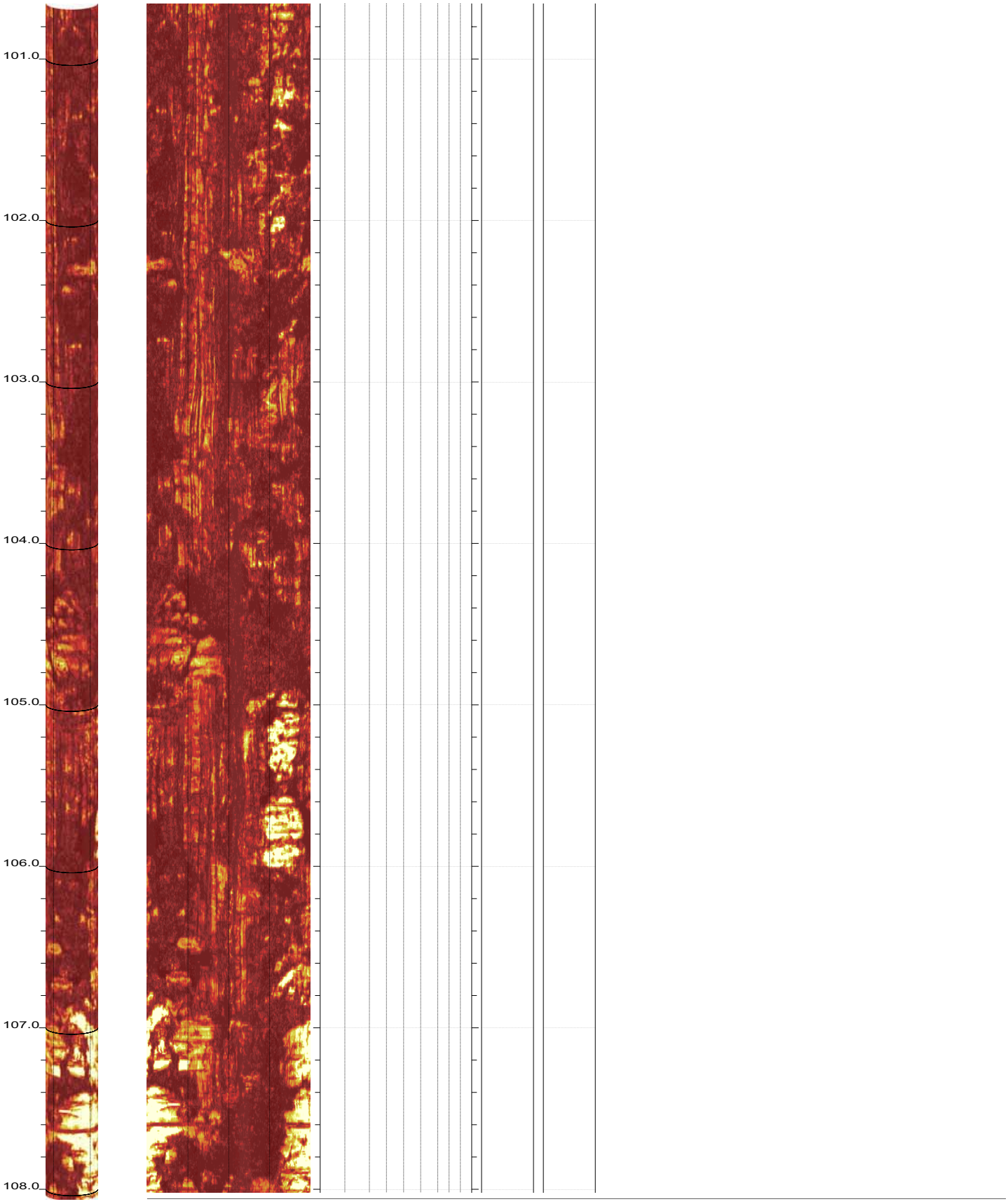
Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 5 of 11



Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 6 of 11

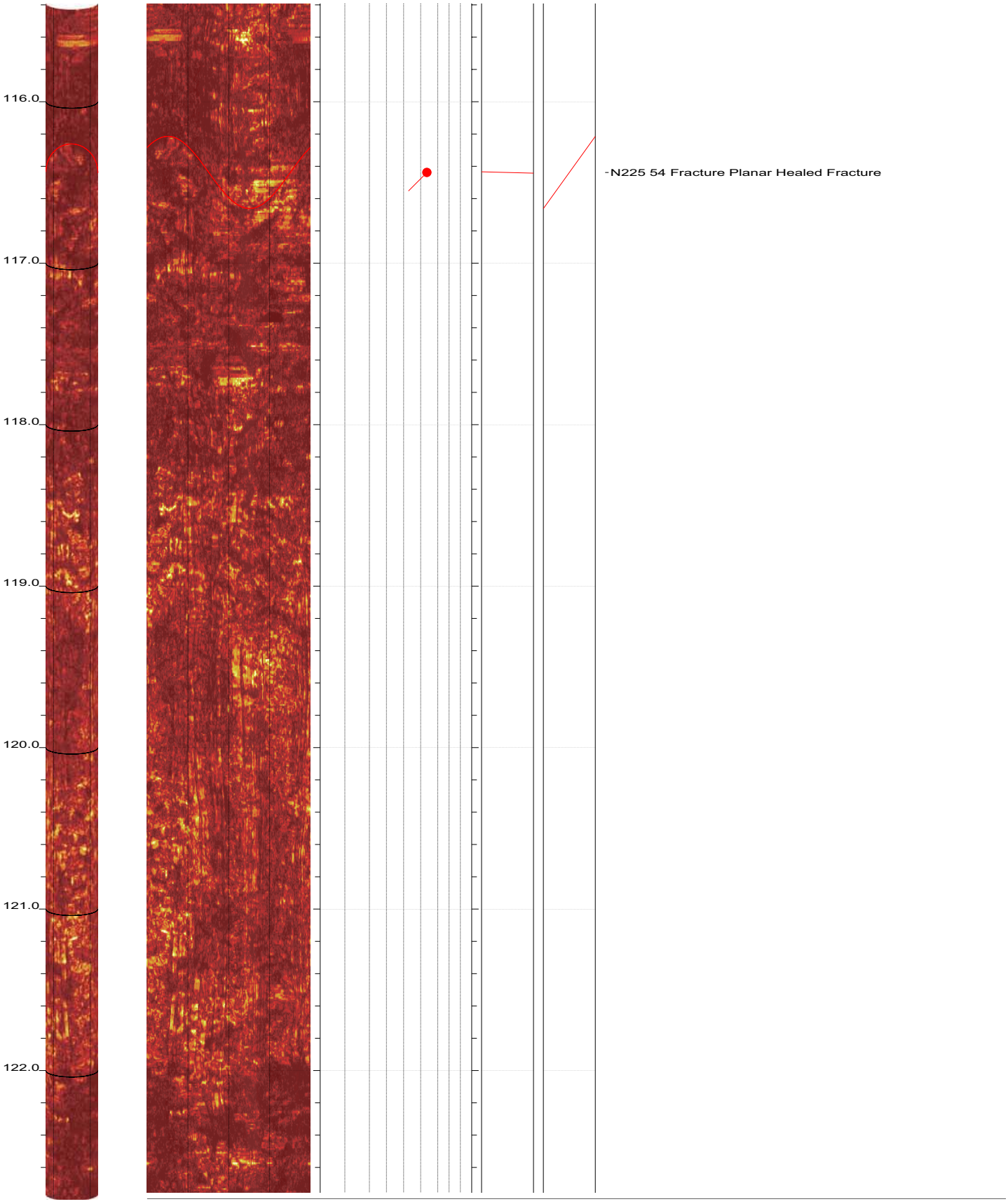


Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 7 of 11

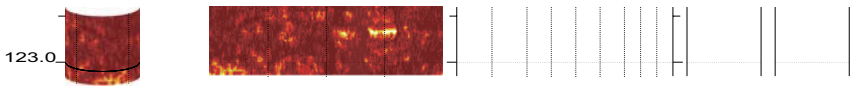


Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 8 of 11

Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 9 of 11



Doyle Drive BTNB-R4 Acoustic Televiewer Dips Sheet 10 of 11


123.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

16 Jun 2008

ARUP

Borehole: BTNB-R5

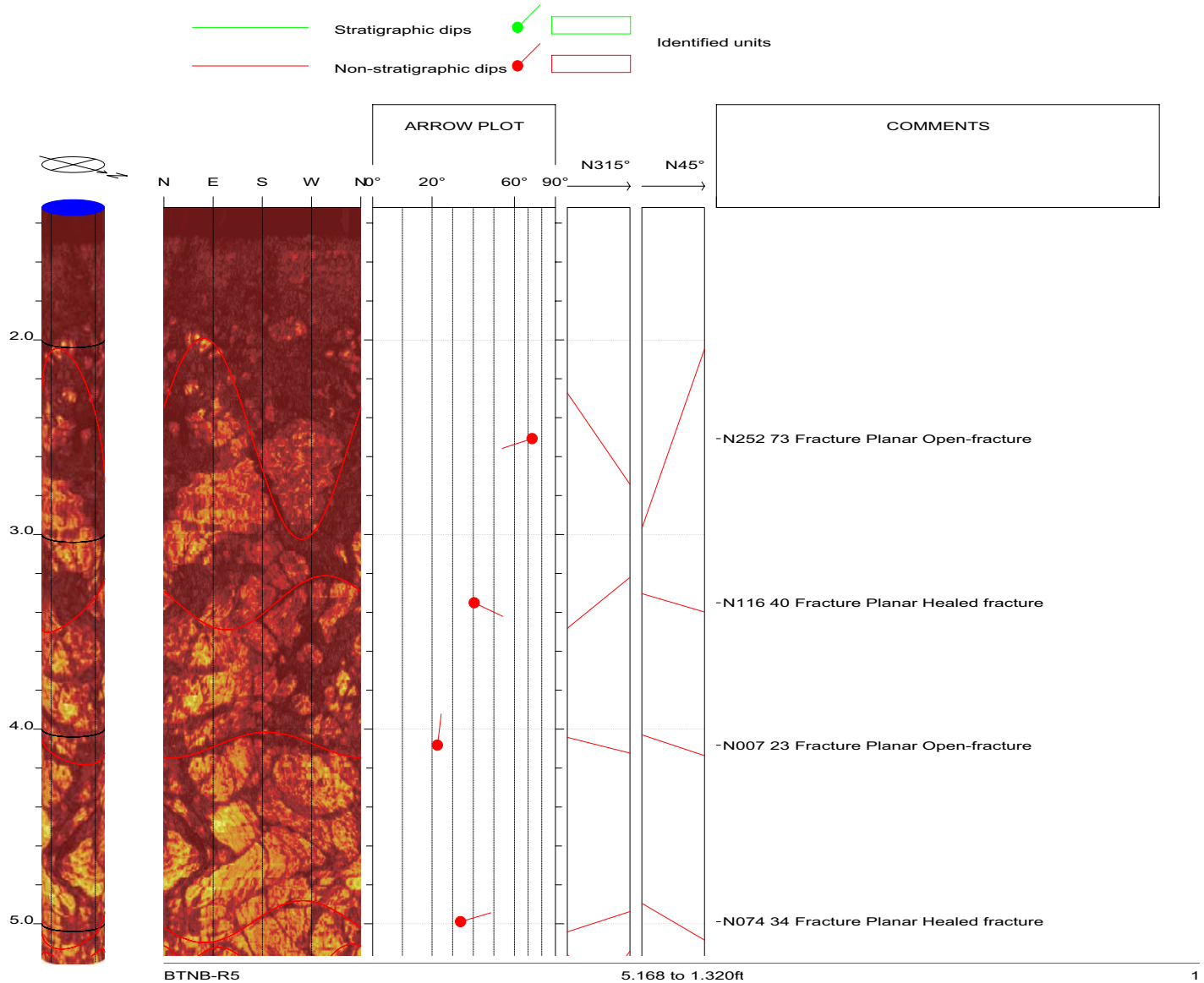
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

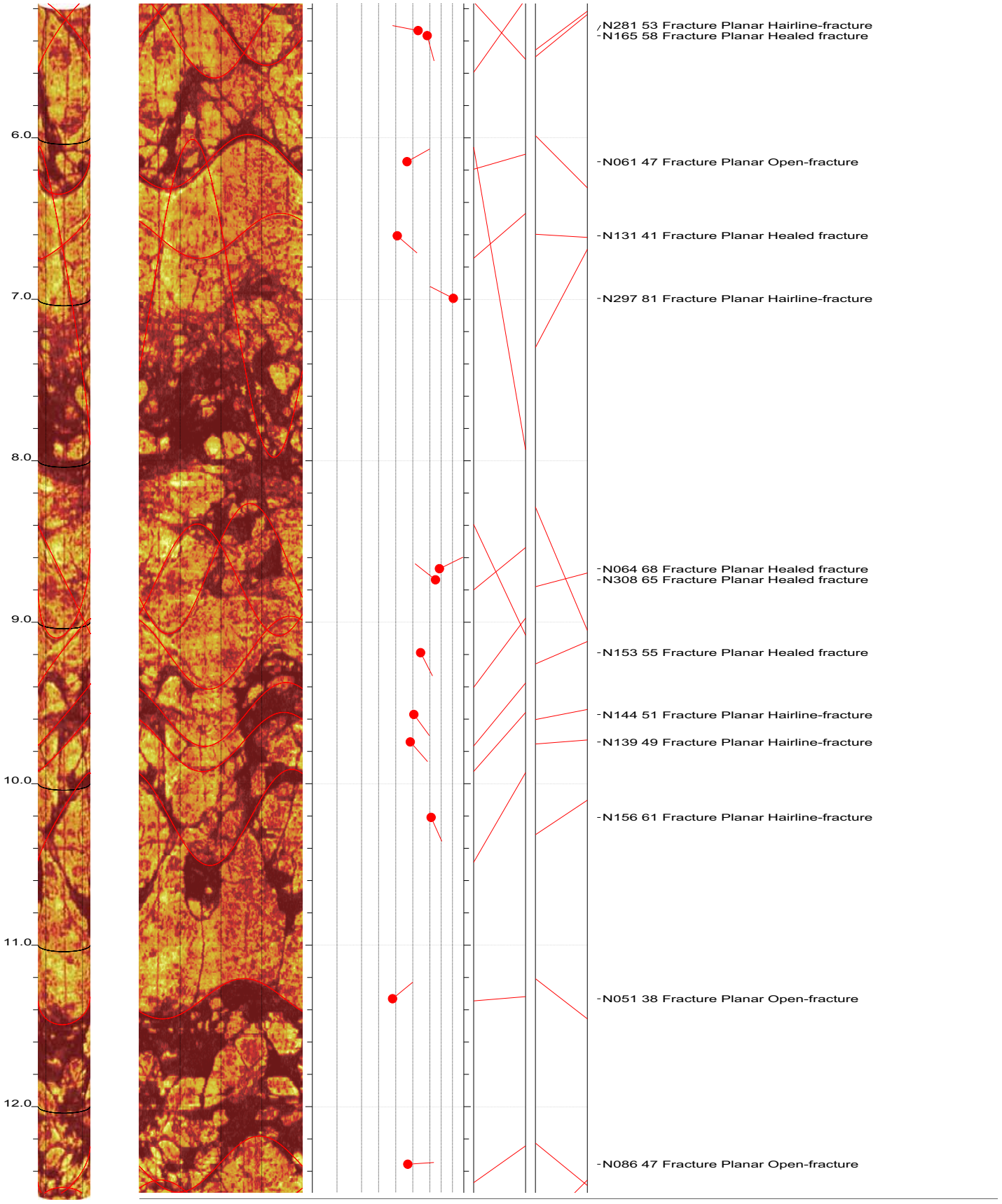
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 106.160 to 1.320ft
Format: BHTV-NESWN

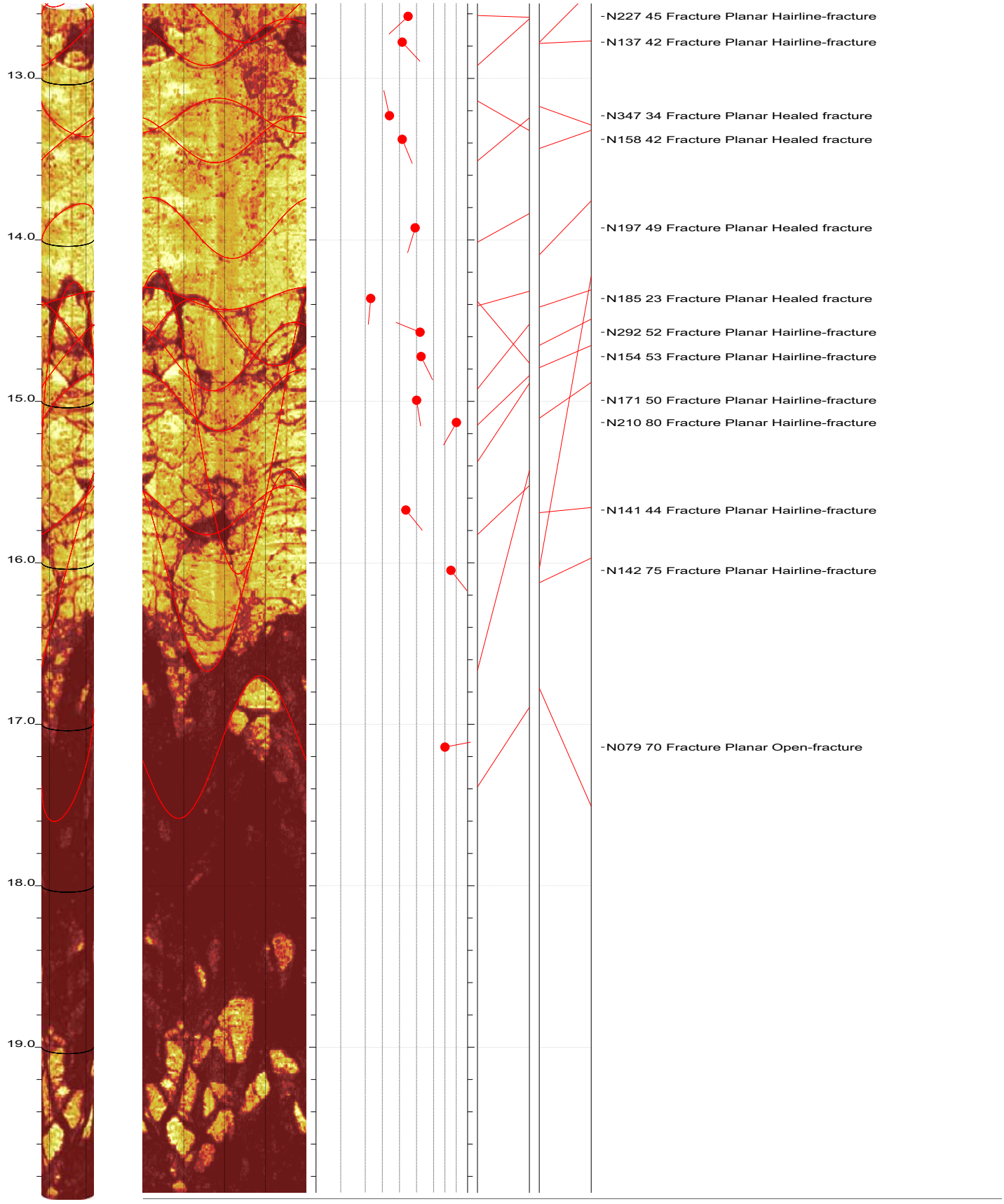
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



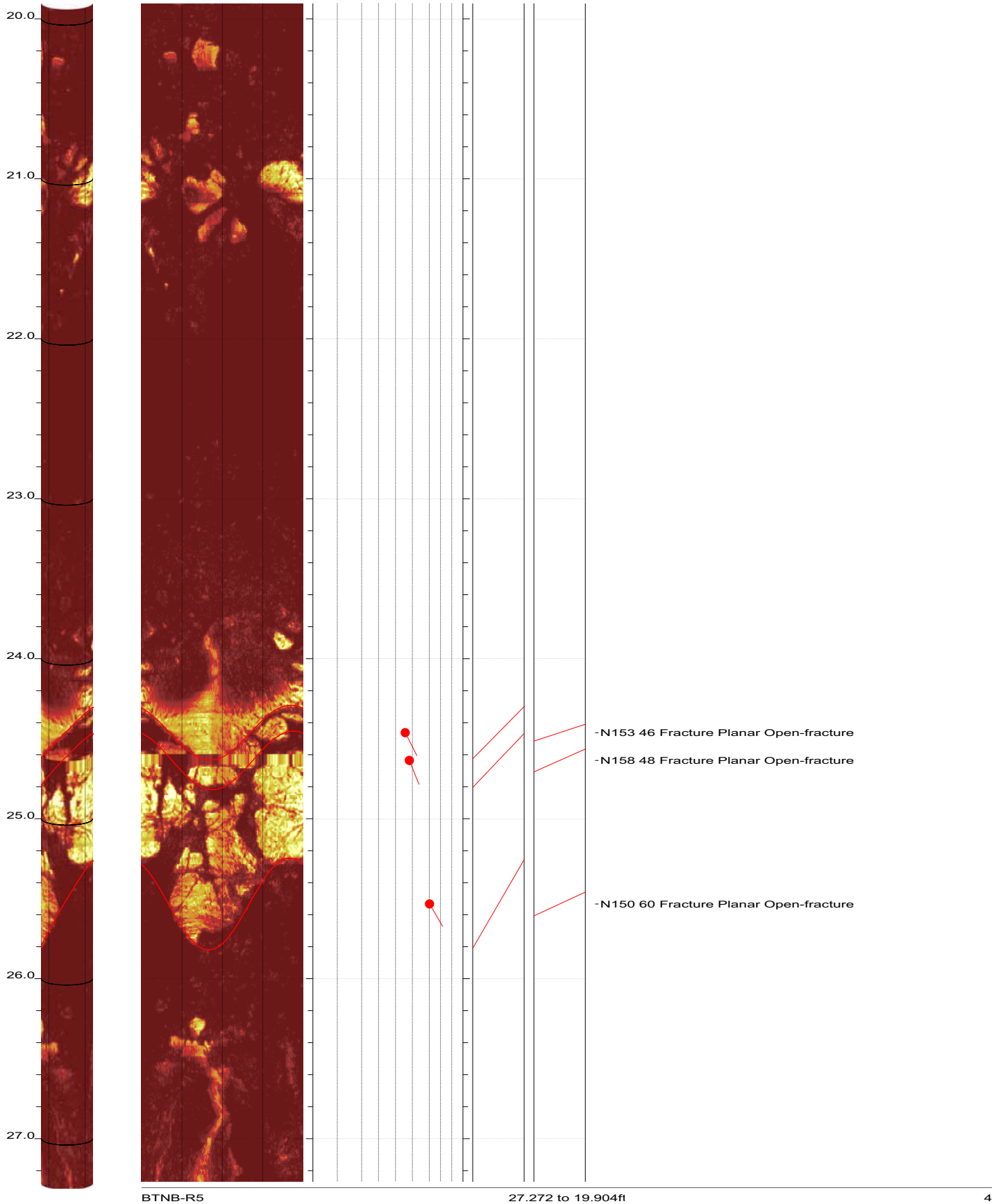
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 1 of 15



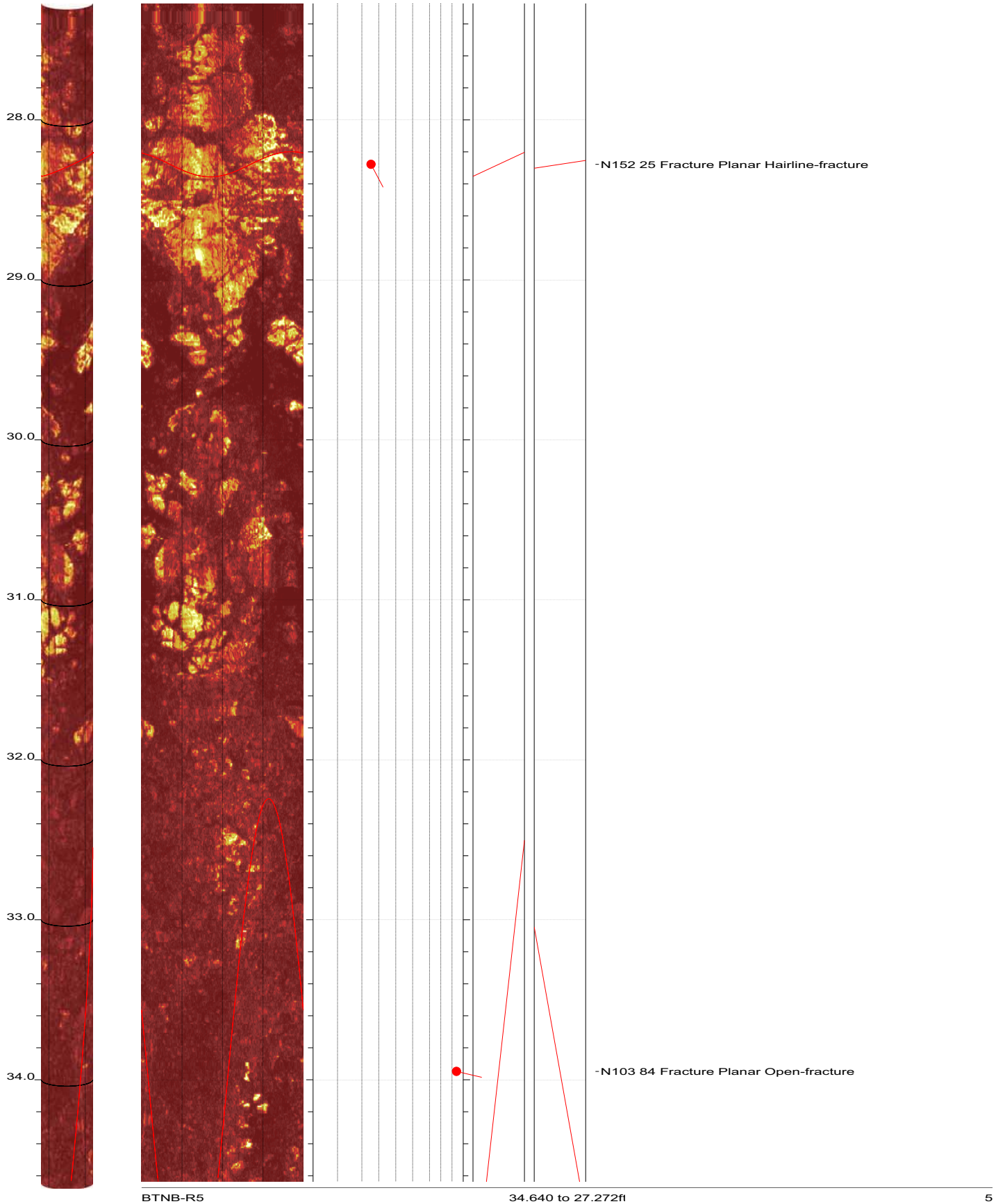
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 2 of 15



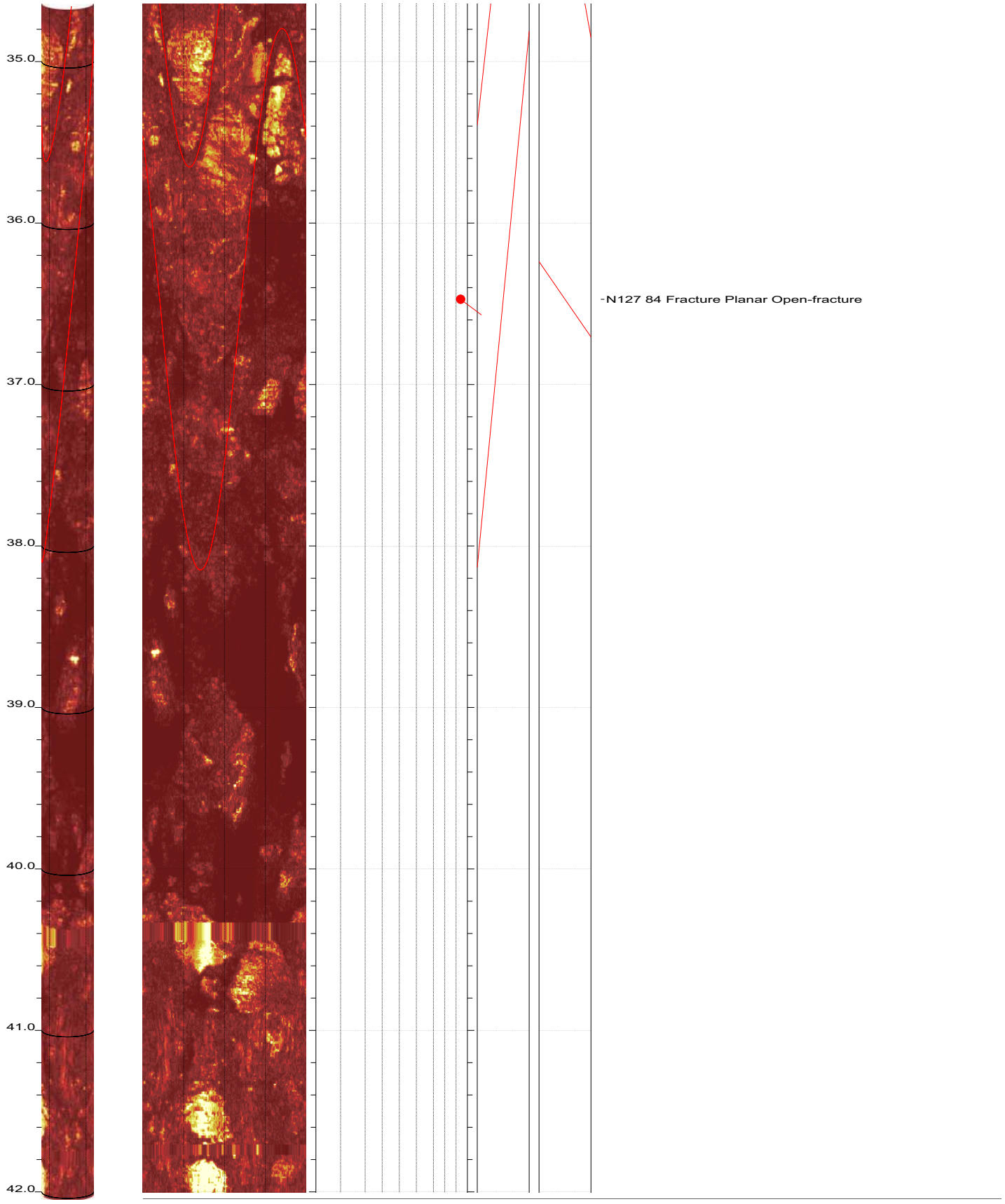
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 3 of 15



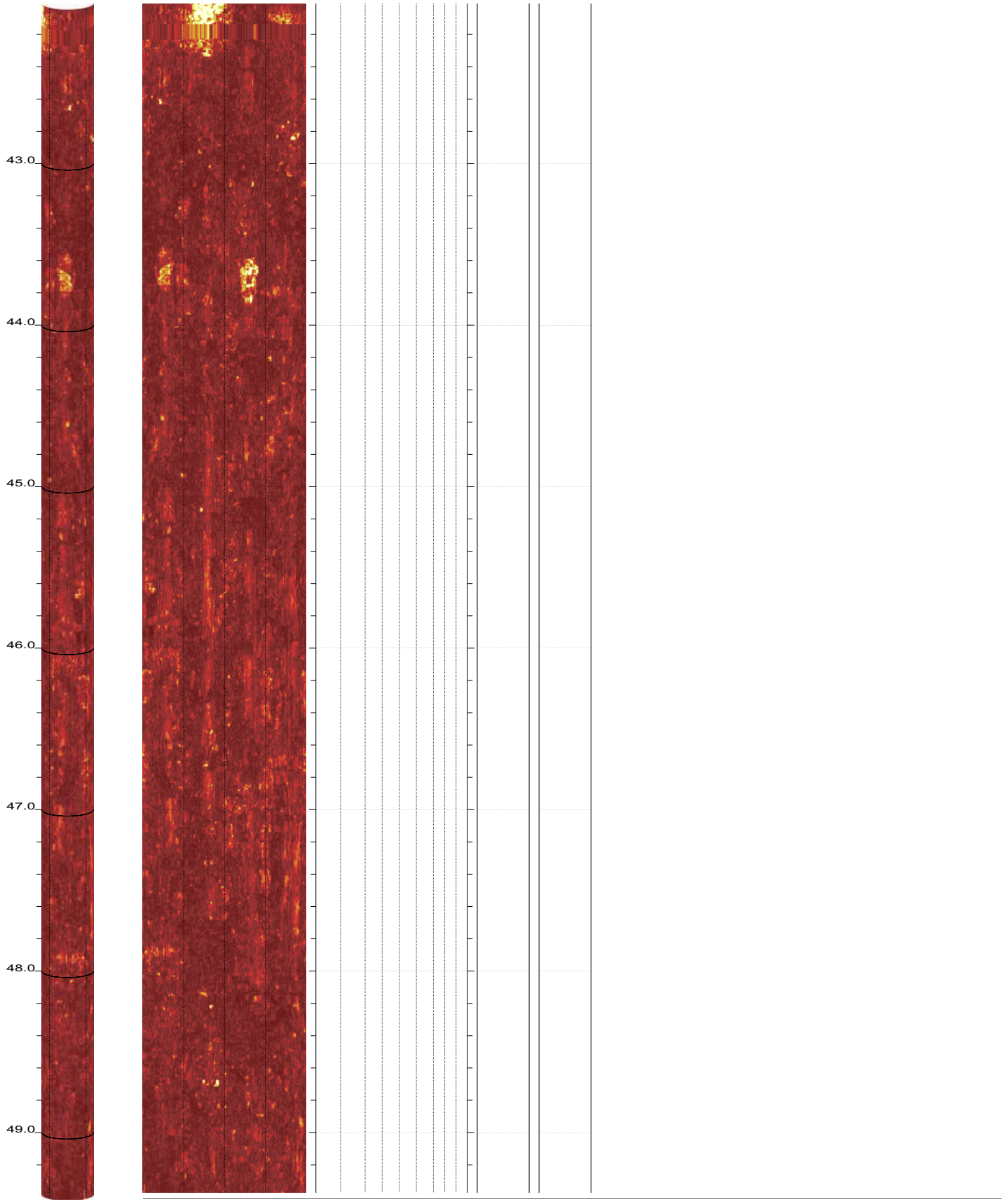
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 4 of 15

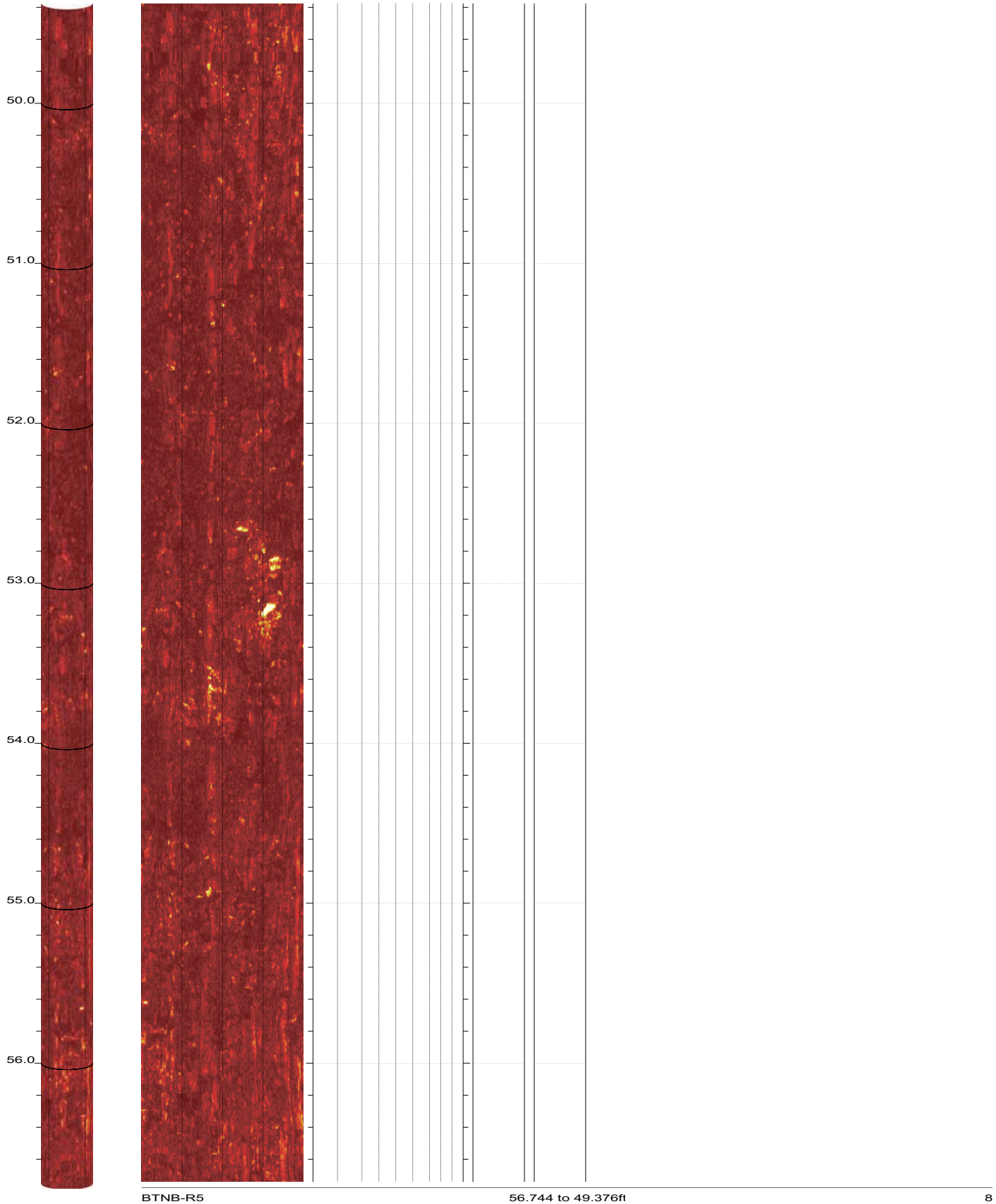


Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 5 of 15

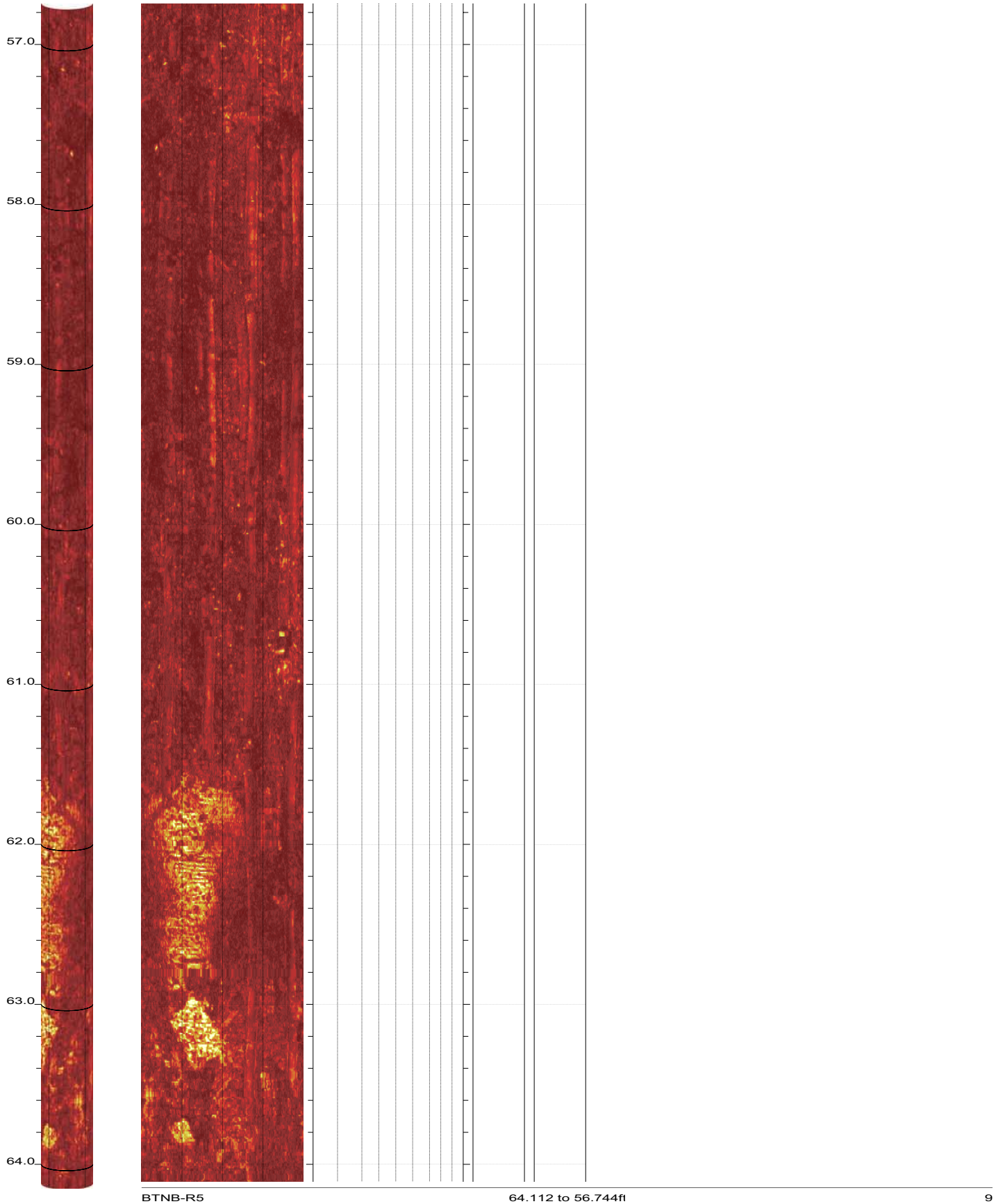


Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 6 of 15

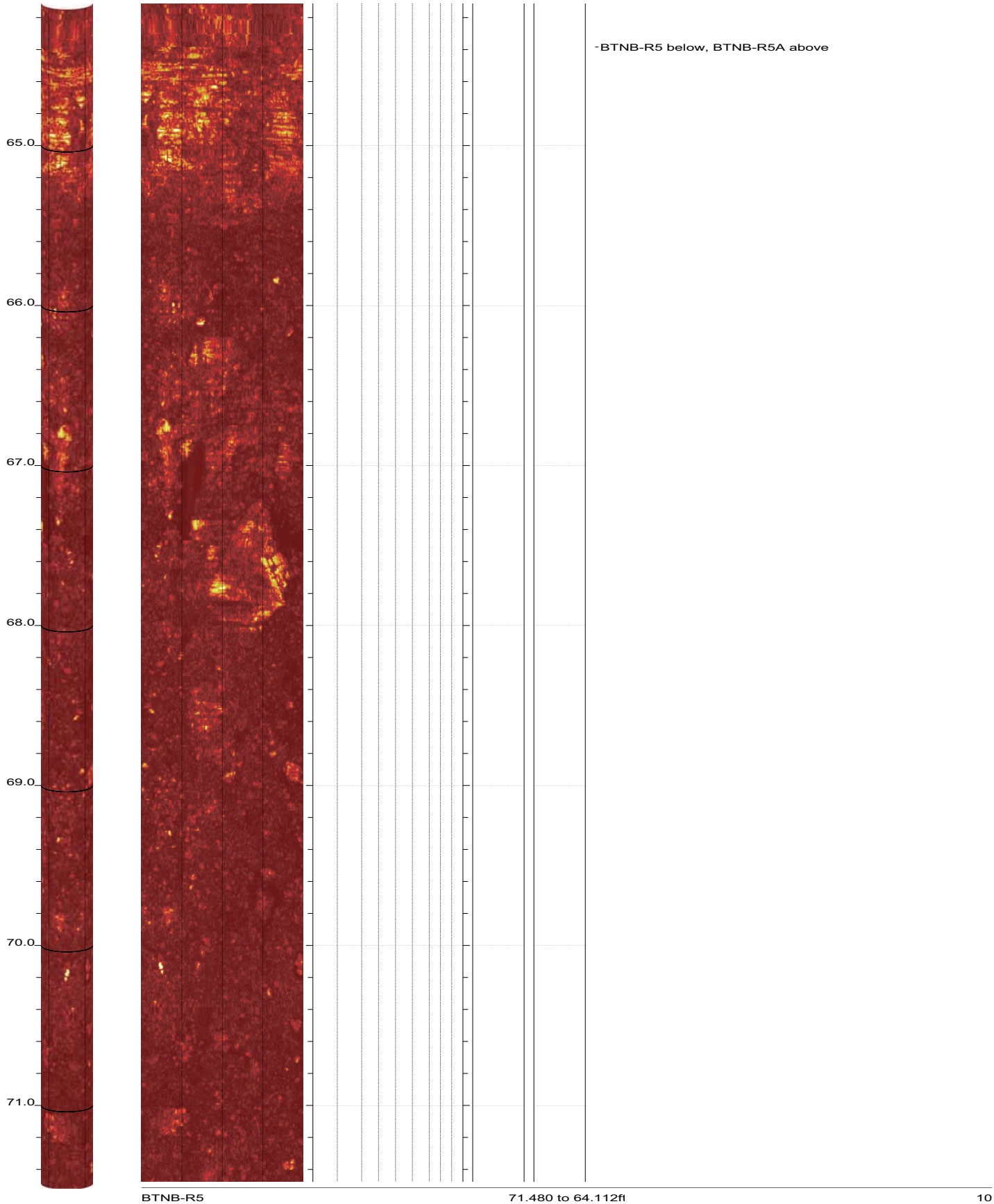

43.0
44.0
45.0
46.0
47.0
48.0
49.0
BTNB-R5
49.376 to 42.008ft
7



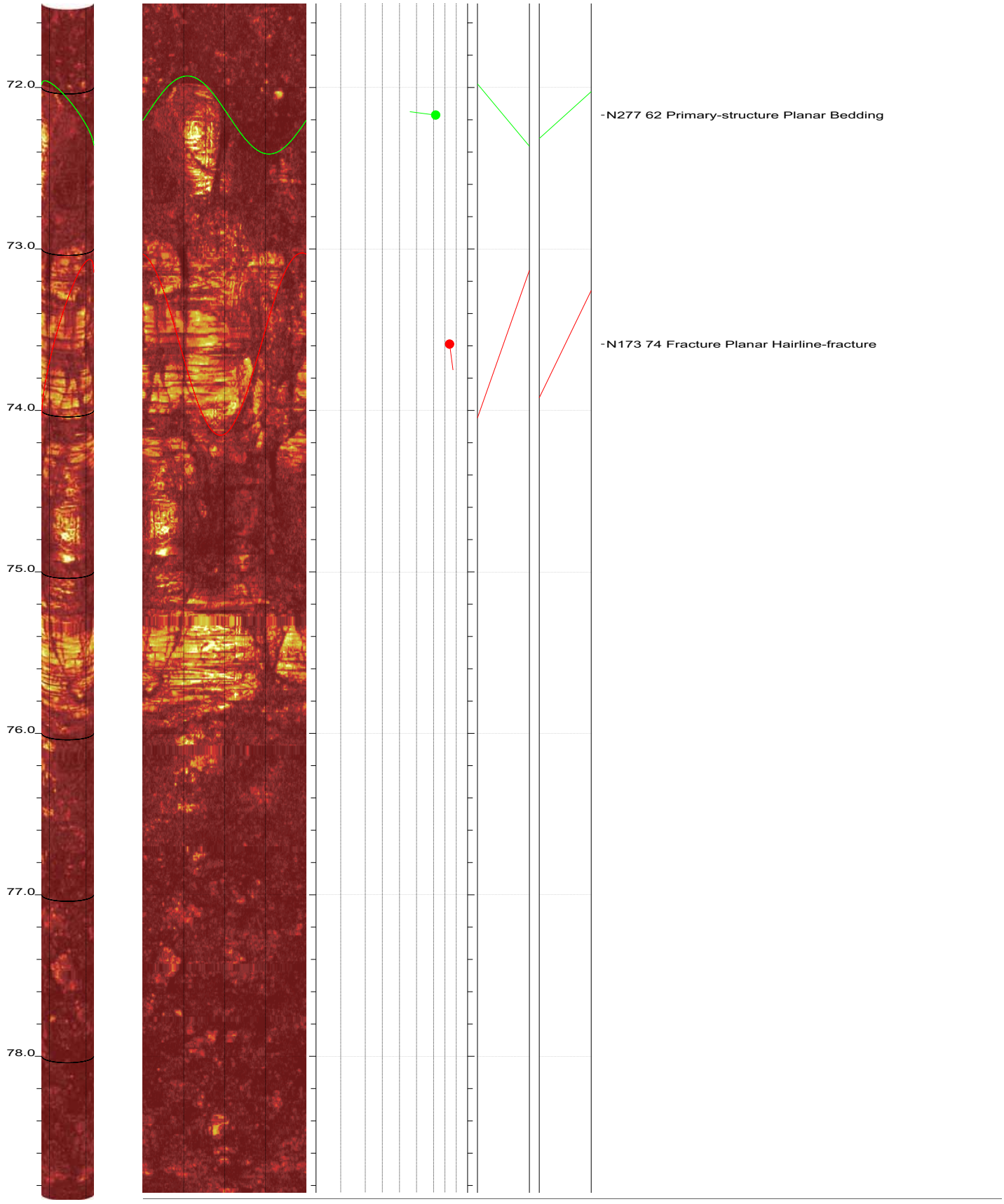
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 8 of 15



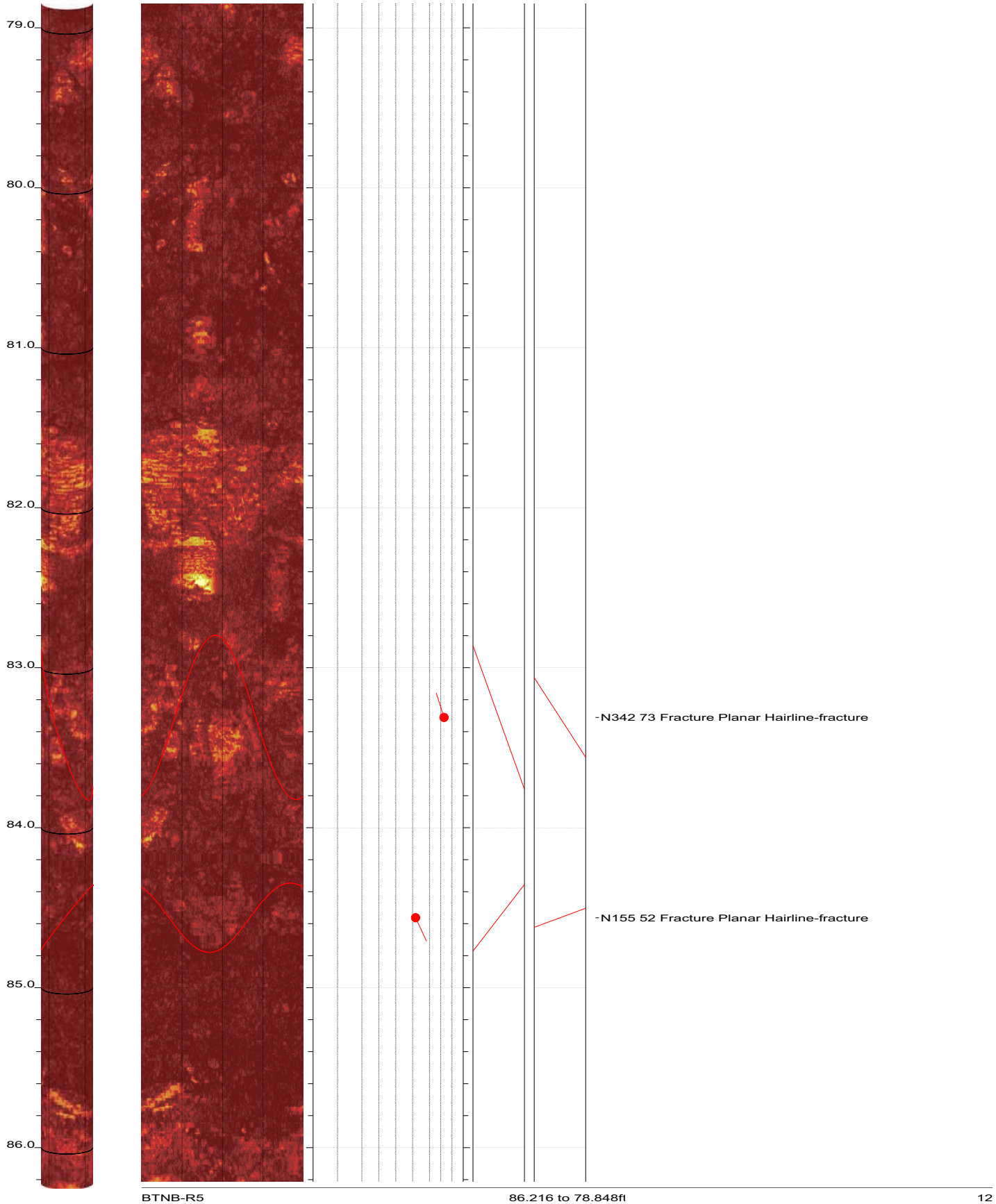
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 9 of 15



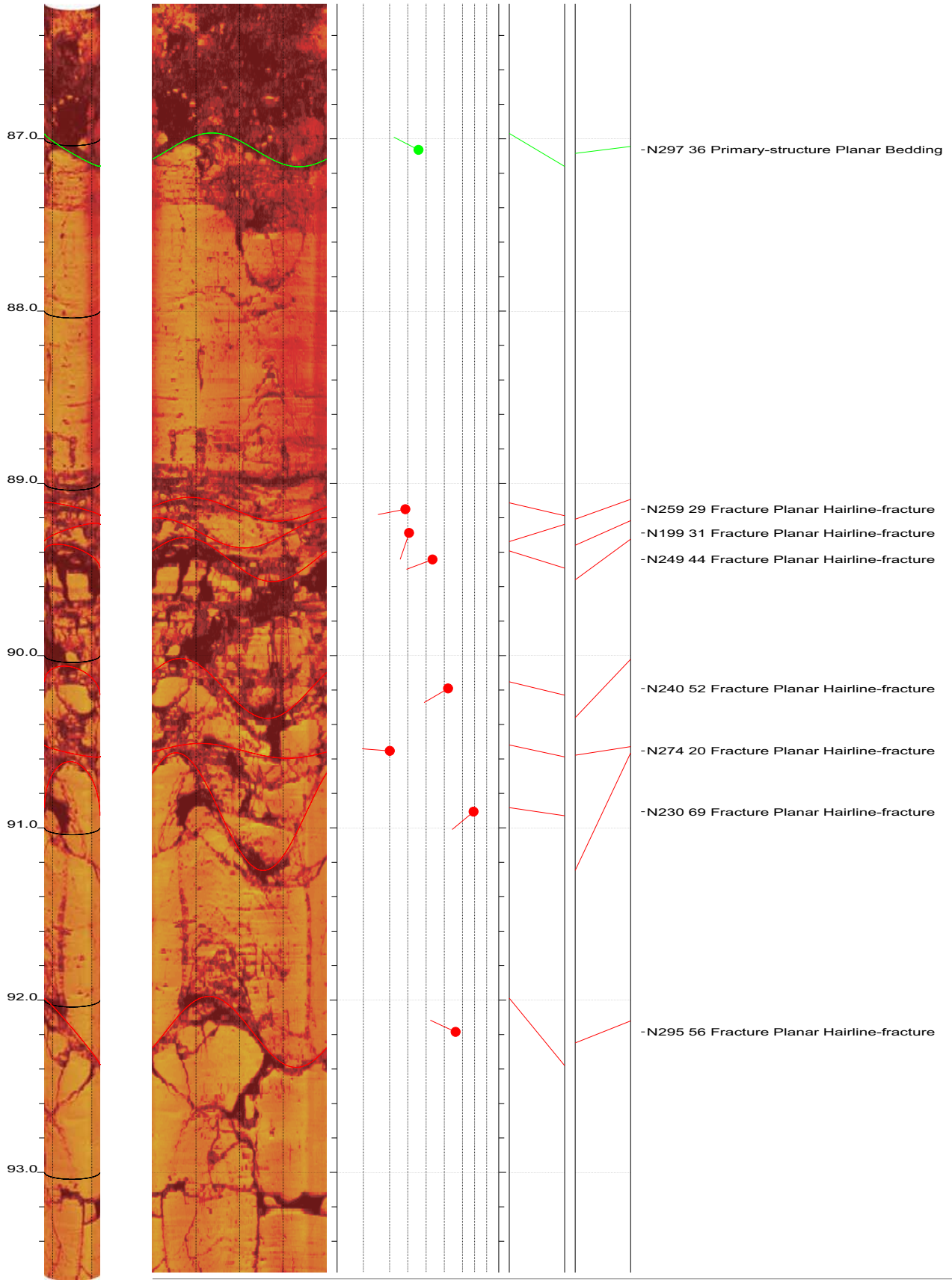
Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 10 of 15



Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 11 of 15

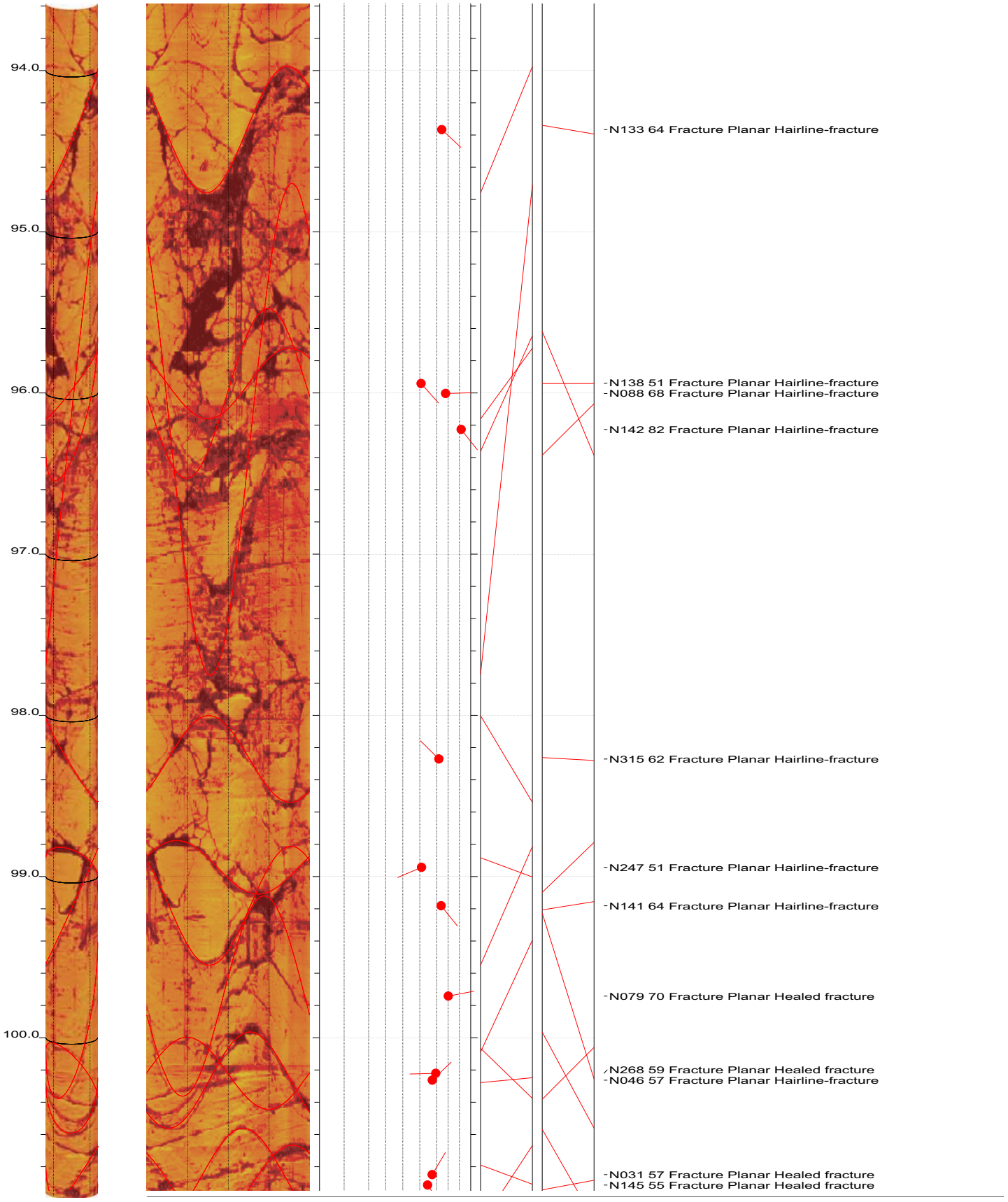


Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 12 of 15

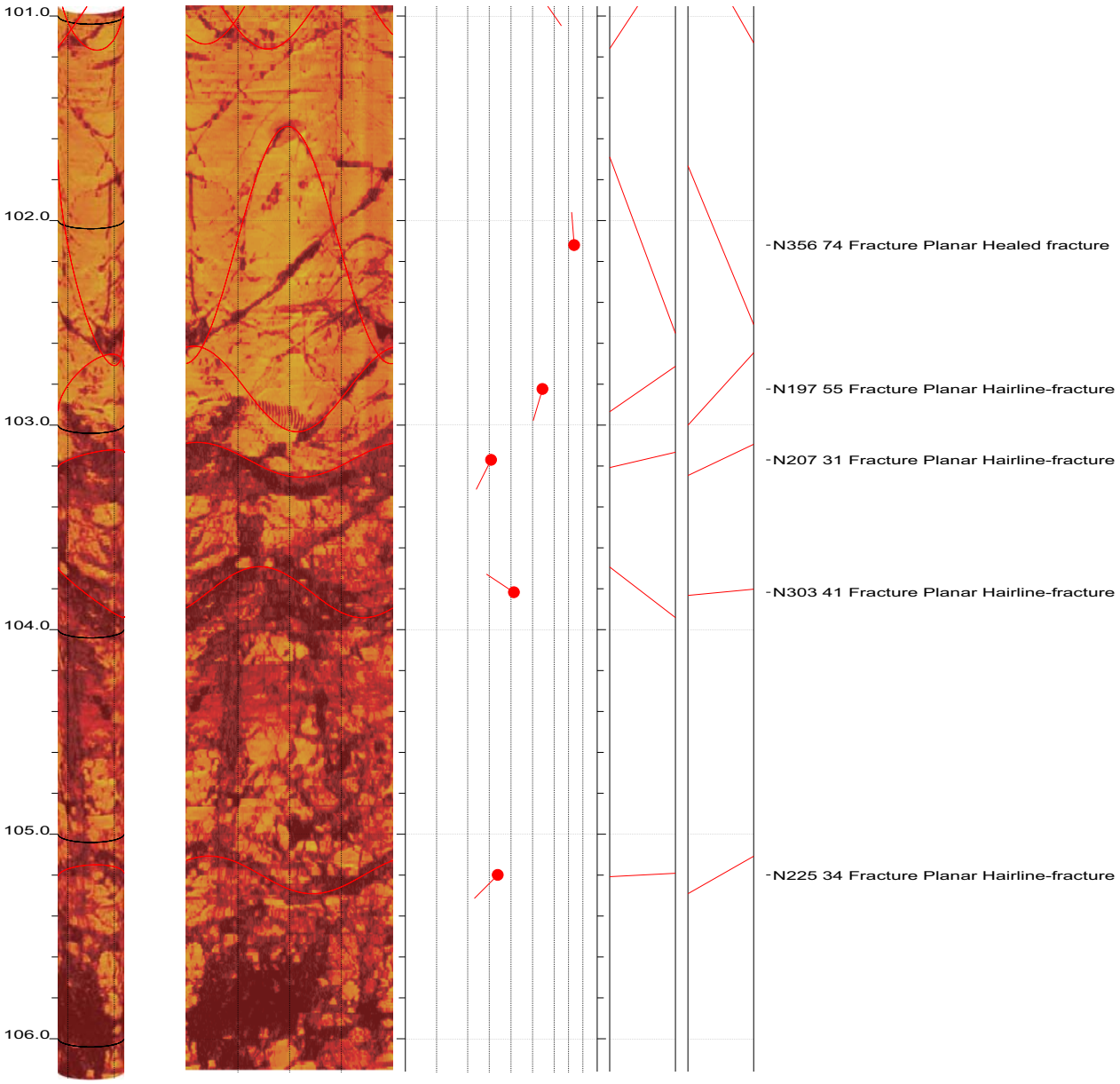


BTNB-R5 93.584 to 86.216fl 13

Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 13 of 15



Doyle Drive BTNB-R5 and BTNB-R5A Acoustic Televiewer Dips Sheet 14 of 15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102.0
103.0
104.0
105.0
106.0
-N356 74 Fracture Planar Healed fracture
-N197 55 Fracture Planar Hairline-fracture
-N207 31 Fracture Planar Hairline-fracture
-N303 41 Fracture Planar Hairline-fracture
-N225 34 Fracture Planar Hairline-fracture

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

14 Jun 2008

ARUP

Borehole: BTNB-R7

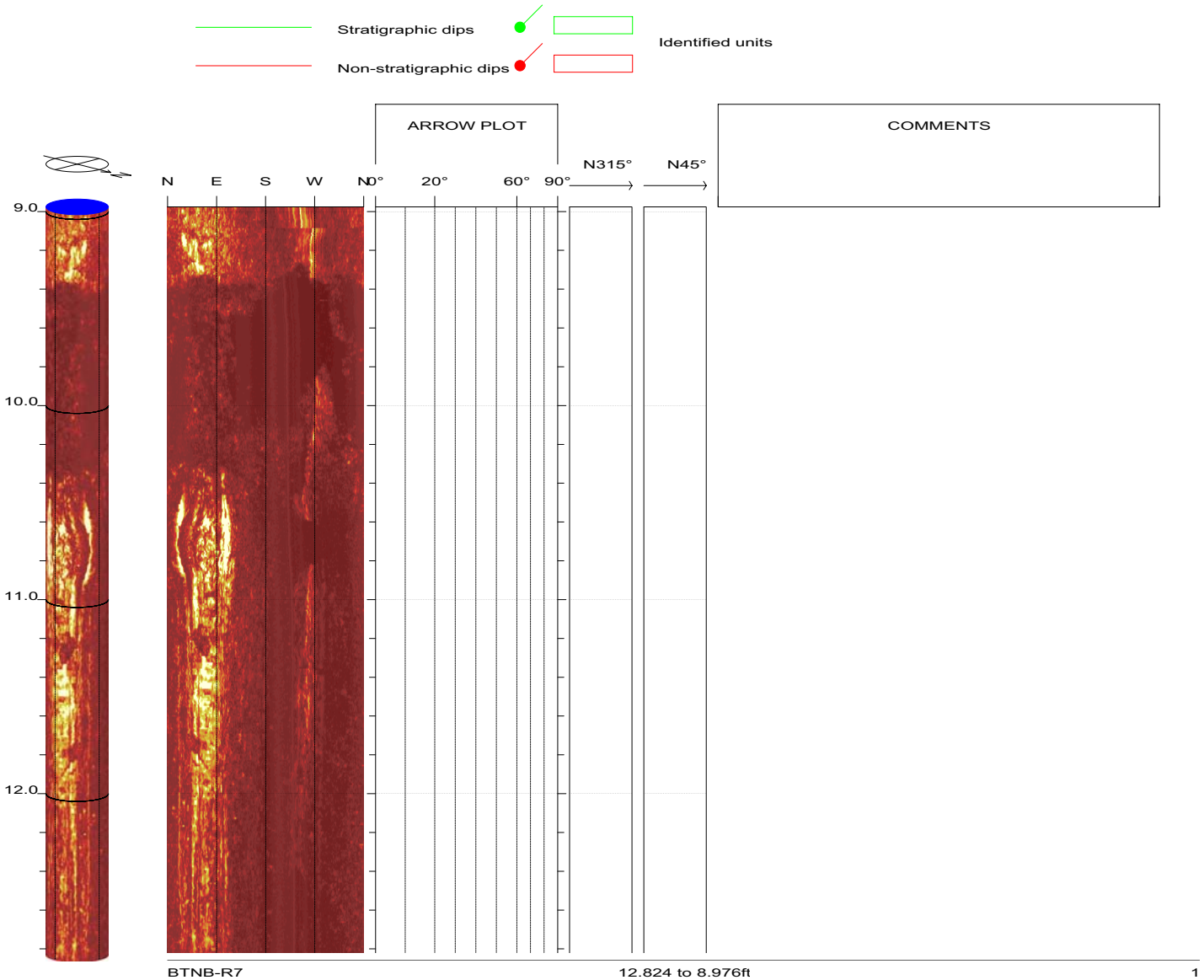
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

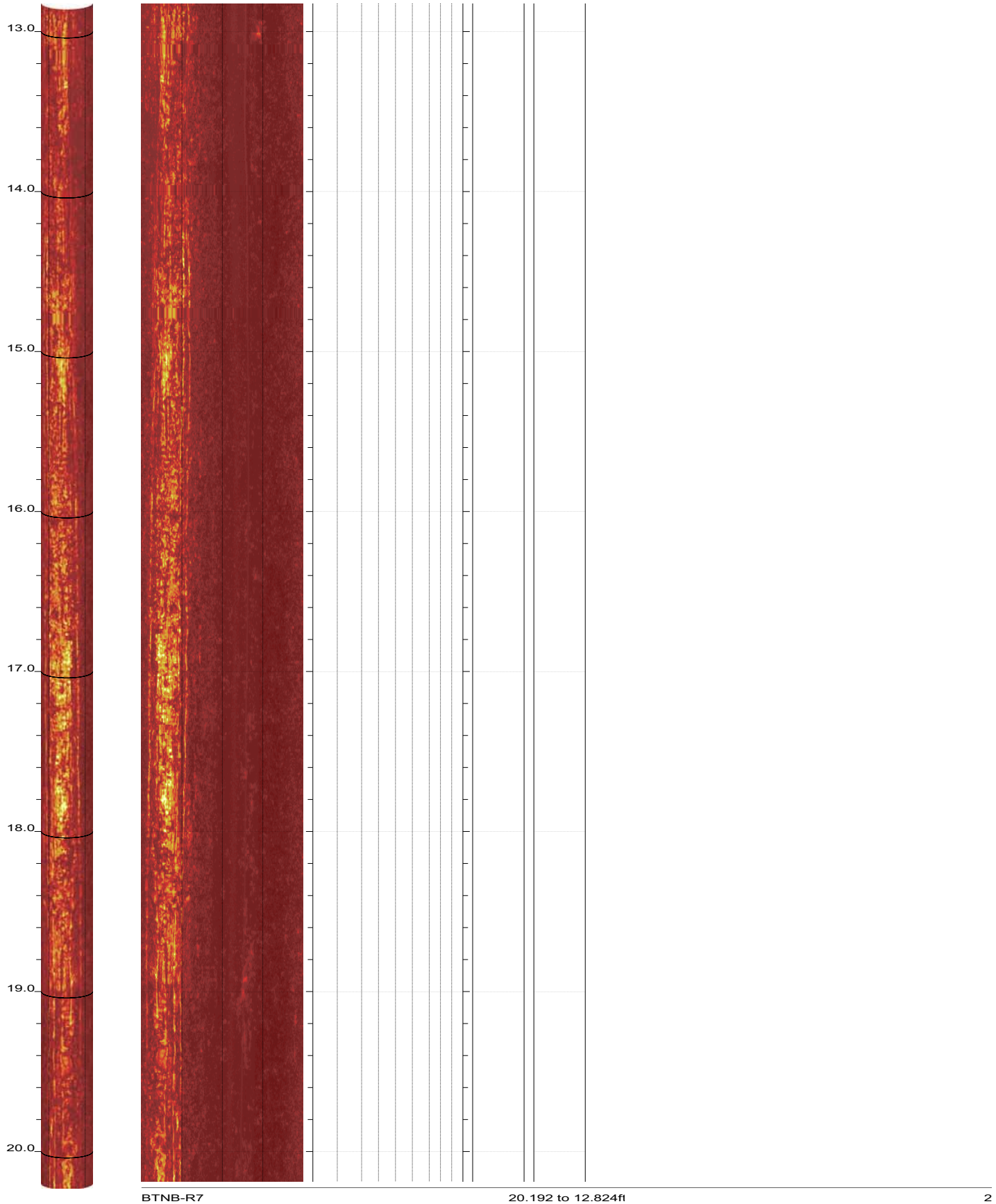
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 111.968 to 8.976ft
Format: BHTV-NESWN

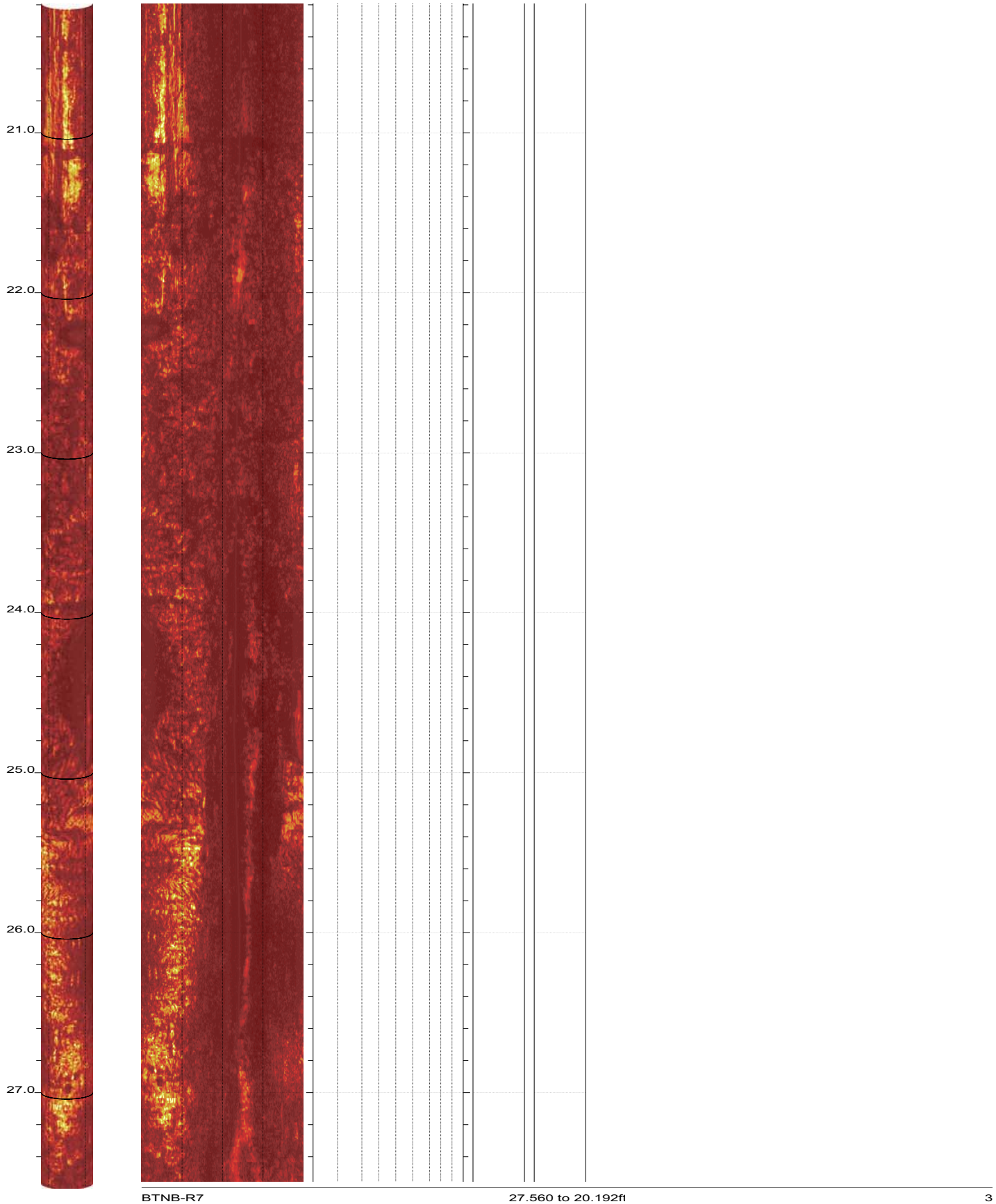
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



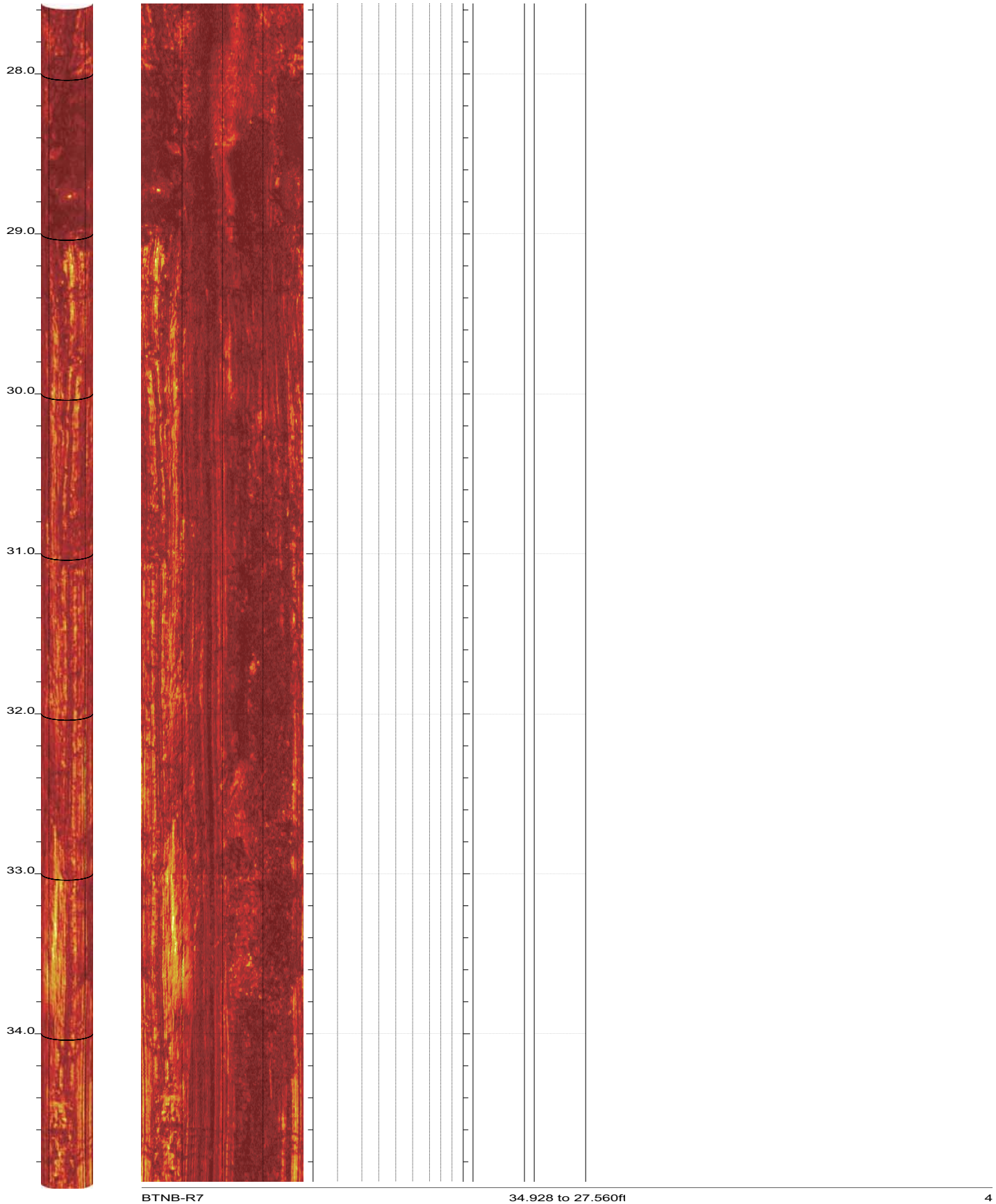
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 1 of 15



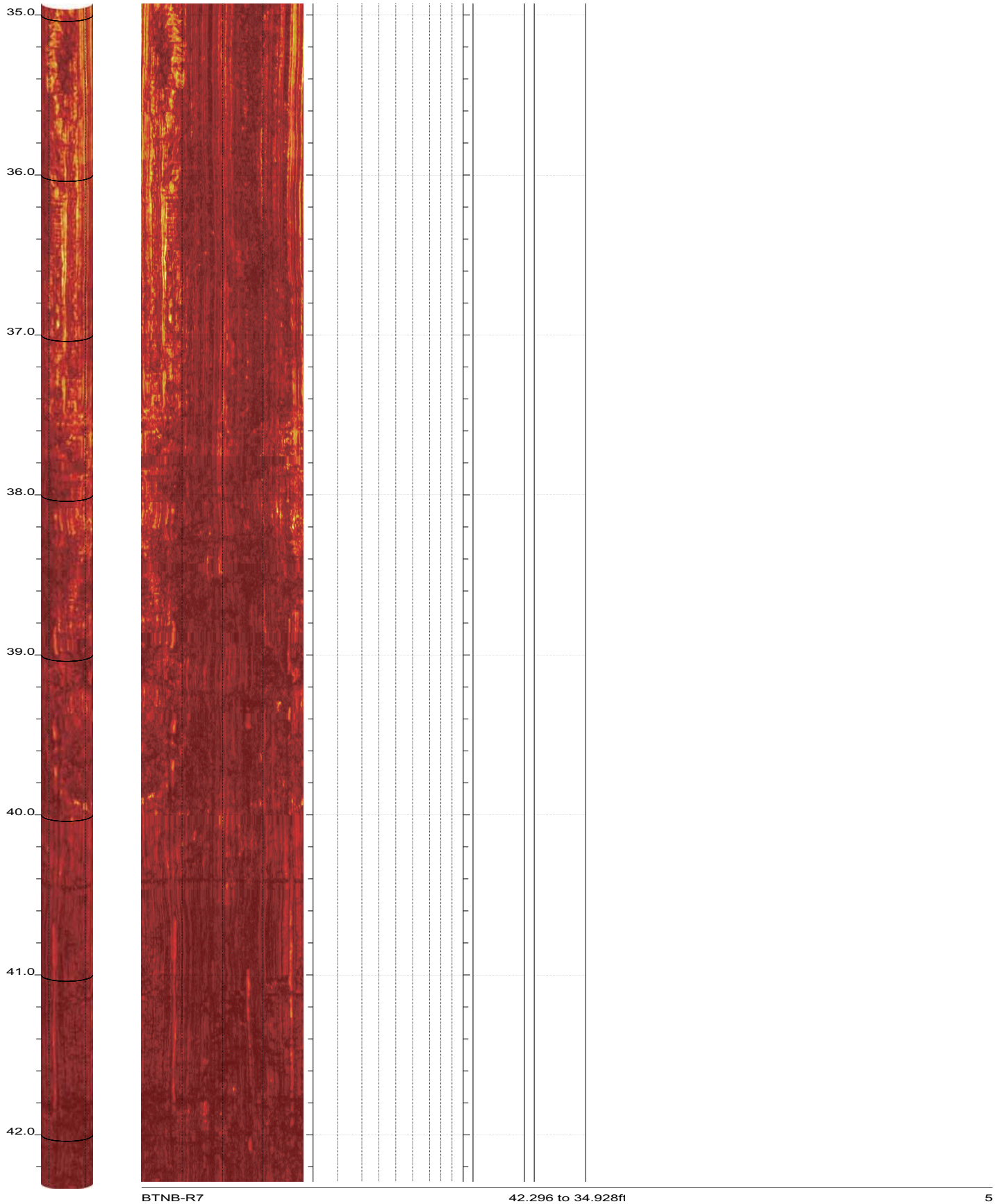
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 2 of 15



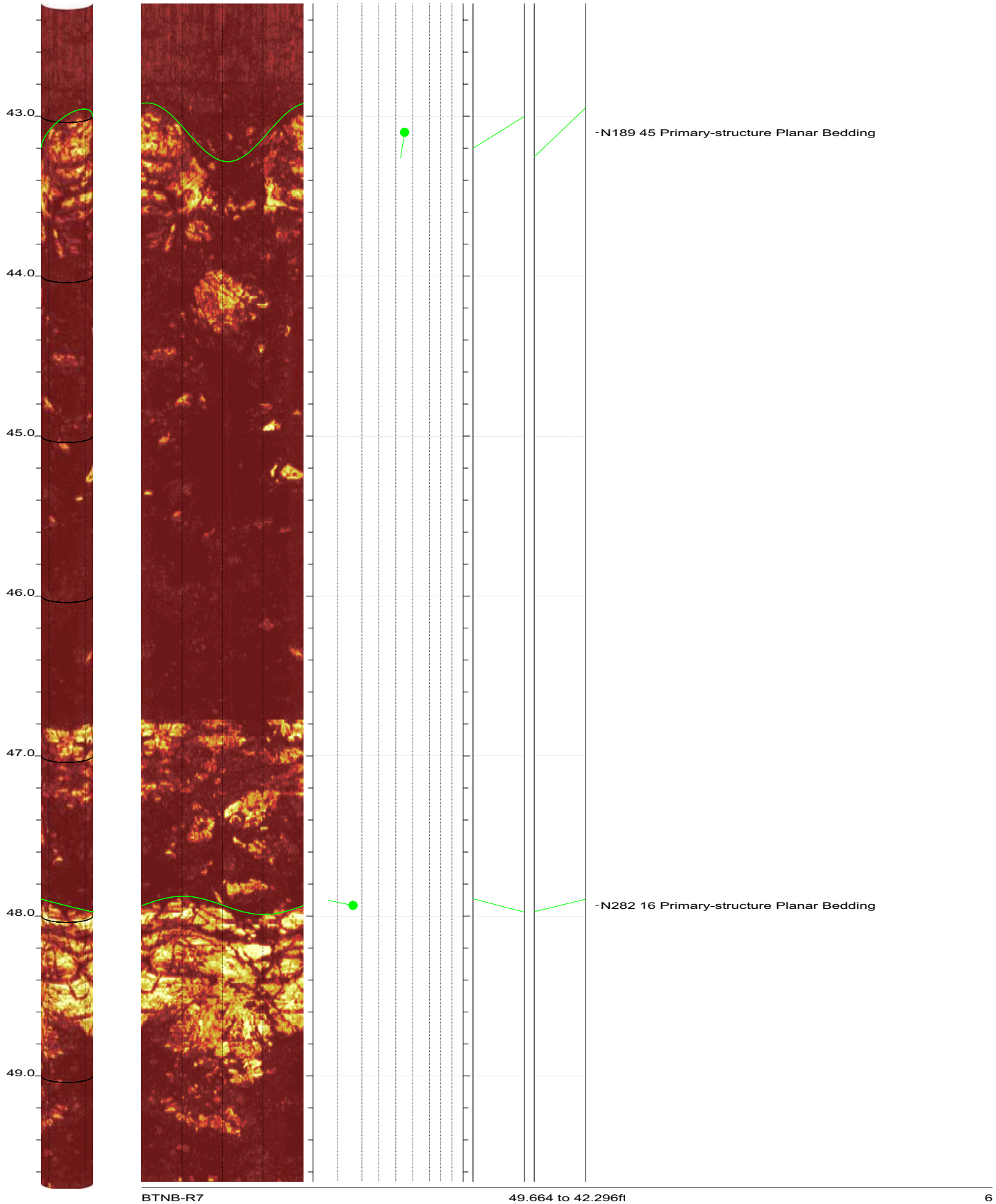
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 3 of 15



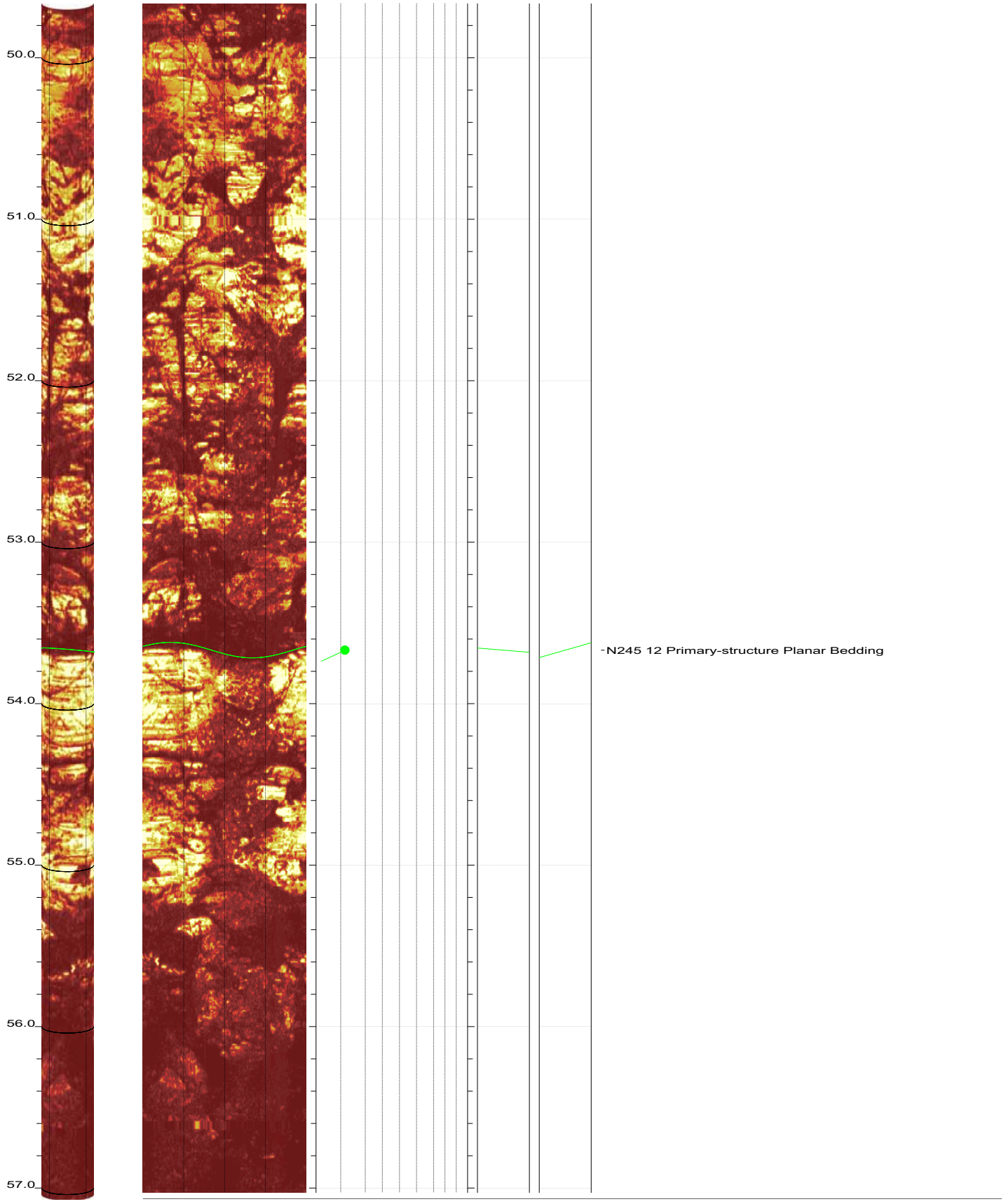
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 4 of 15



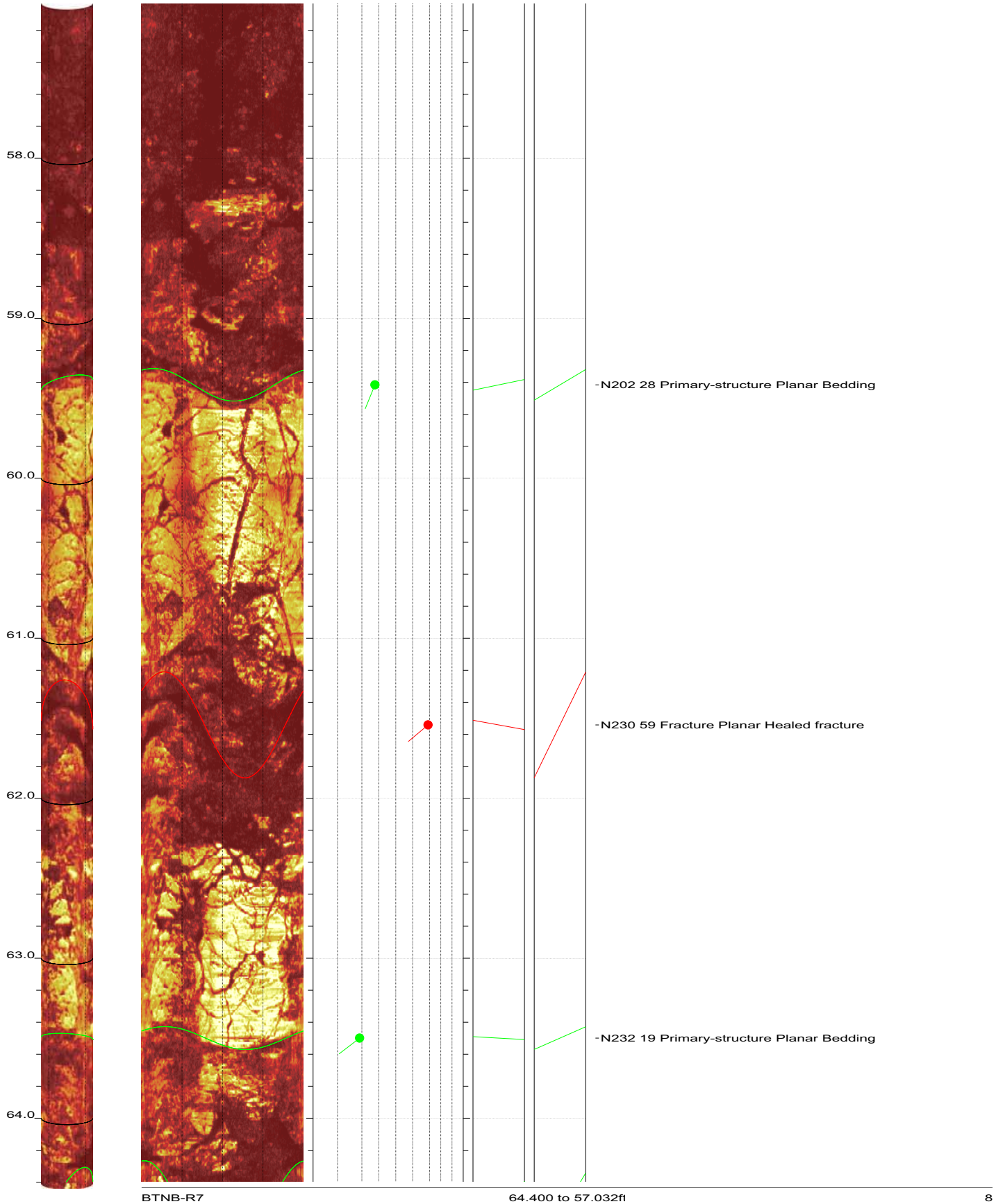
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 5 of 15



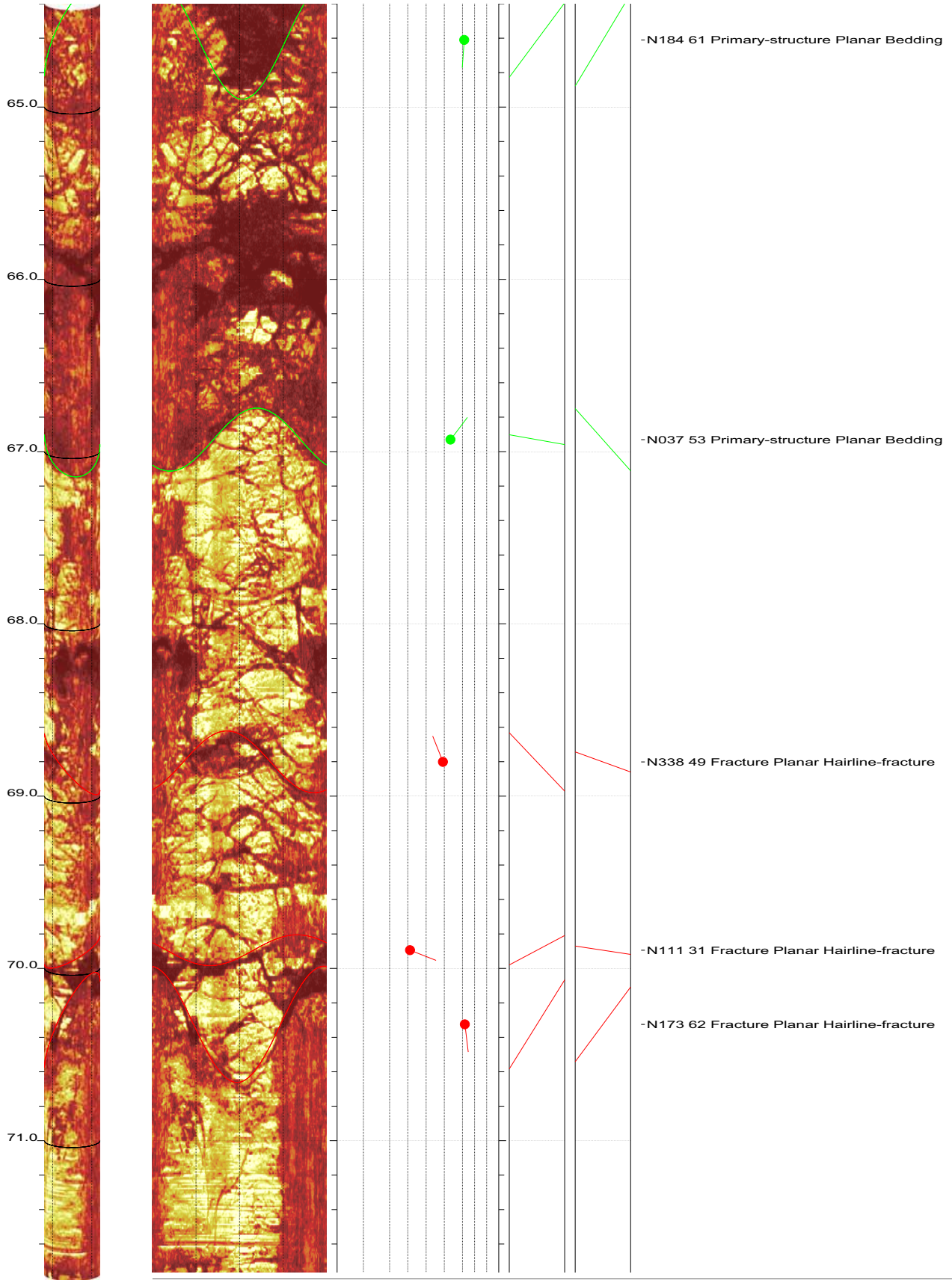
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 6 of 15



Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 7 of 15

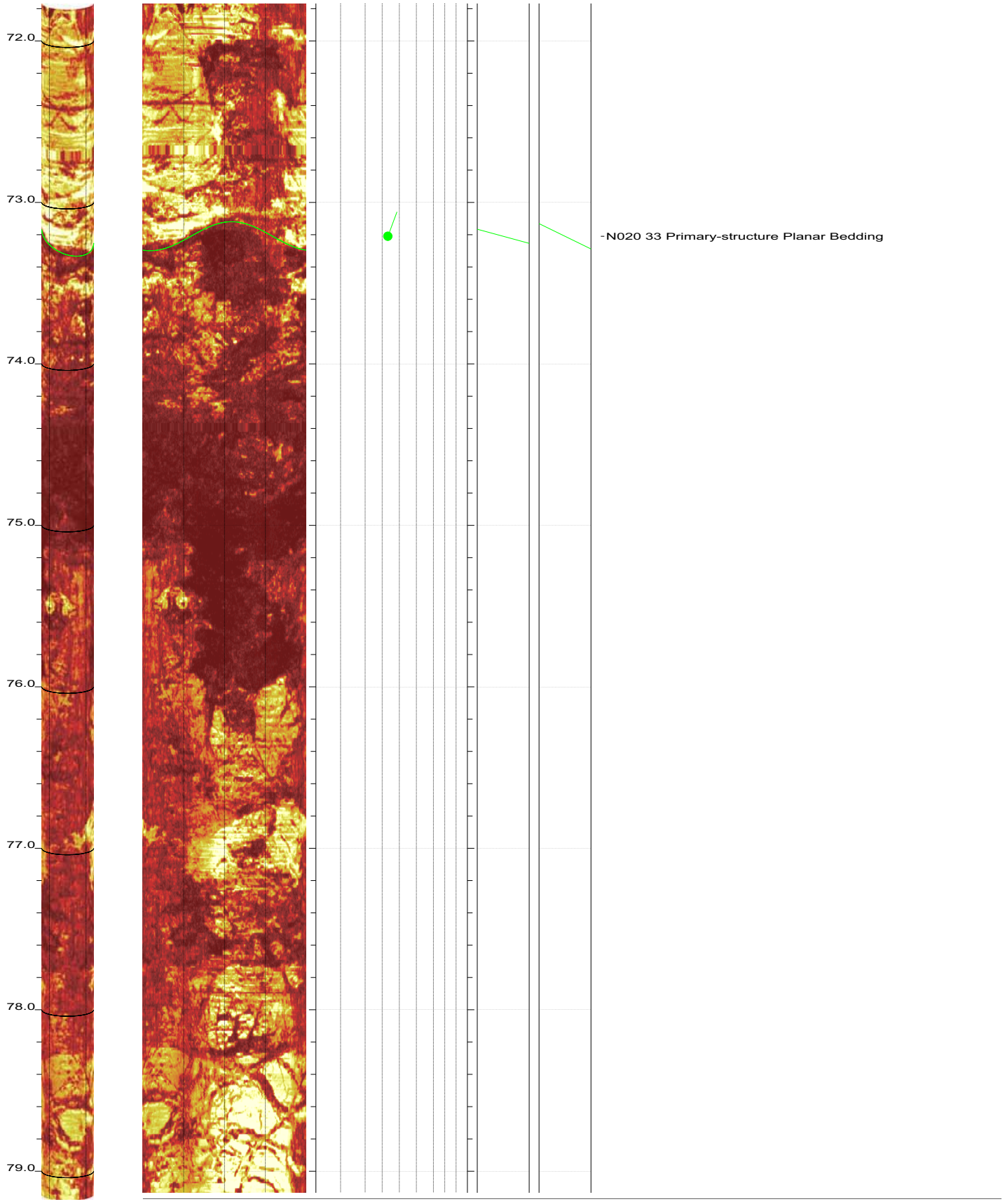


Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 8 of 15

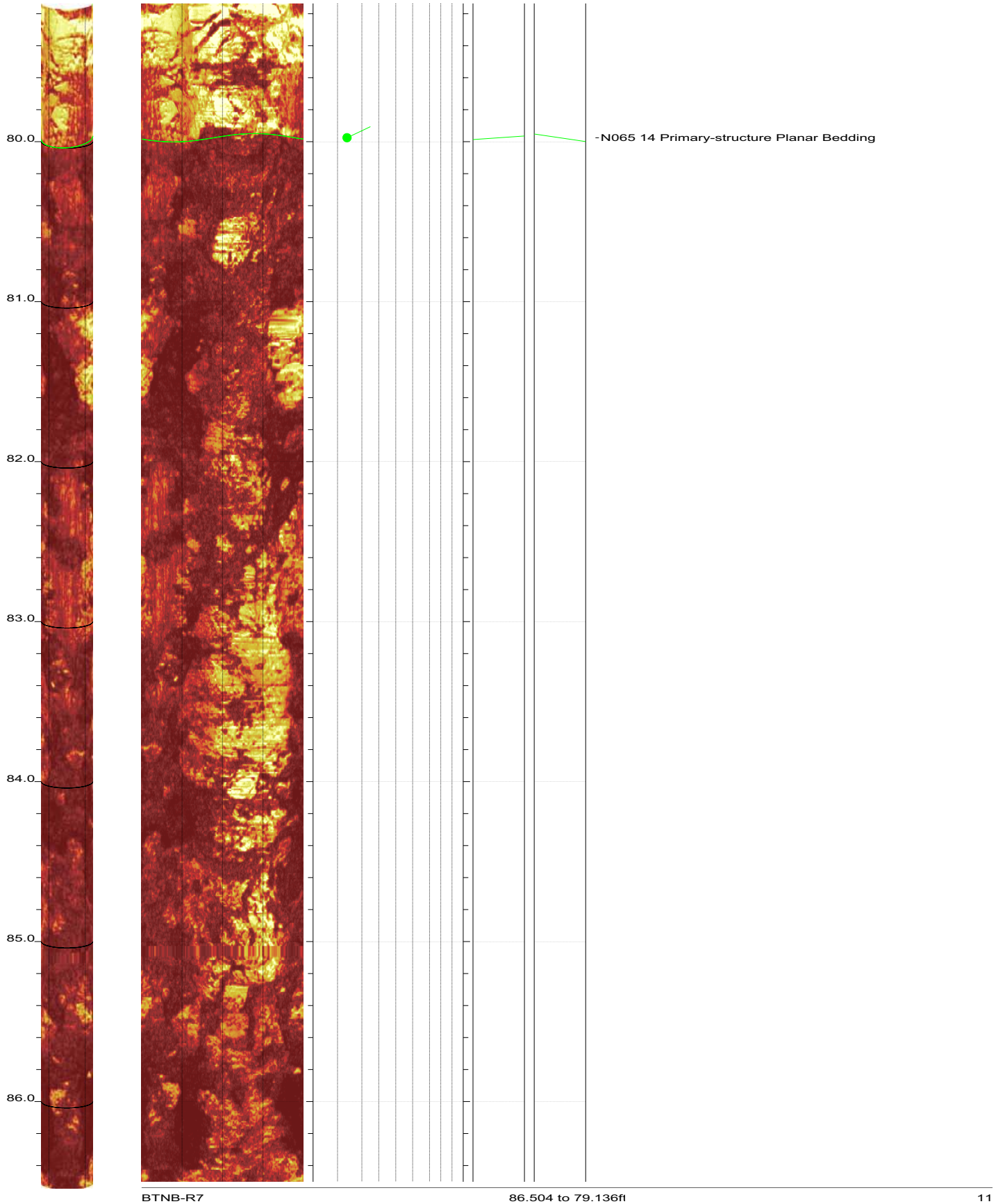


BTNB-R7 71.768 to 64.400ft 9

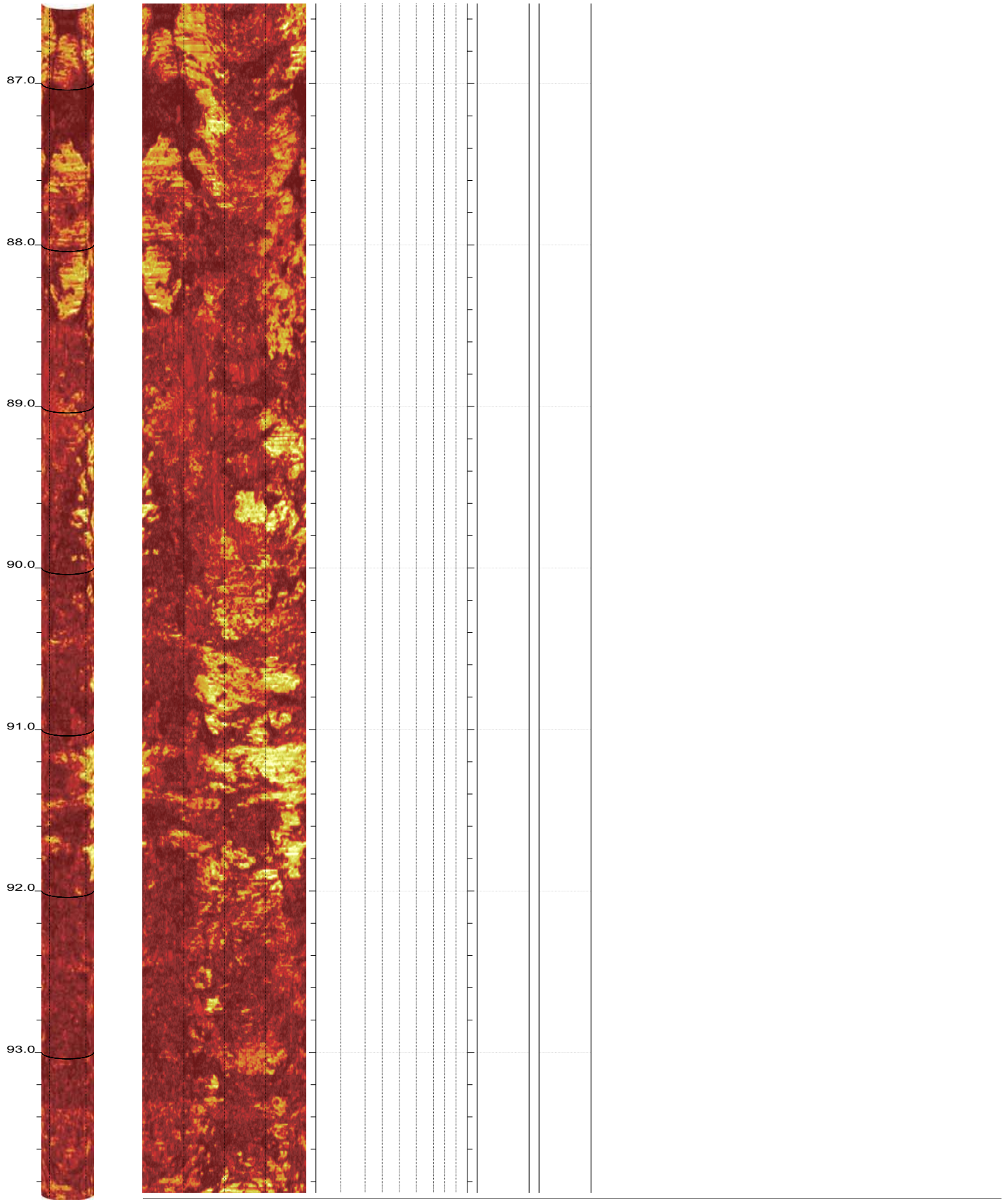
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 9 of 15



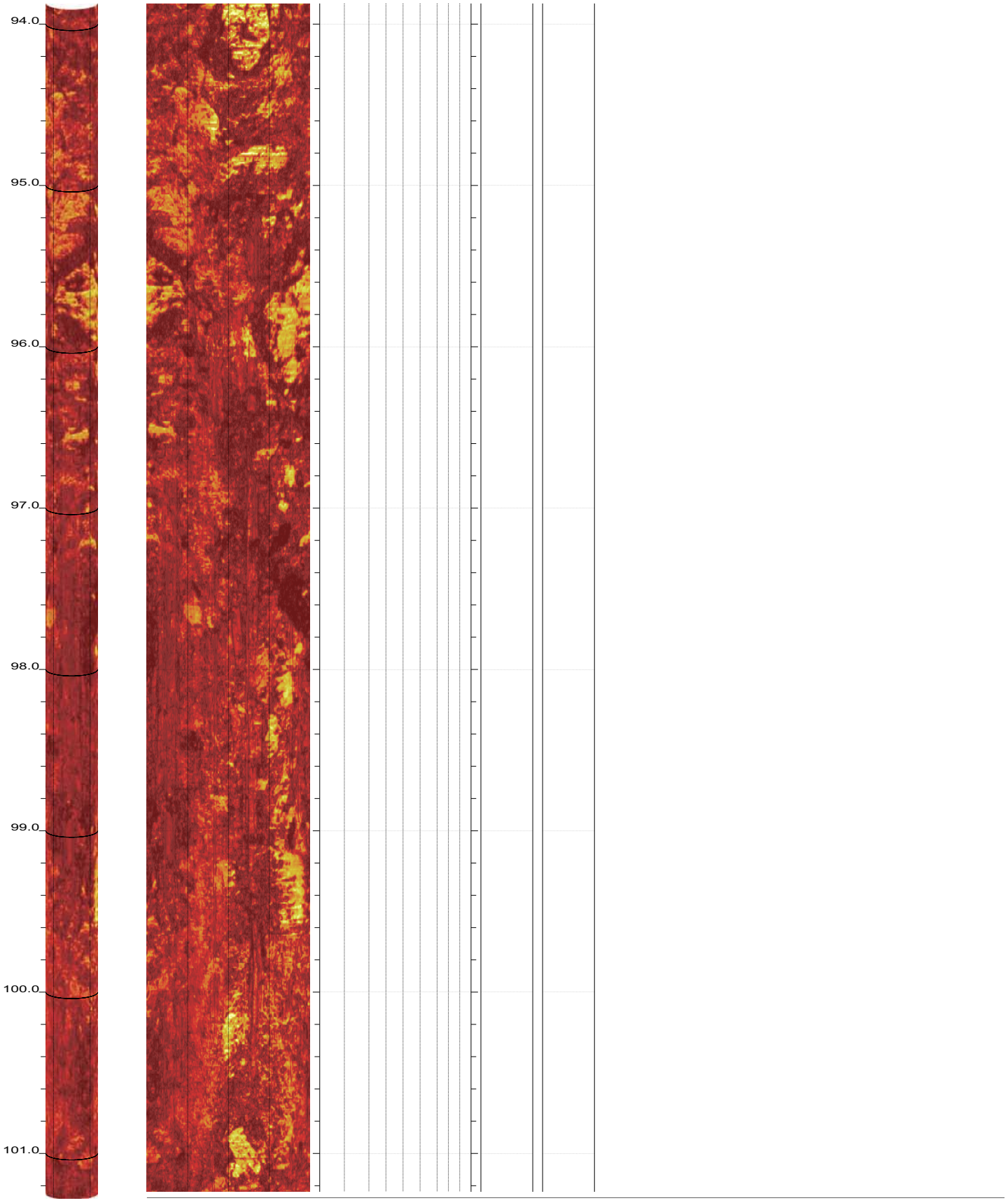
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 10 of 15



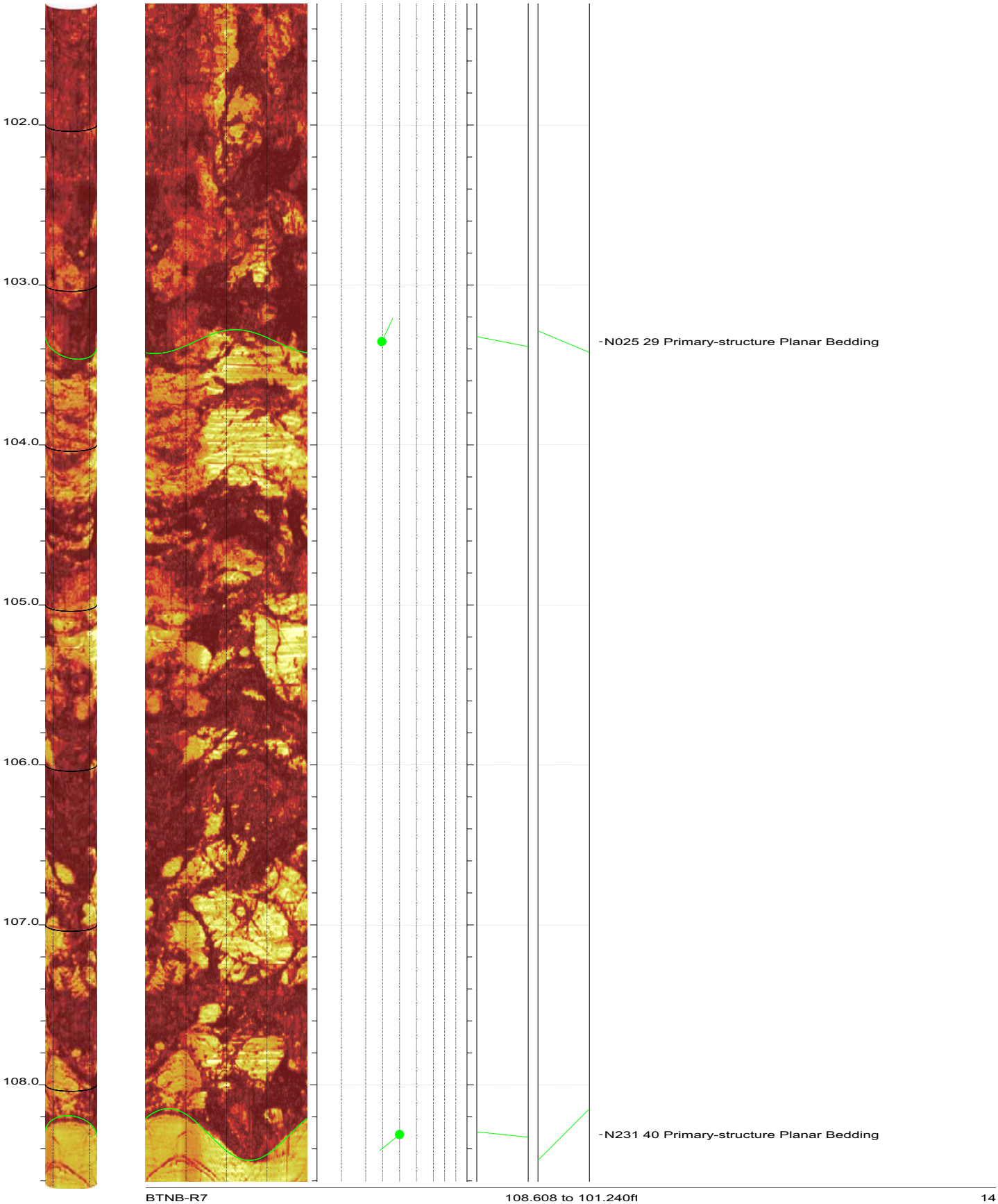
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 11 of 15



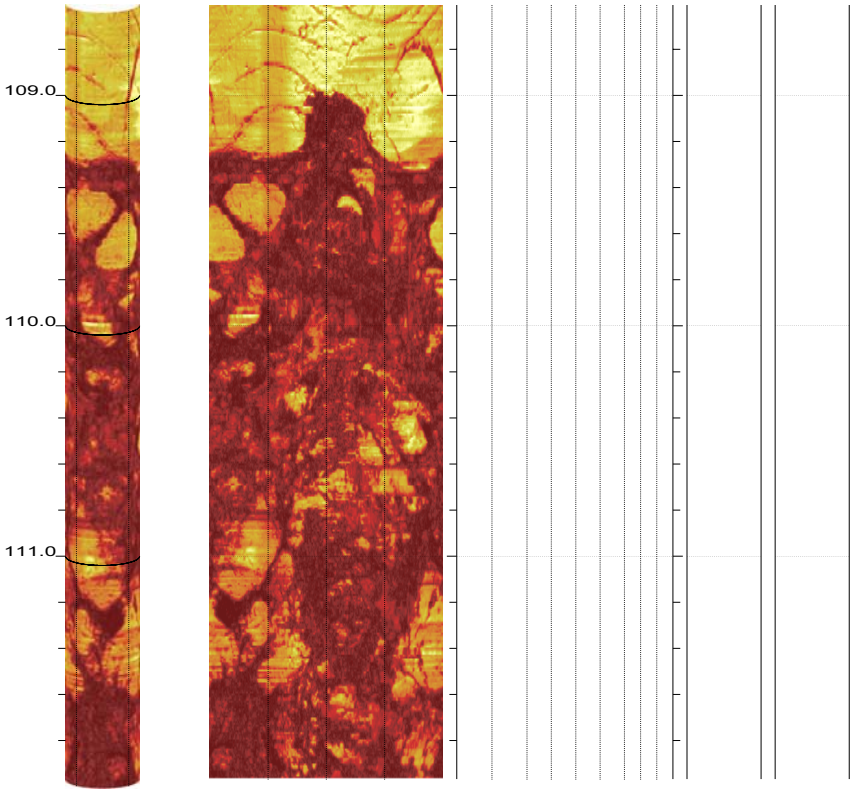
Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 12 of 15



Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 13 of 15



Doyle Drive BTNB-R7 Acoustic Televiewer Dips Sheet 14 of 15


109.0
110.0
111.0

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

14 Jun 2008

ARUP

Borehole: BTSB-R3

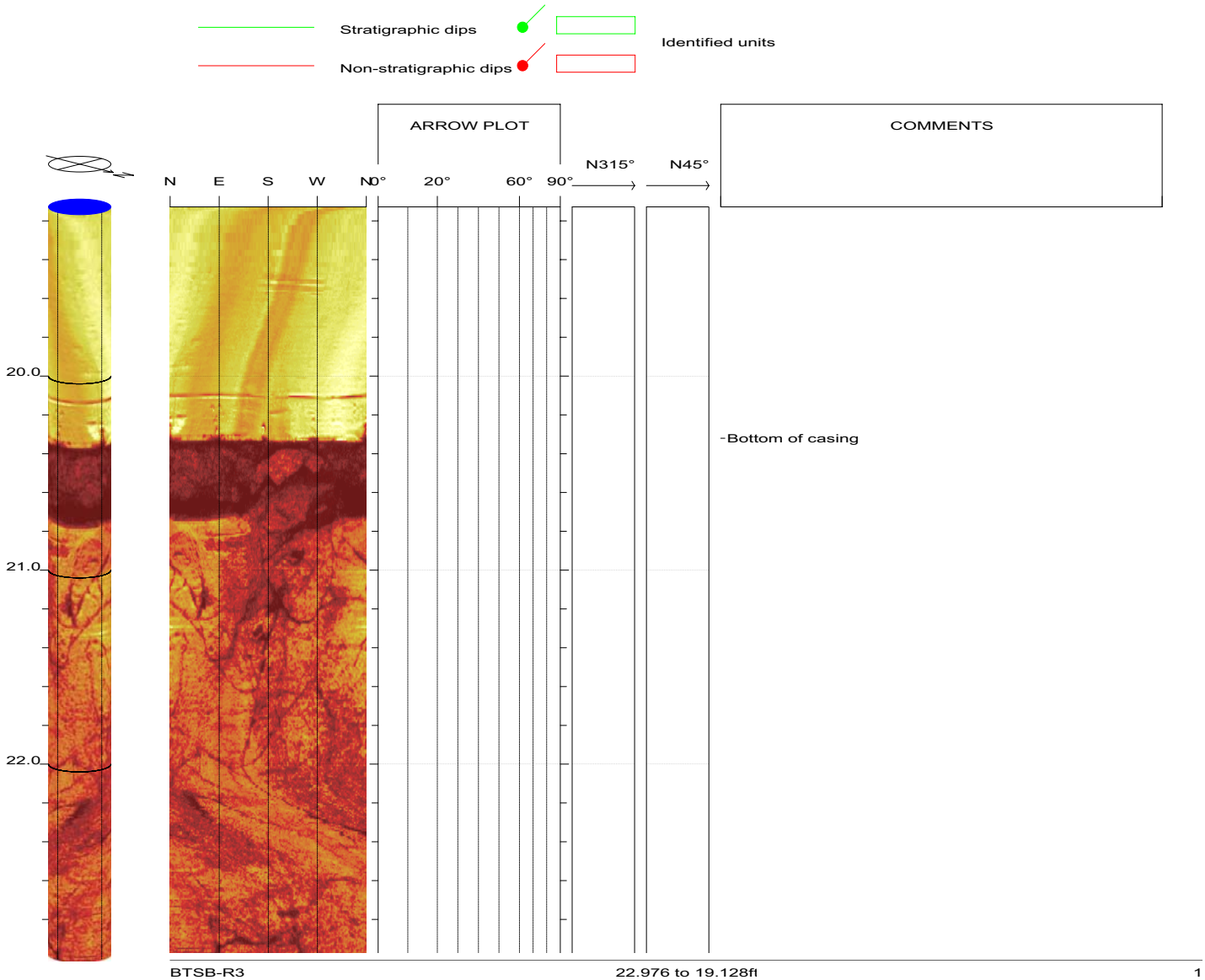
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

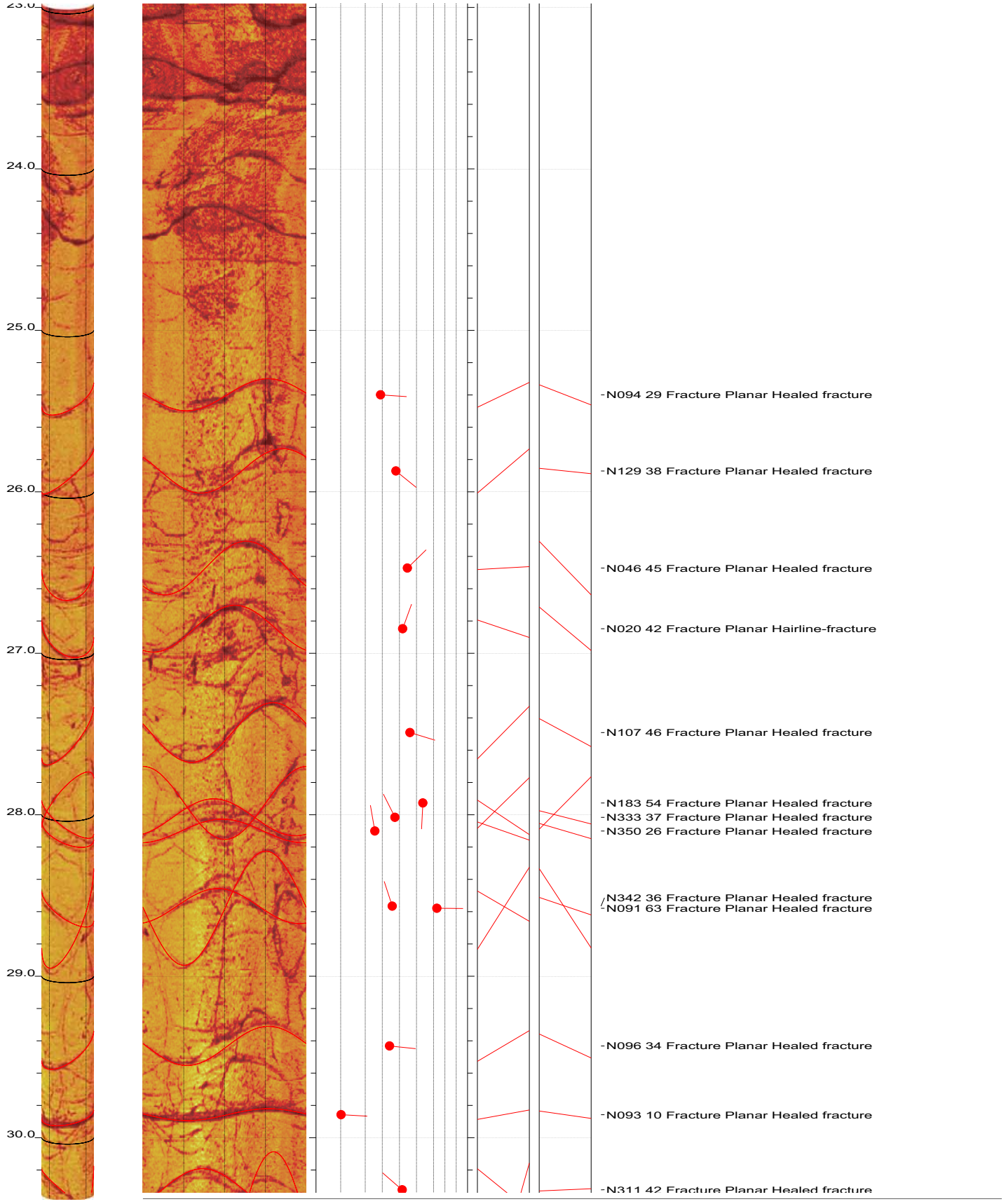
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 108.368 to 19.128ft
Format: BHTV-NESWN

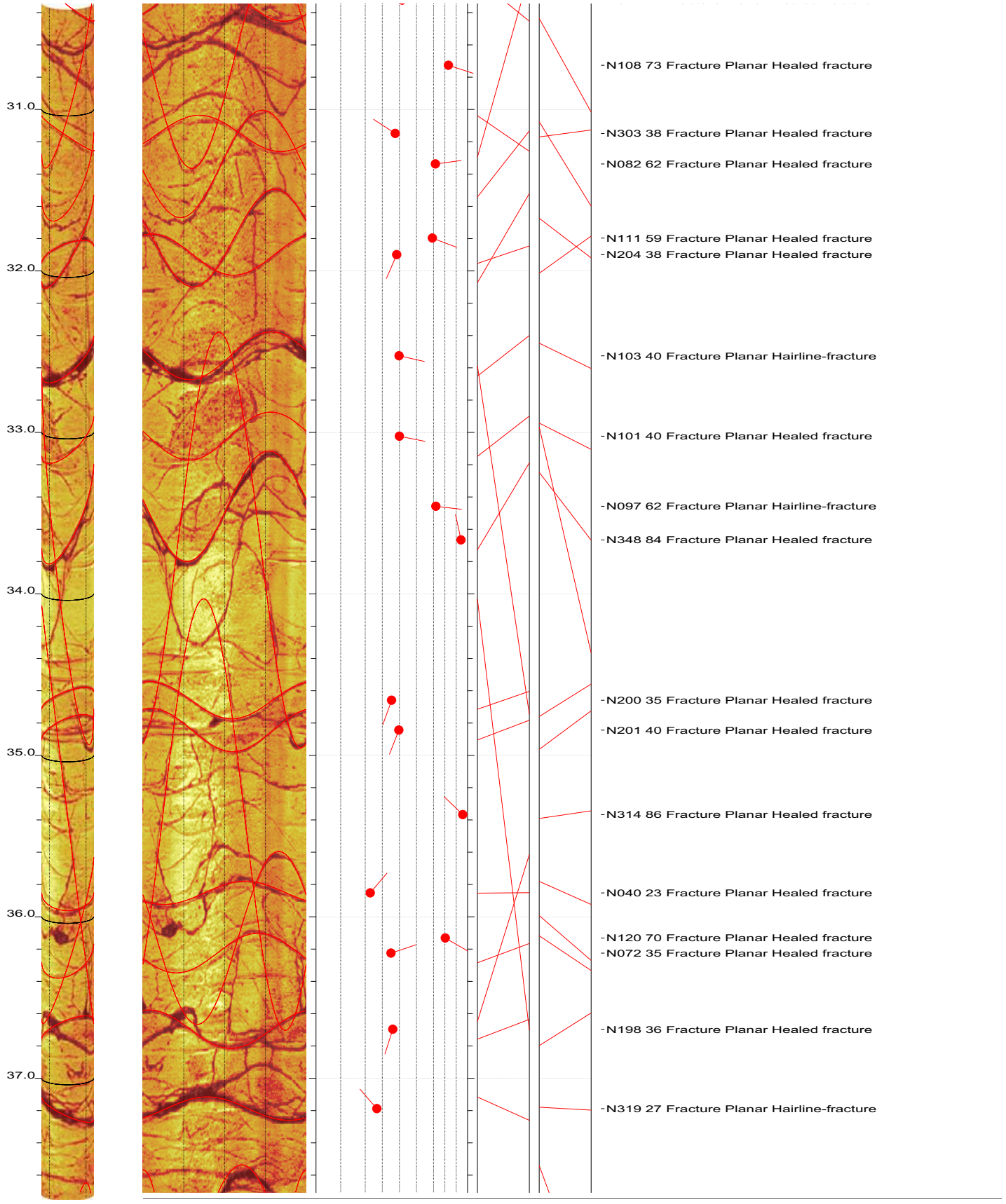
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



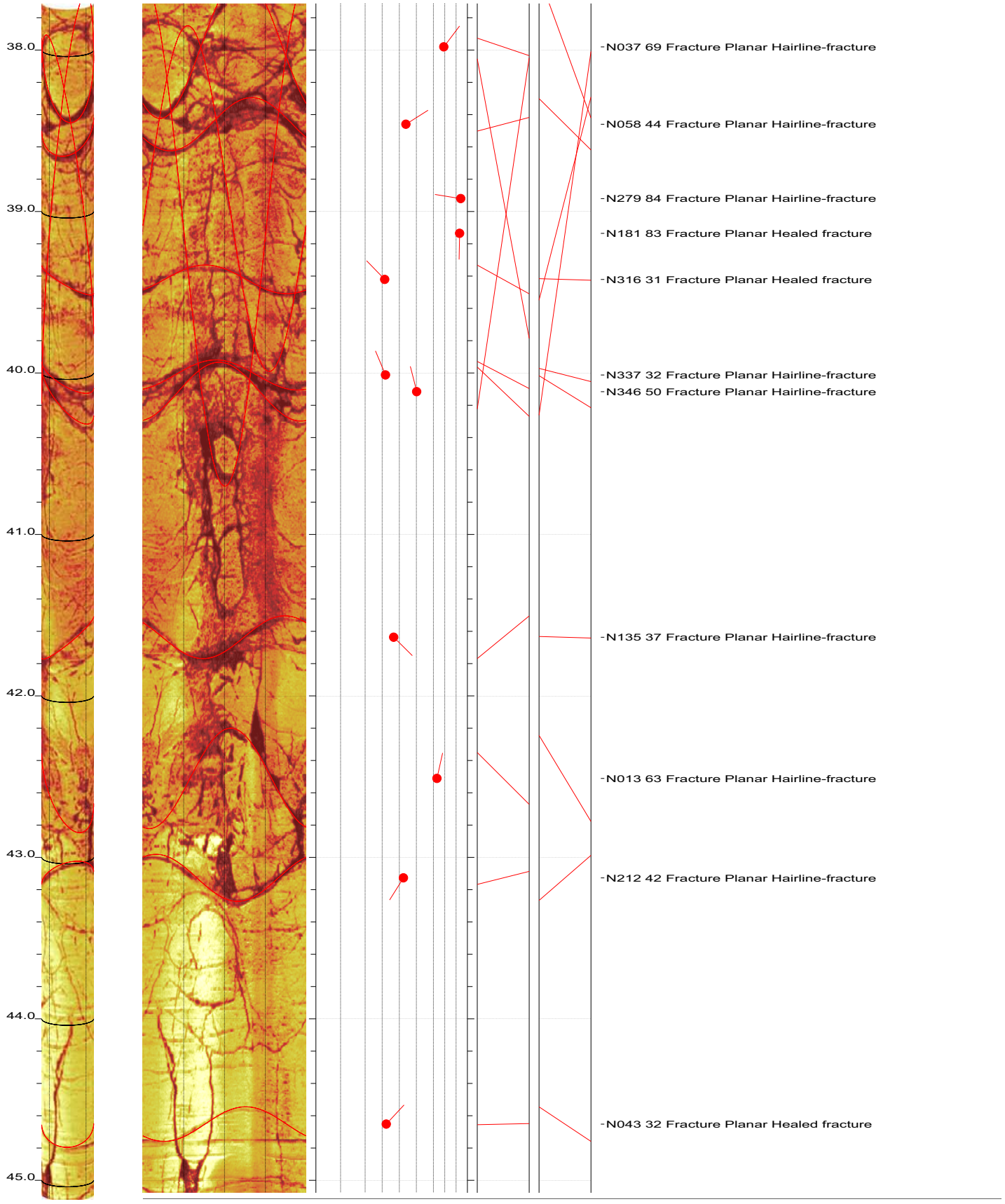
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 1 of 13



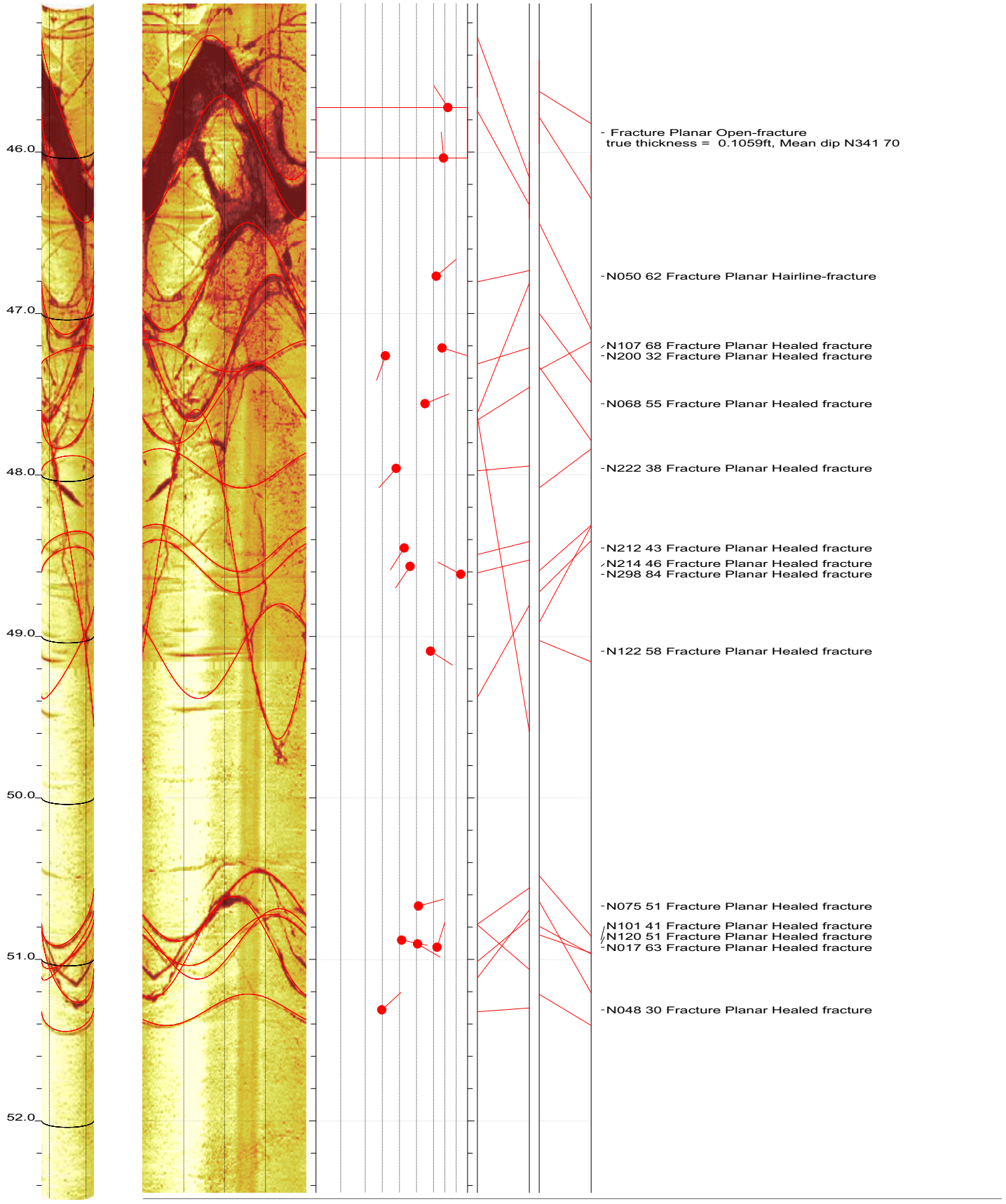
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 2 of 13



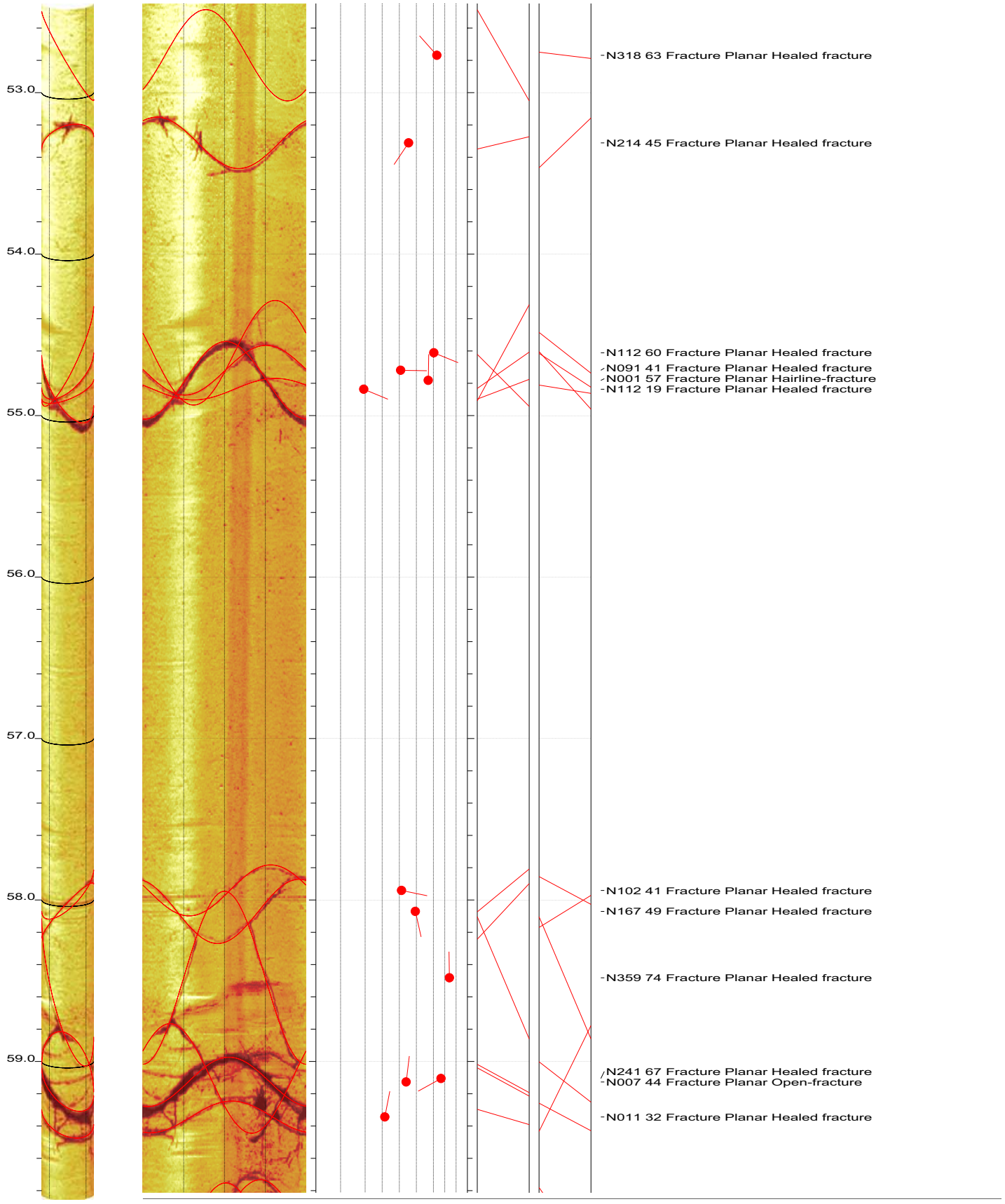
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 3 of 13



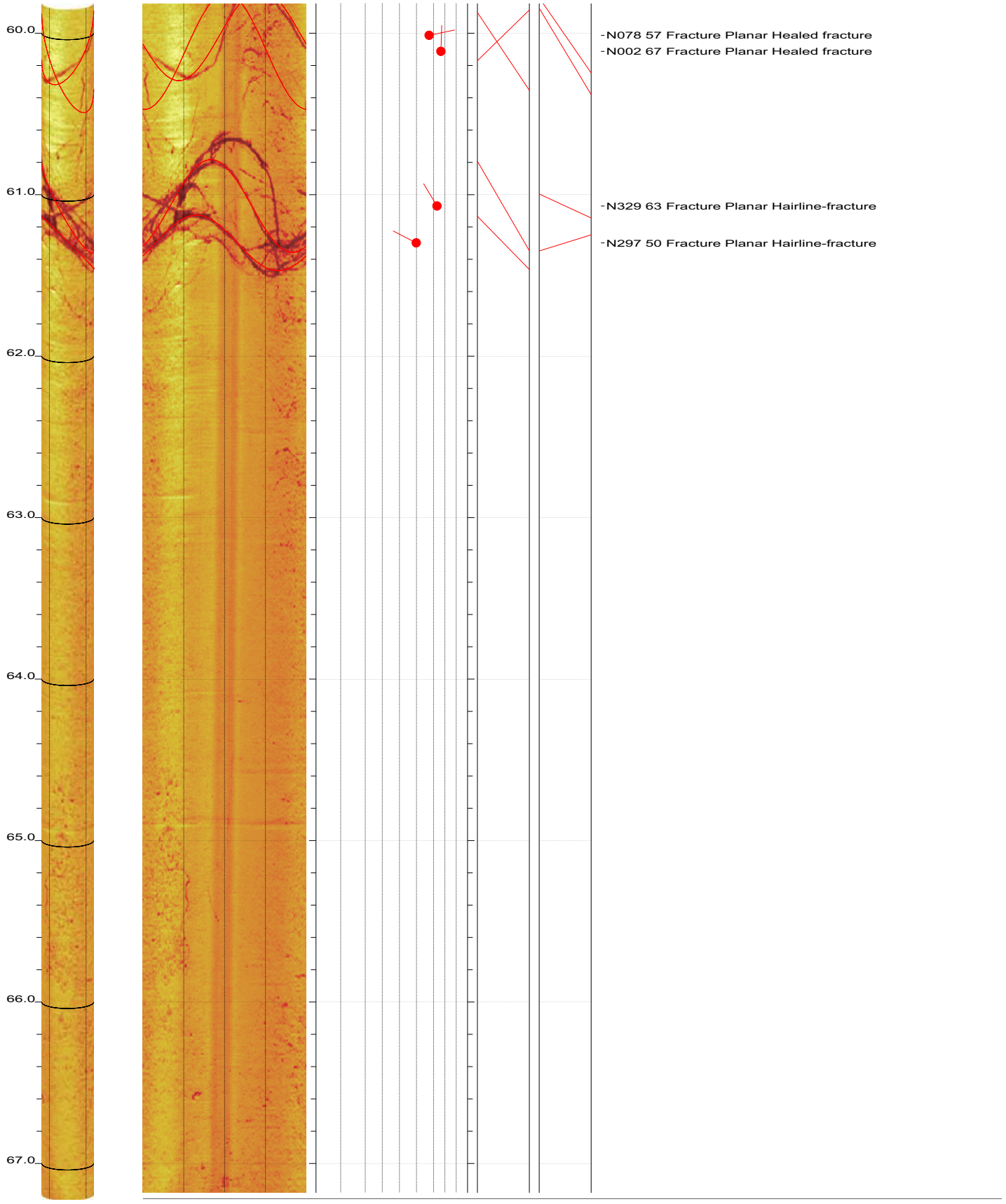
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 4 of 13



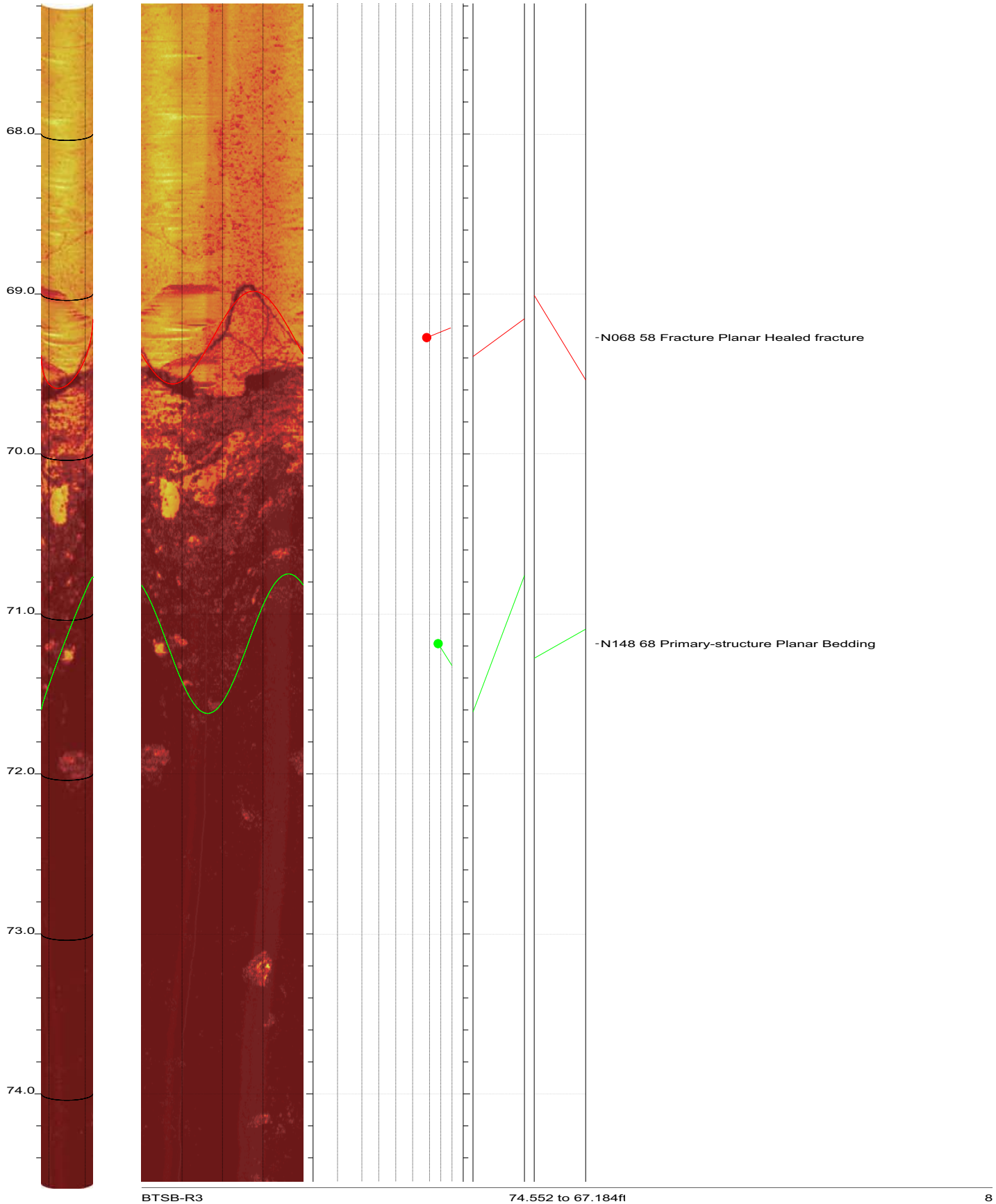
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 5 of 13



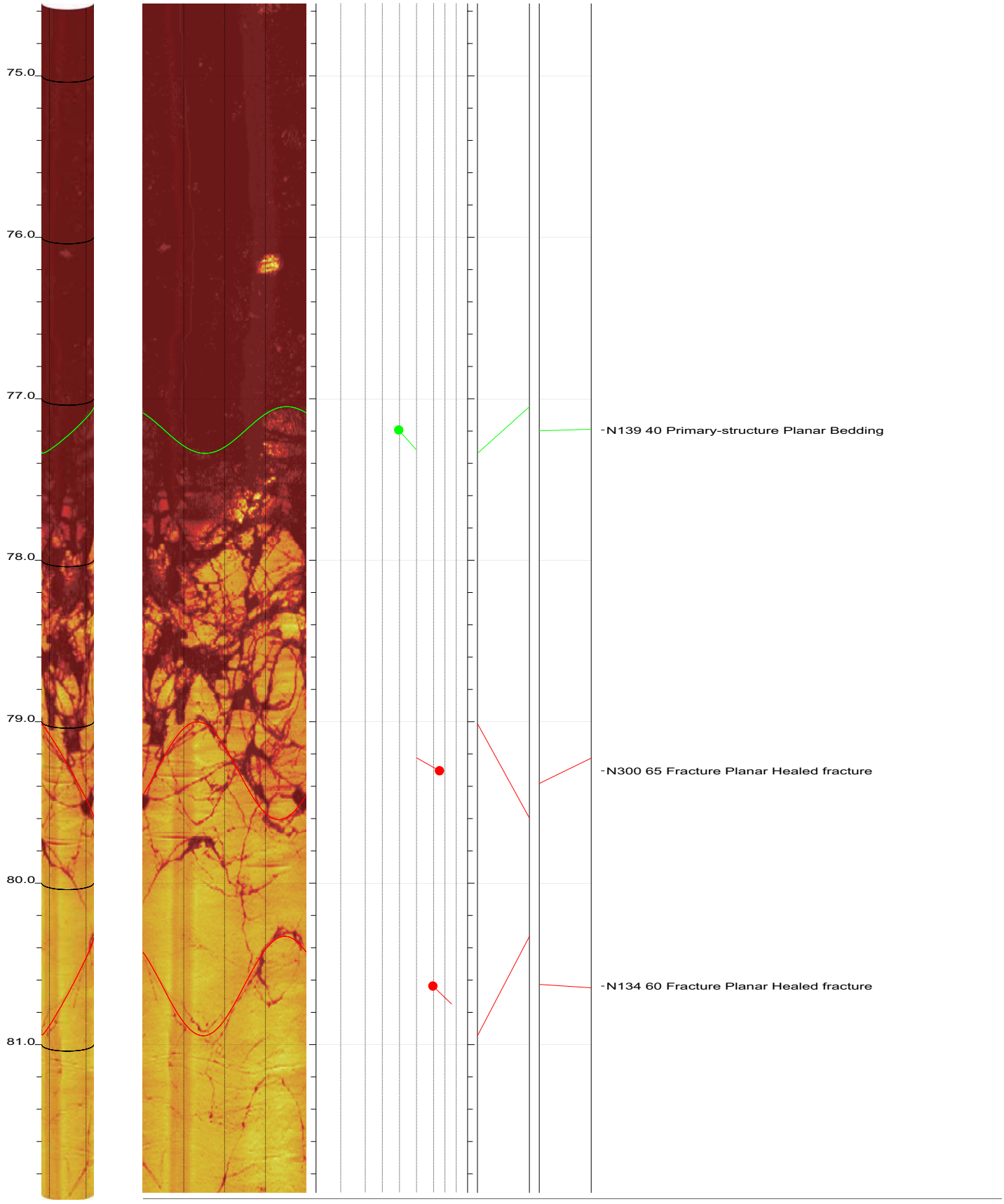
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 6 of 13



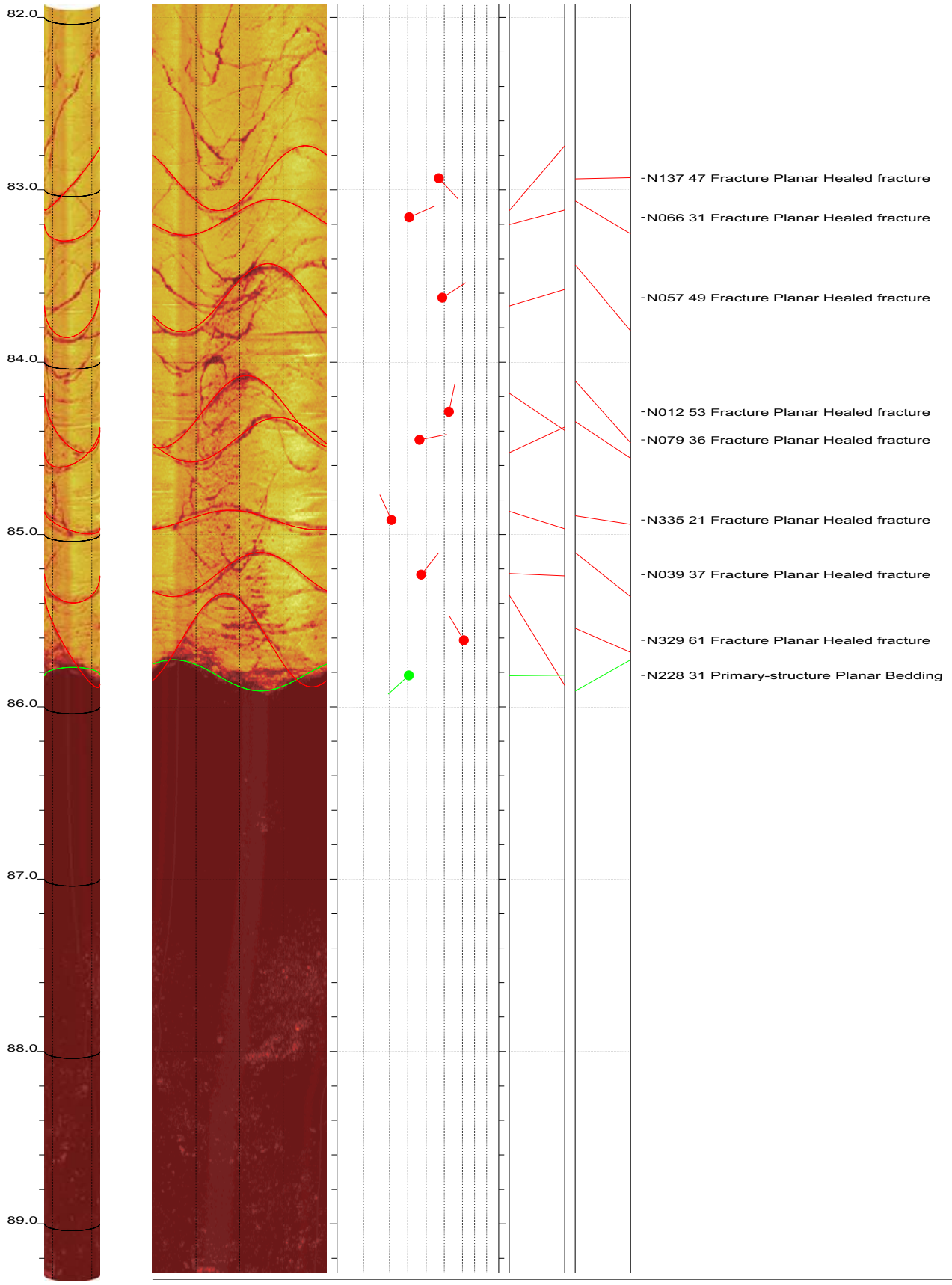
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 7 of 13



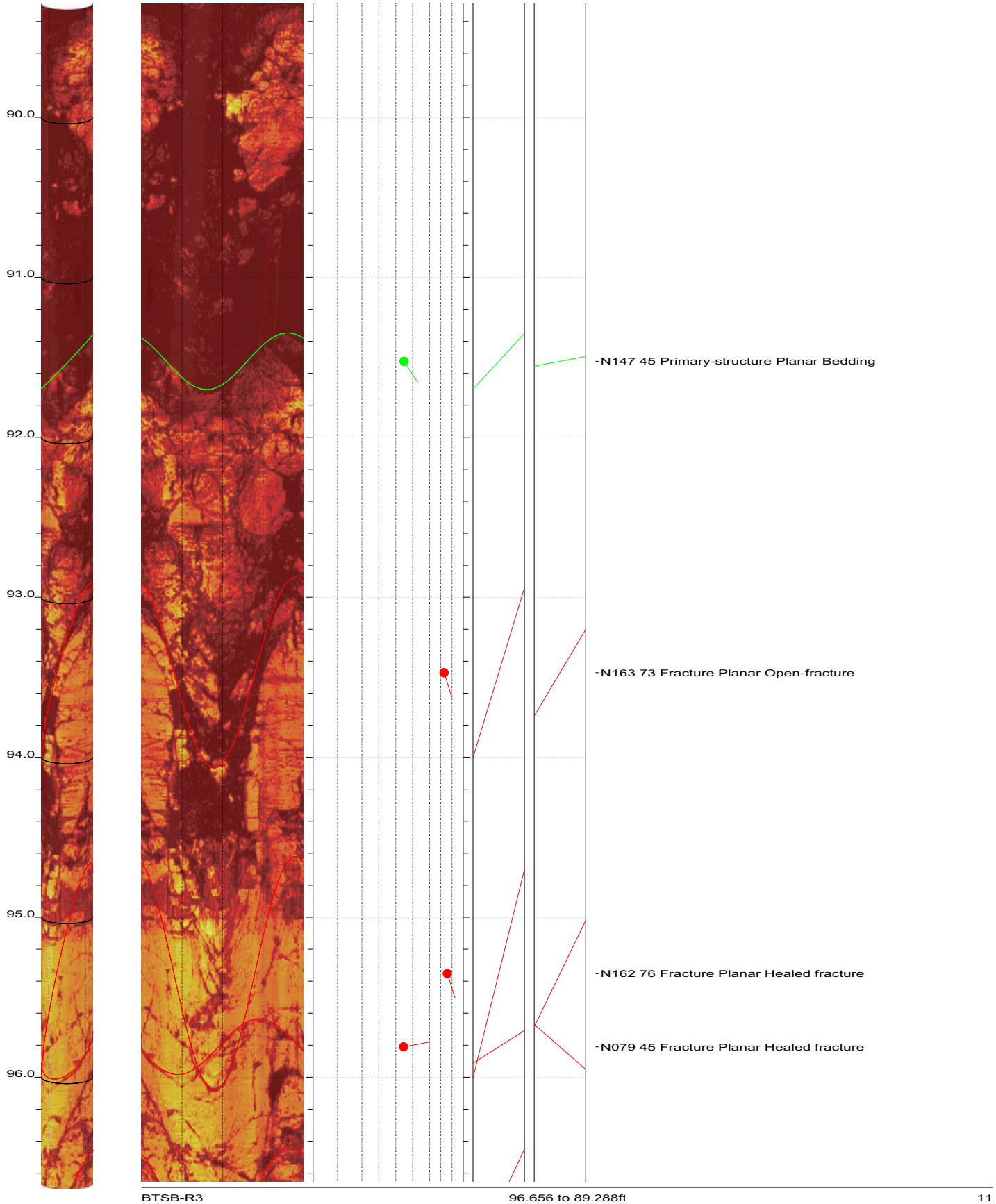
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 8 of 13



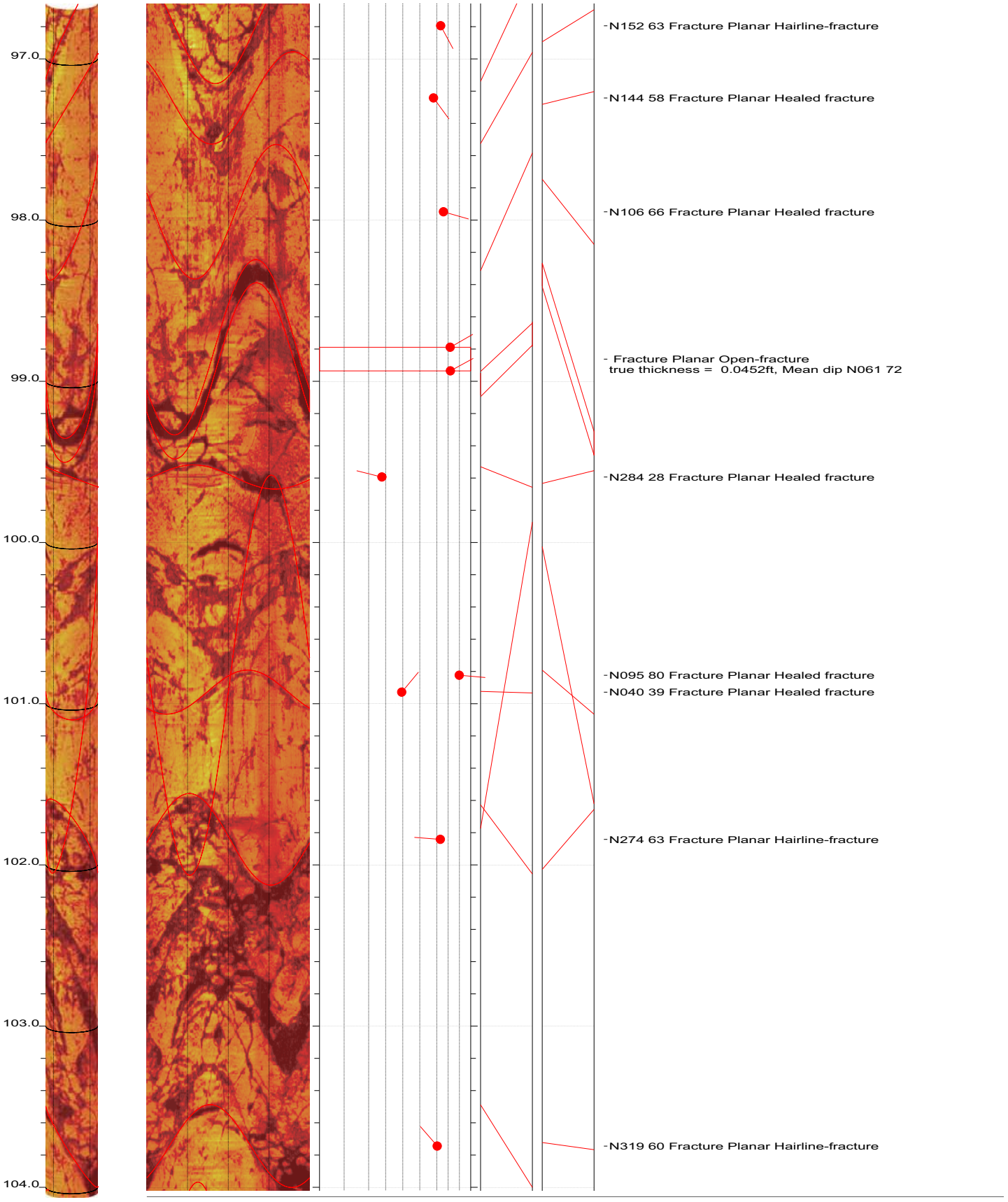
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 9 of 13



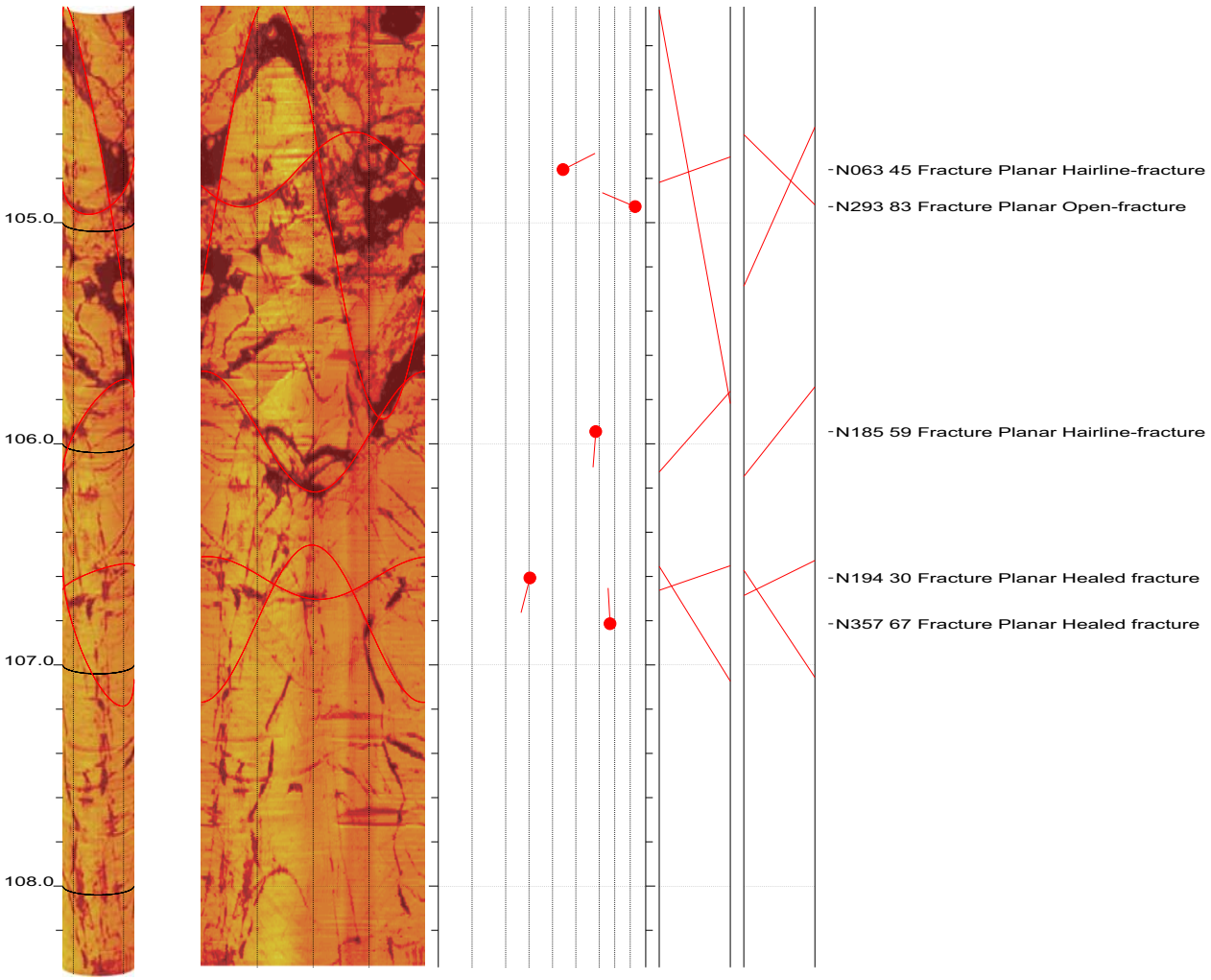
Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 10 of 13



Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 11 of 13



Doyle Drive BTSB-R3 Acoustic Televiewer Dips Sheet 12 of 13


105.0
106.0
107.0
108.0
-N063 45 Fracture Planar Hairline-fracture
-N293 83 Fracture Planar Open-fracture
-N185 59 Fracture Planar Hairline-fracture
-N194 30 Fracture Planar Healed fracture
-N357 67 Fracture Planar Healed fracture

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

15 Jun 2008

ARUP

Borehole: RW6-R1

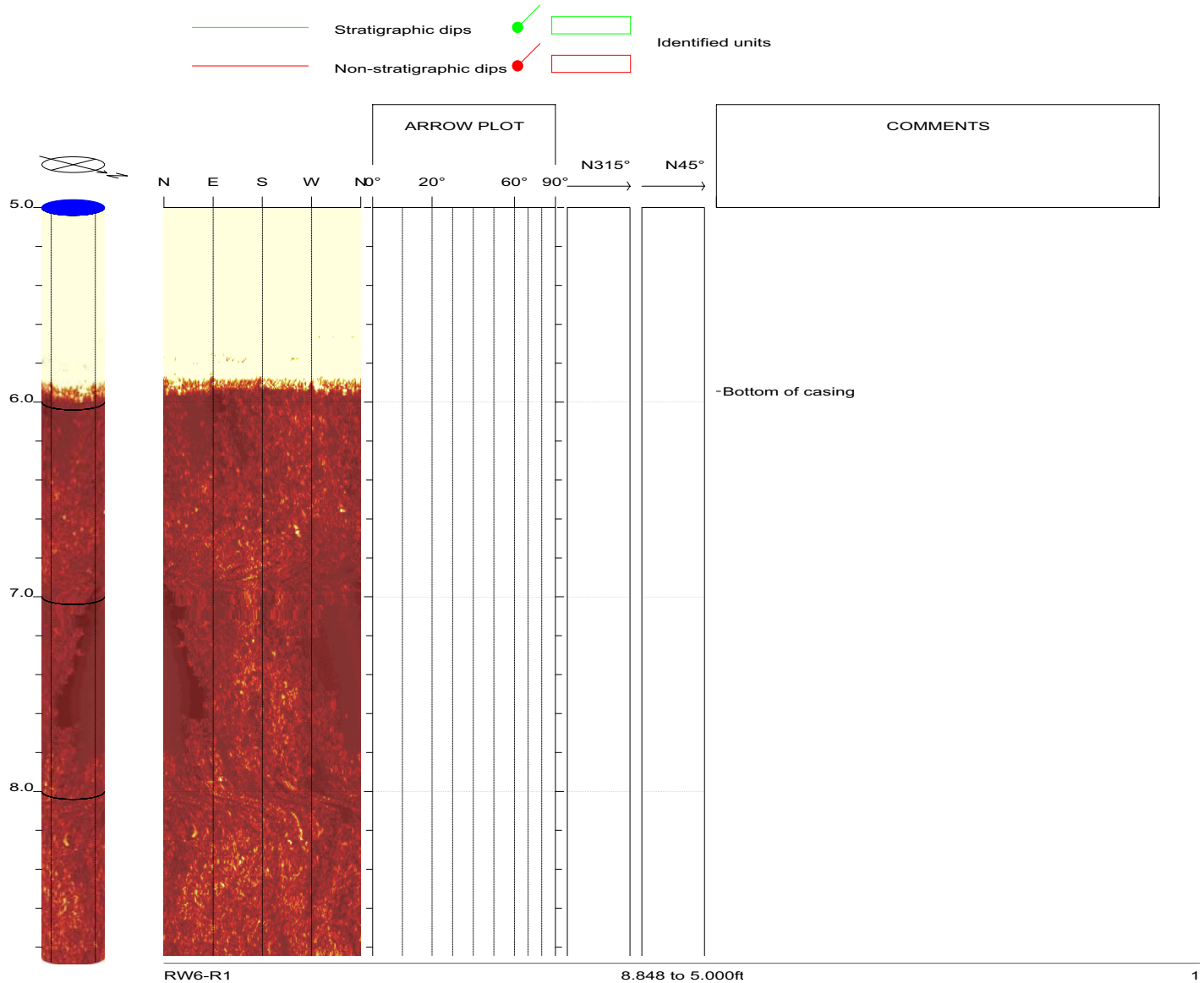
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

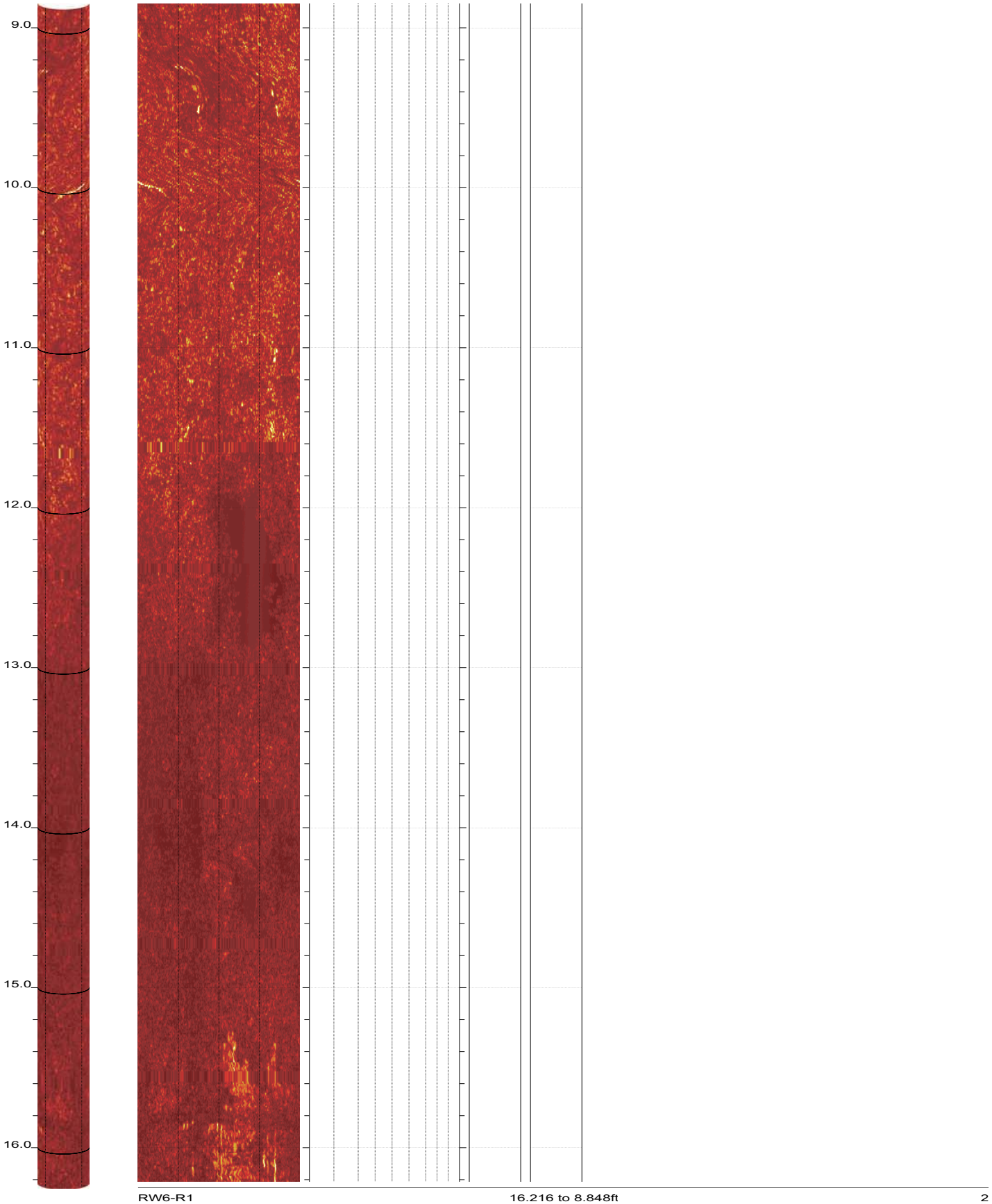
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 57.216 to 5.000ft
Format: BHTV-NESWN

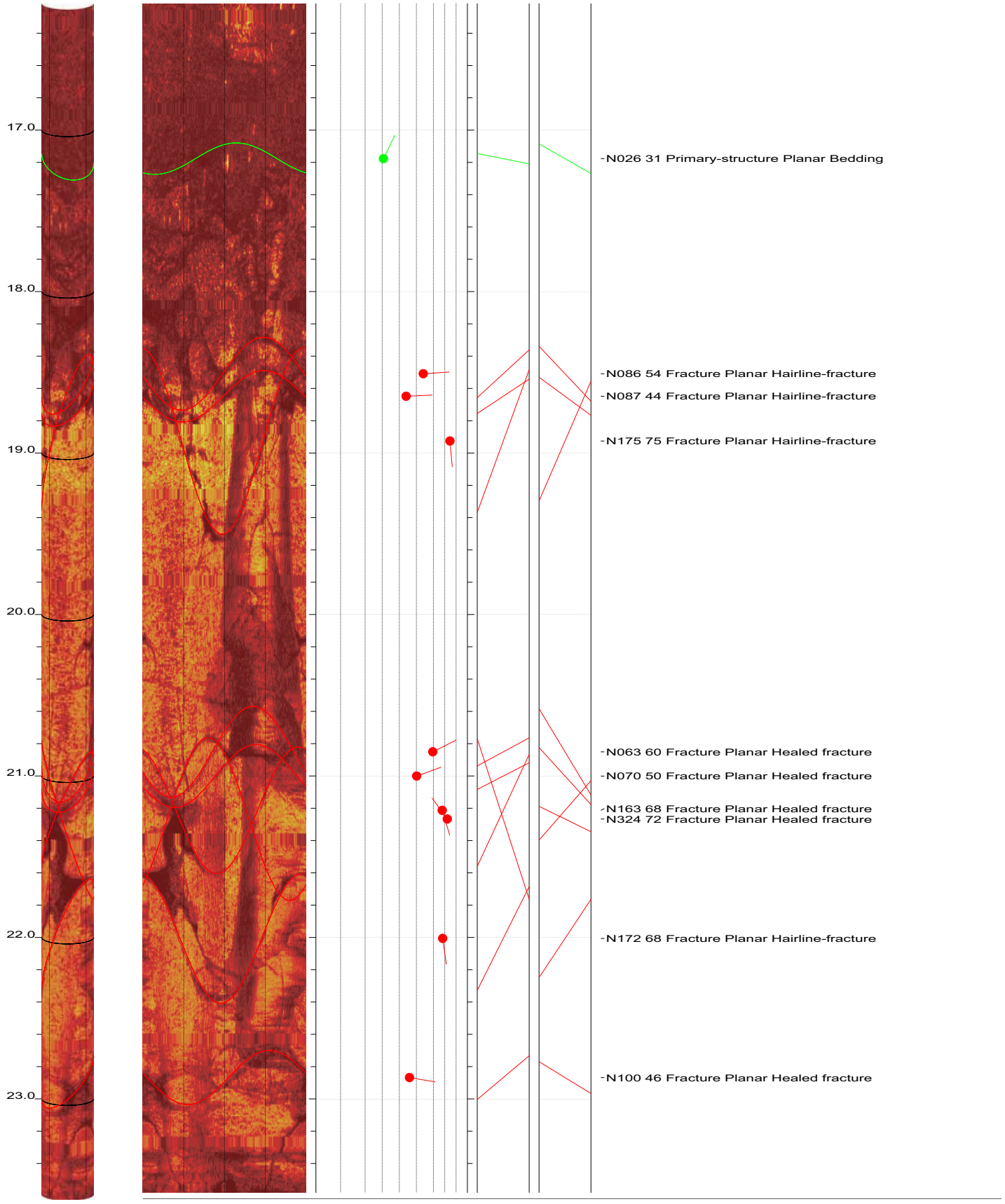
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



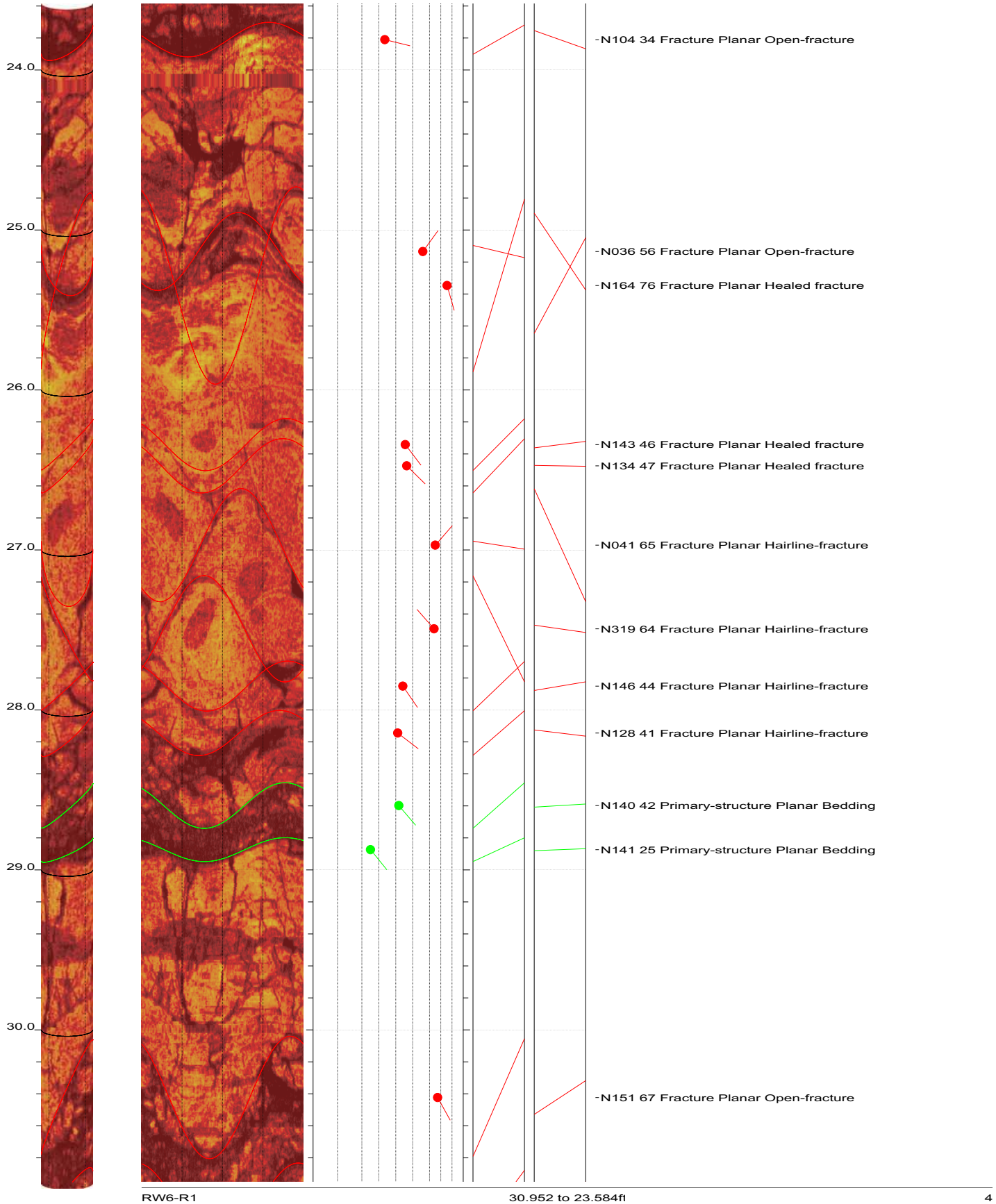
Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 1 of 8



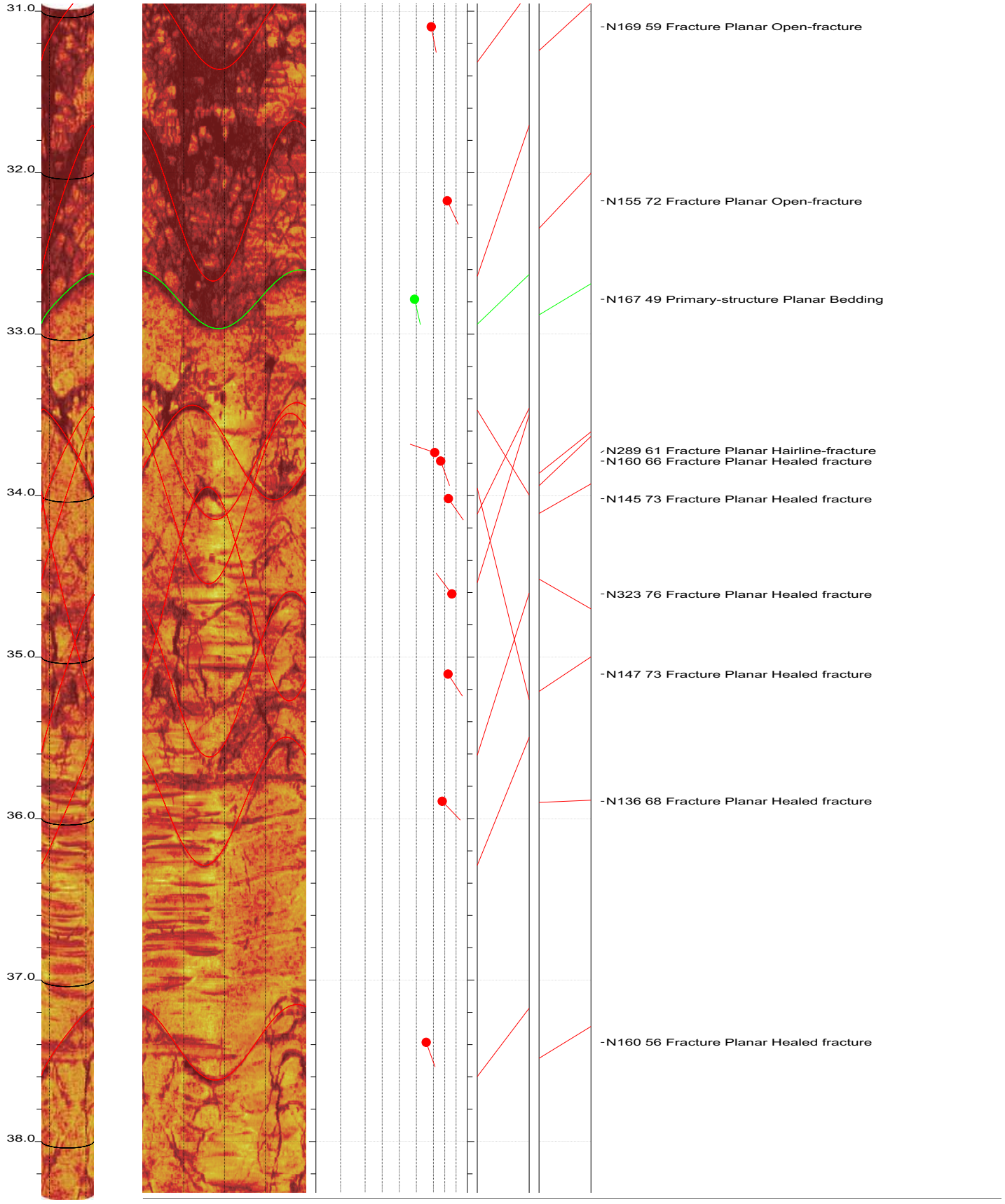
Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 2 of 8



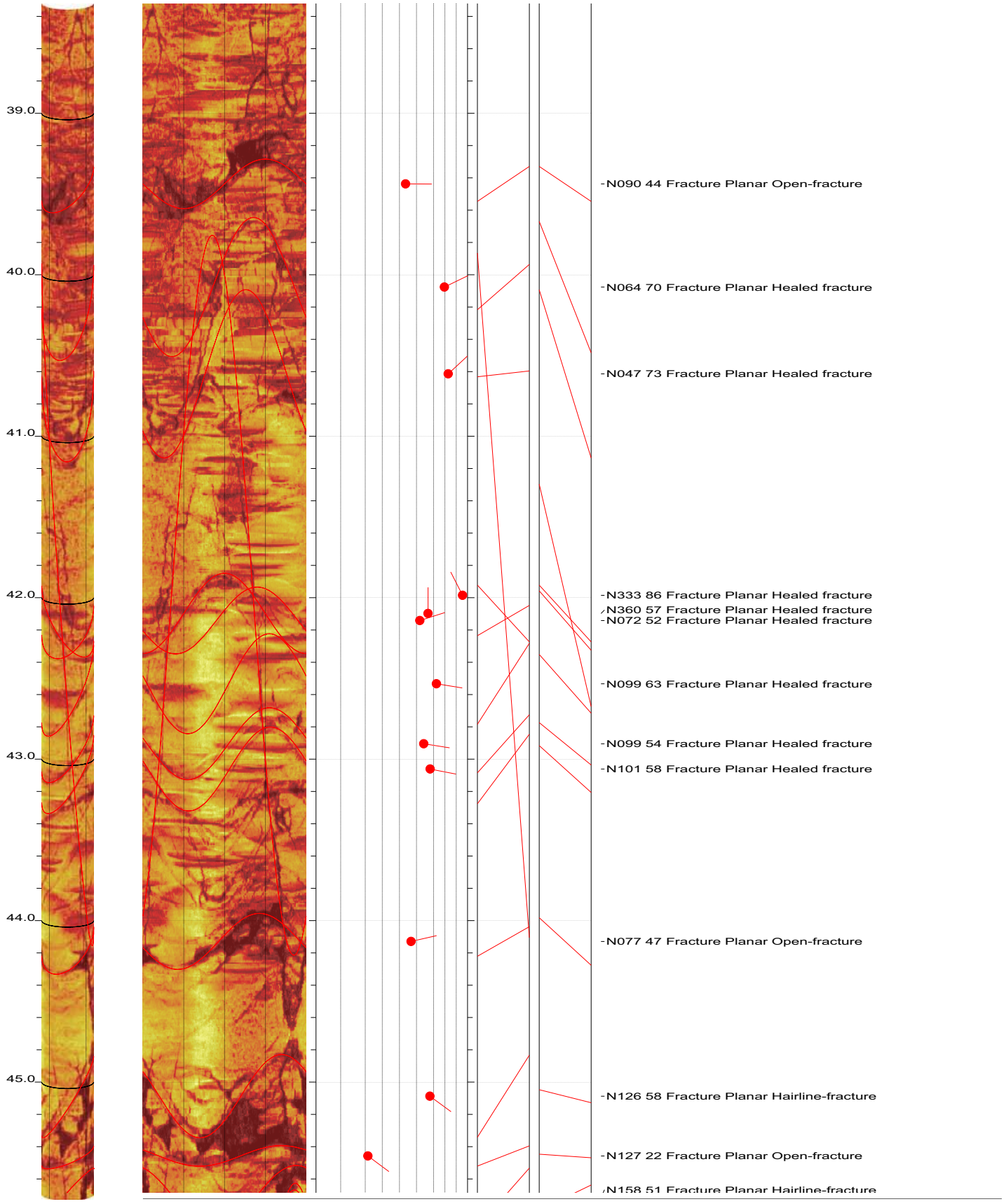
Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 3 of 8



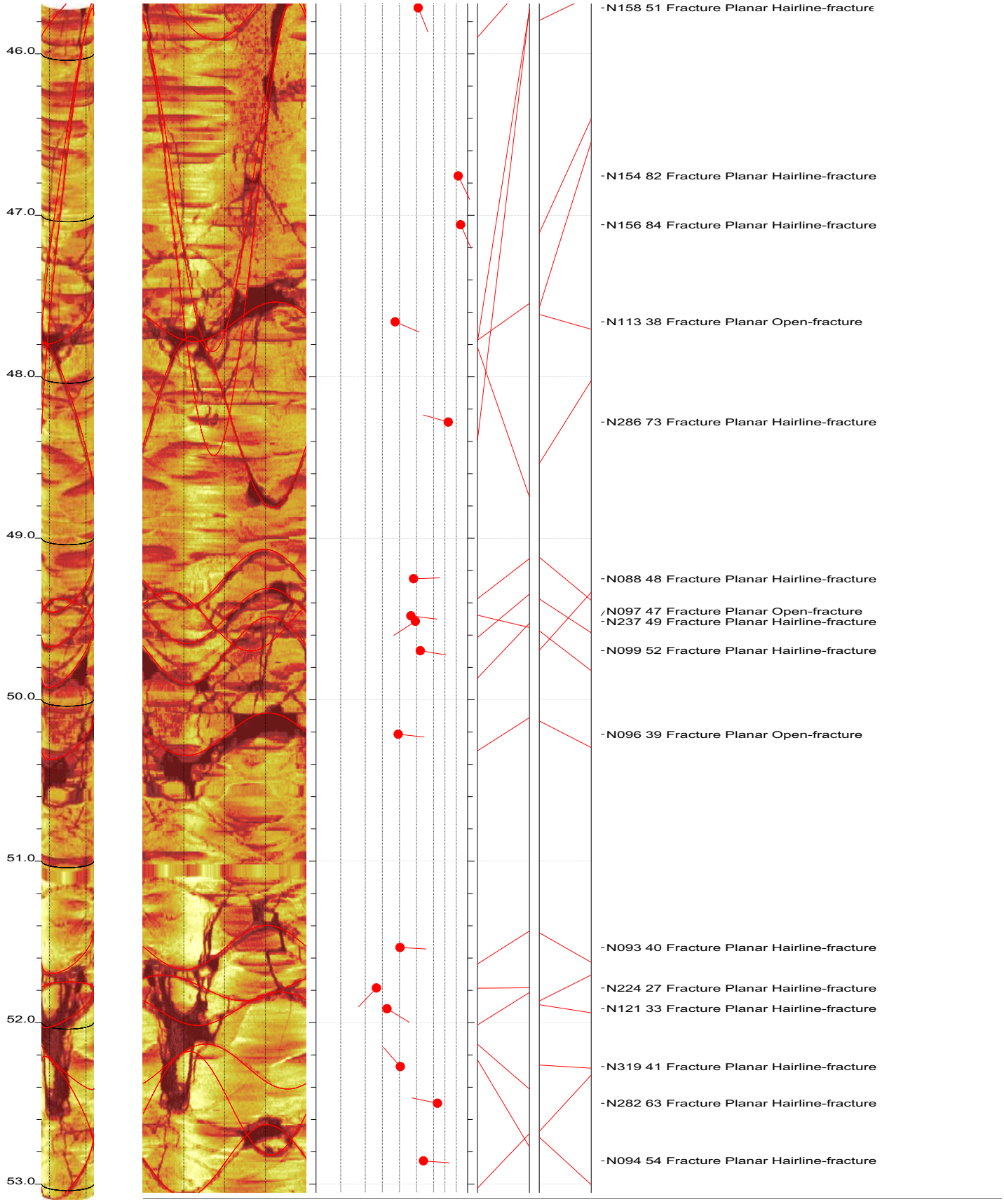
Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 4 of 8



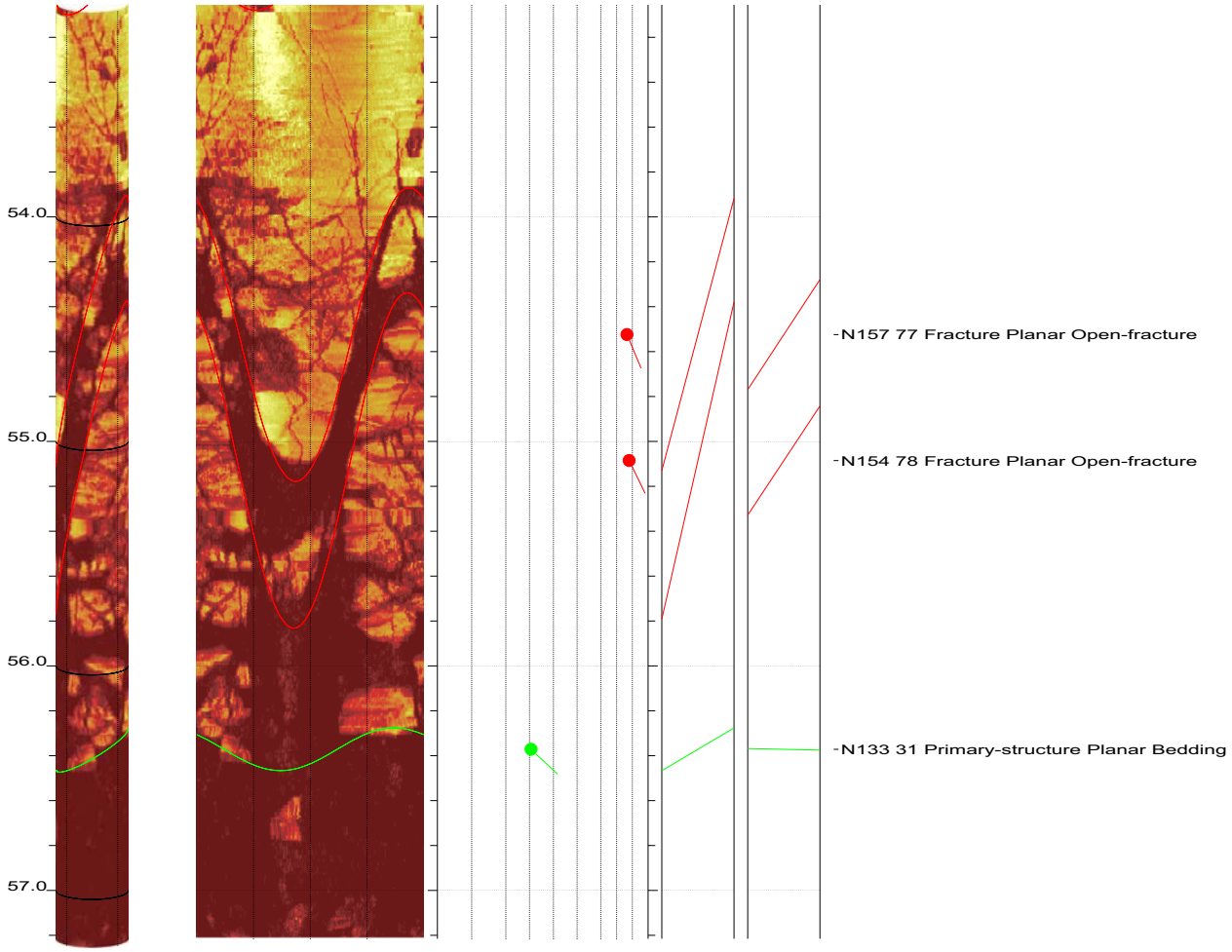
Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 5 of 8



Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 6 of 8



Doyle Drive RW6-R1 Acoustic Televiewer Dips Sheet 7 of 8


54.0
55.0
56.0
57.0
-N157 77 Fracture Planar Open-fracture
-N154 78 Fracture Planar Open-fracture
-N133 31 Primary-structure Planar Bedding

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

16 Jun 2008

ARUP

Borehole: RW6-R2

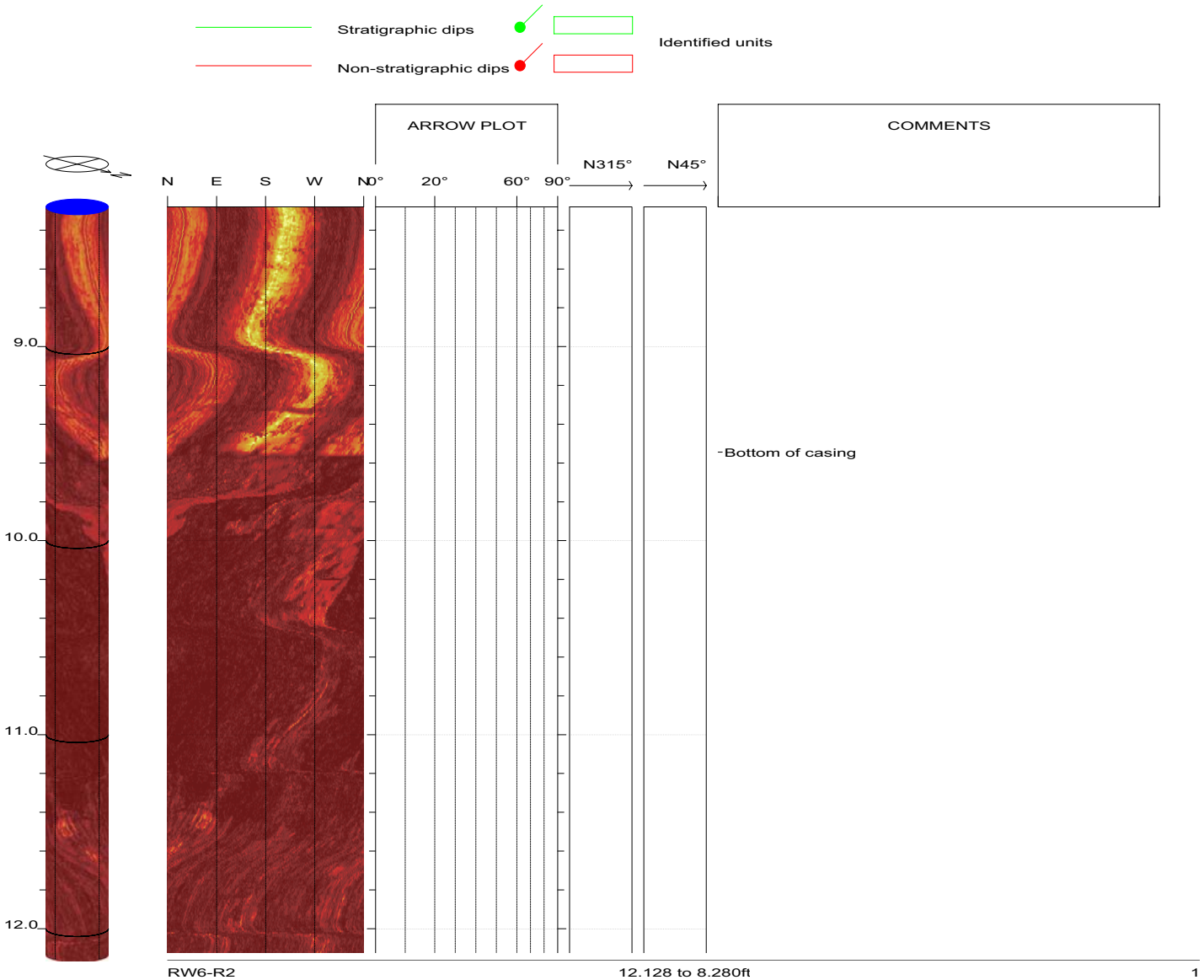
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

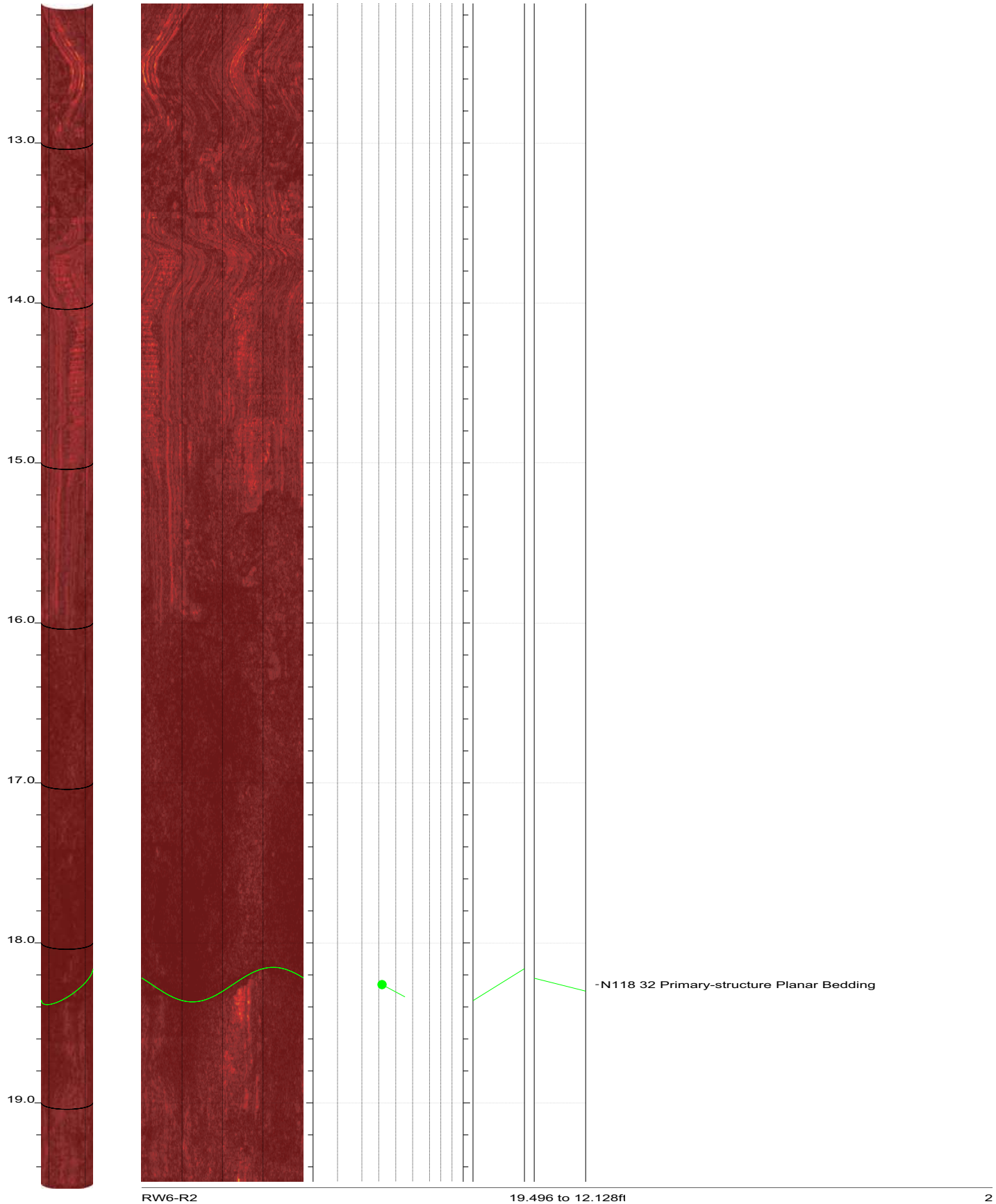
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 112.960 to 8.280ft
Format: BHTV-NESWN

Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude

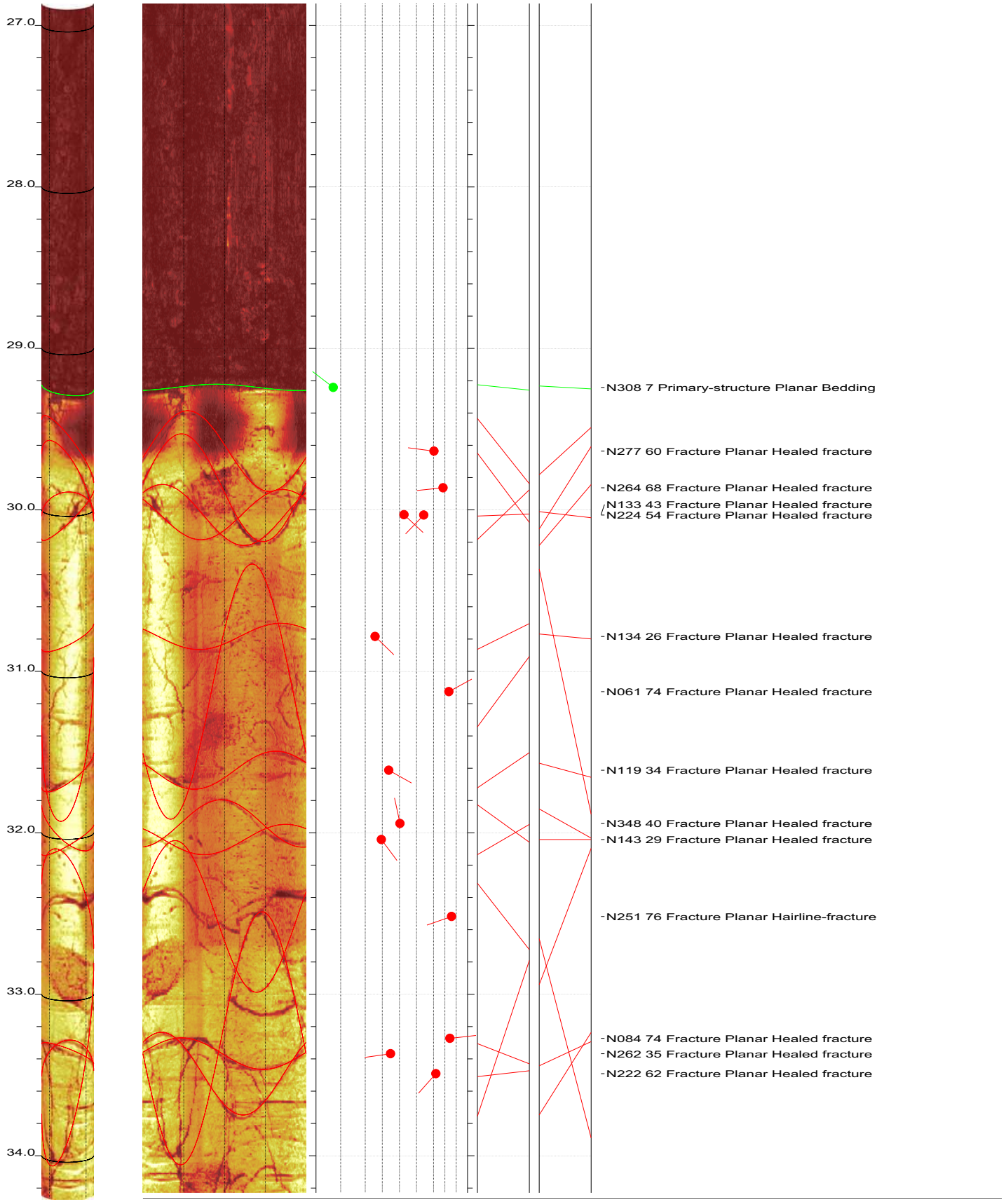


Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 1 of 15

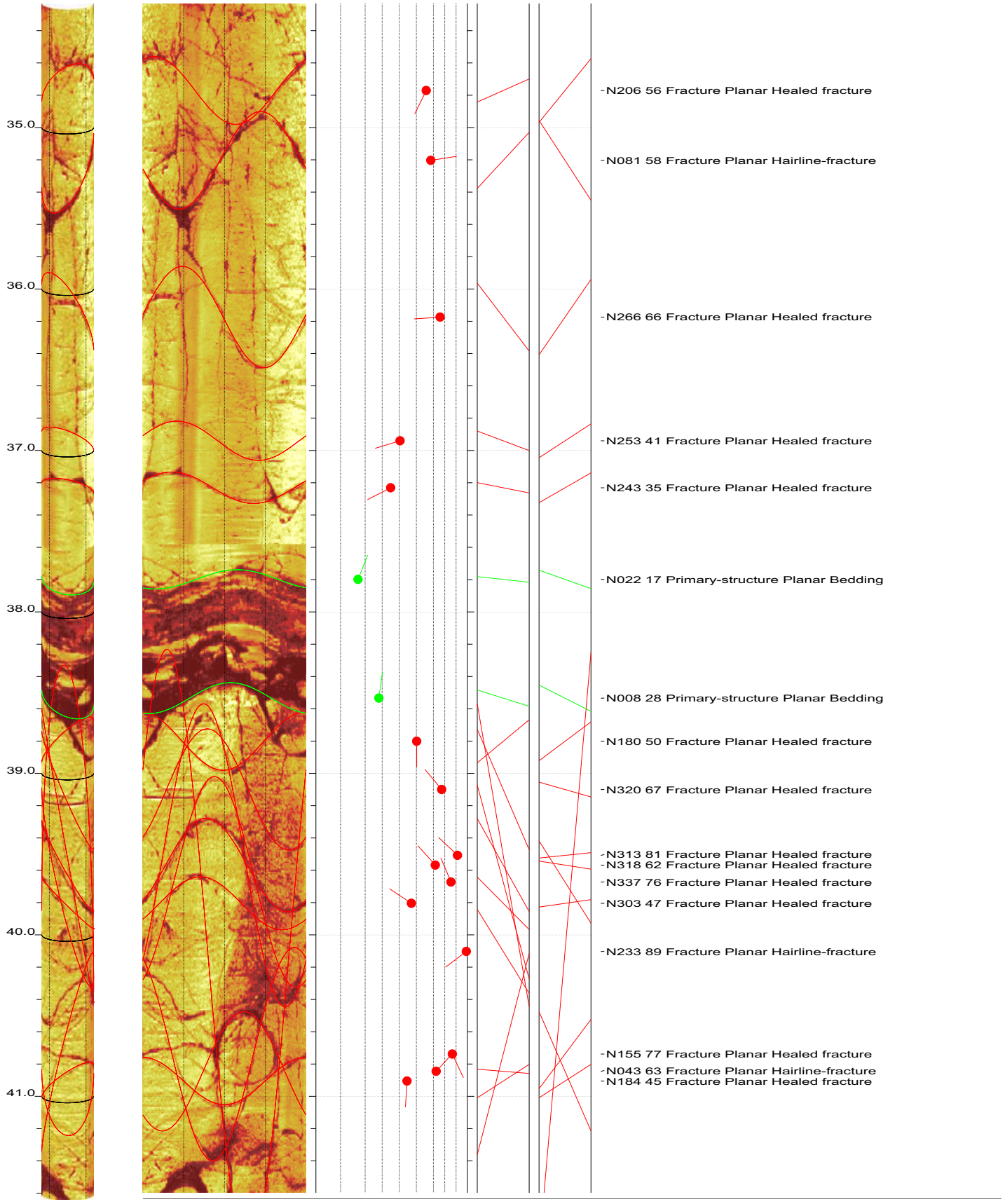


Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 2 of 15

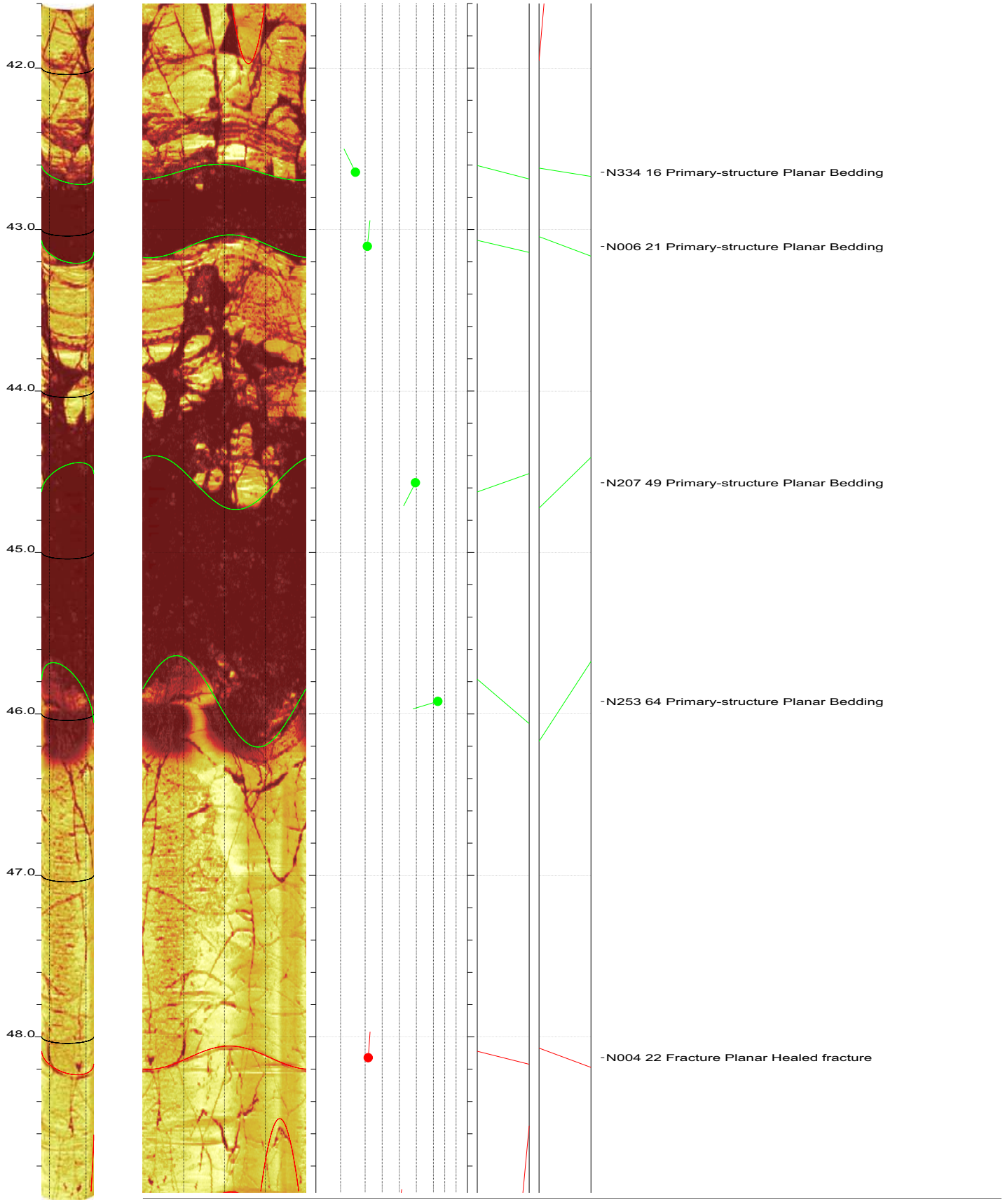
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 3 of 15



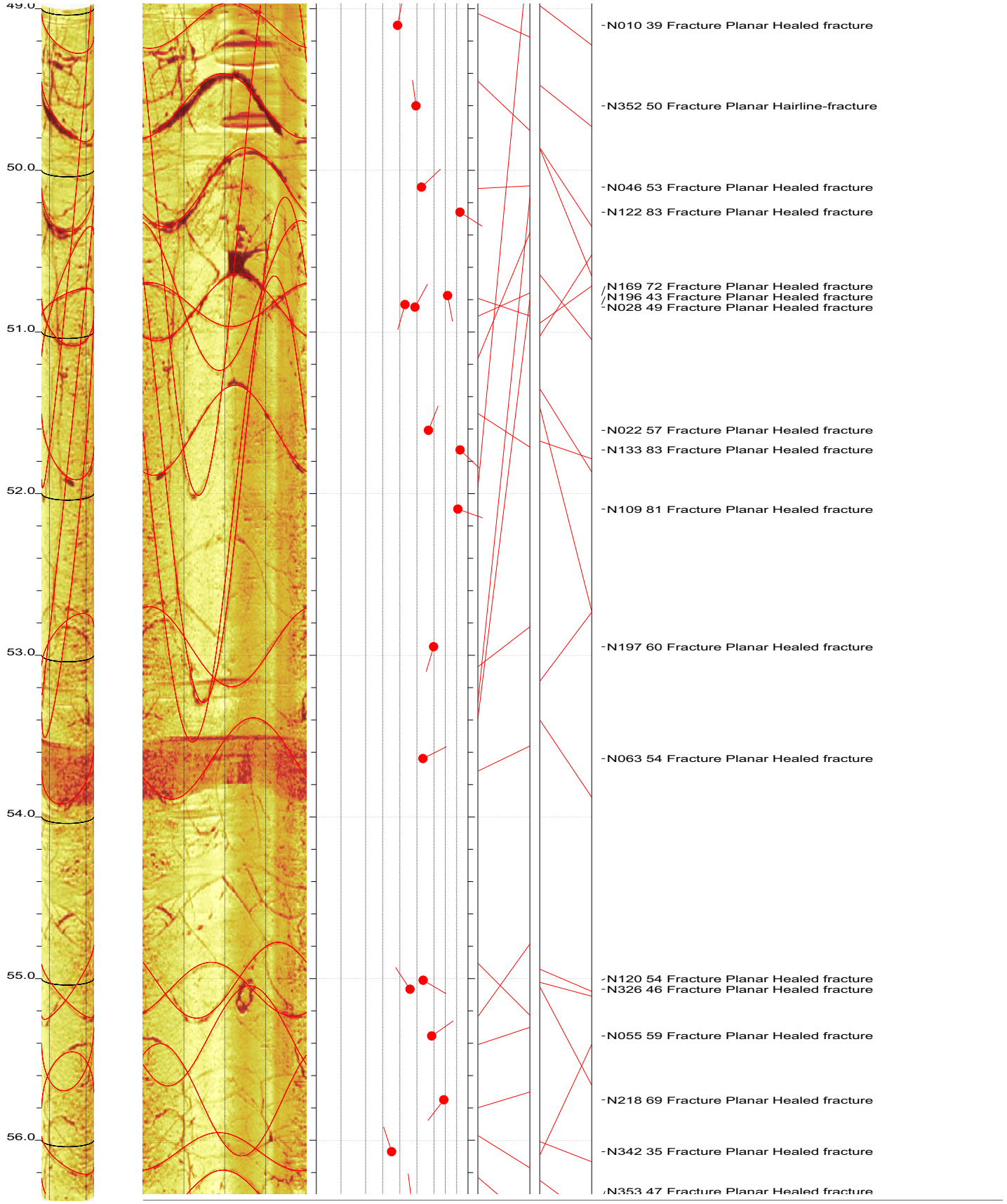
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 4 of 15



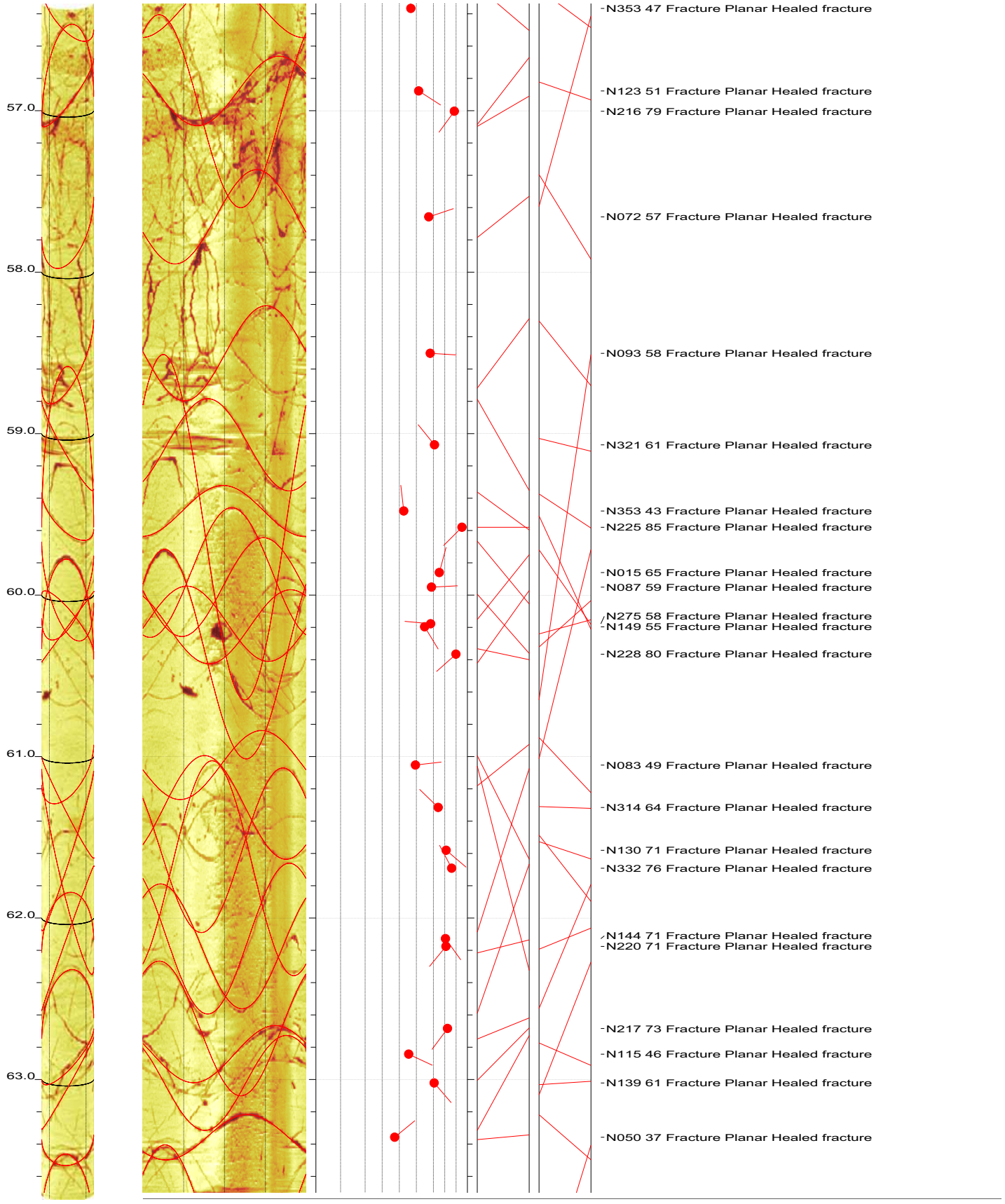
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 5 of 15



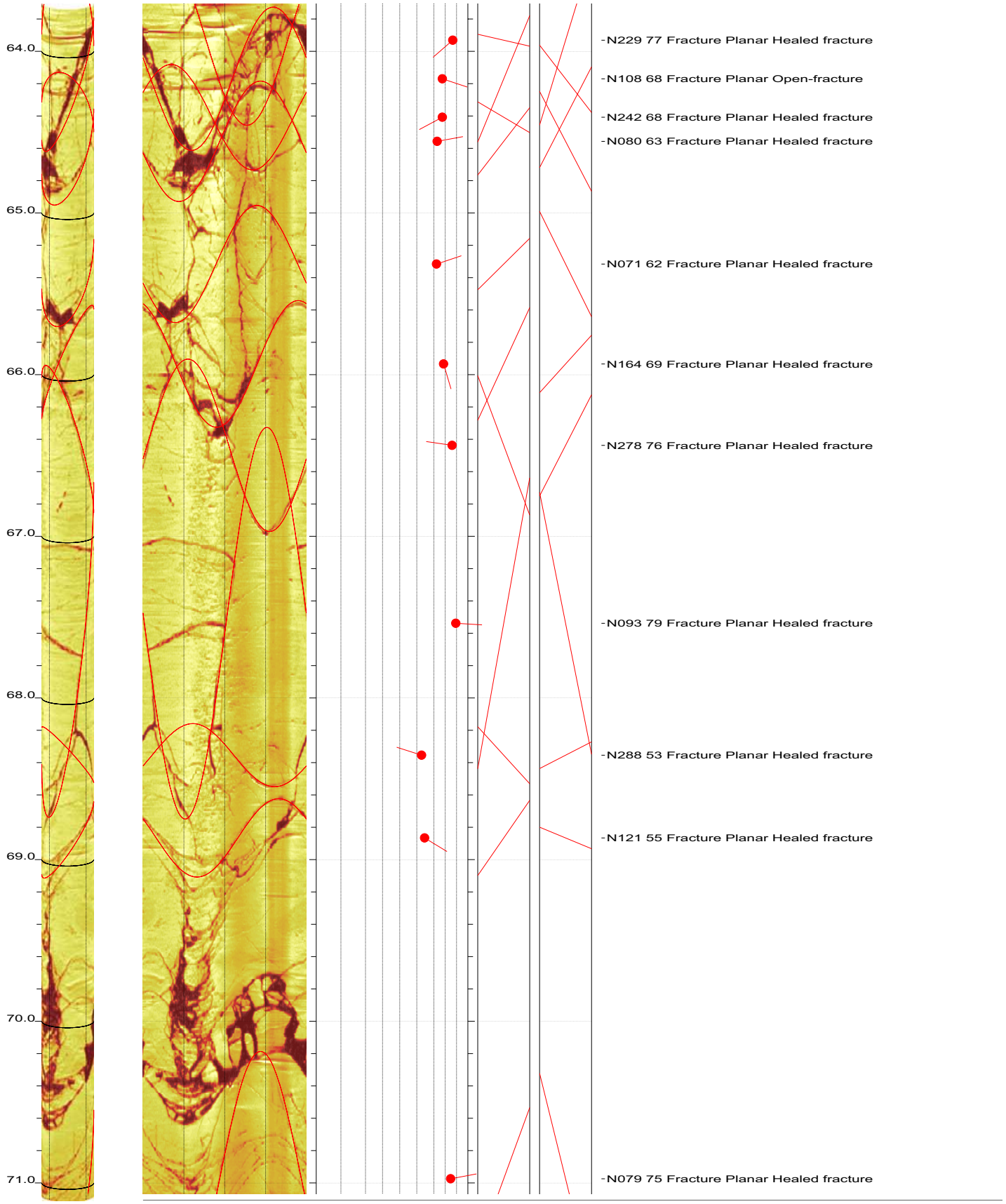
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 6 of 15



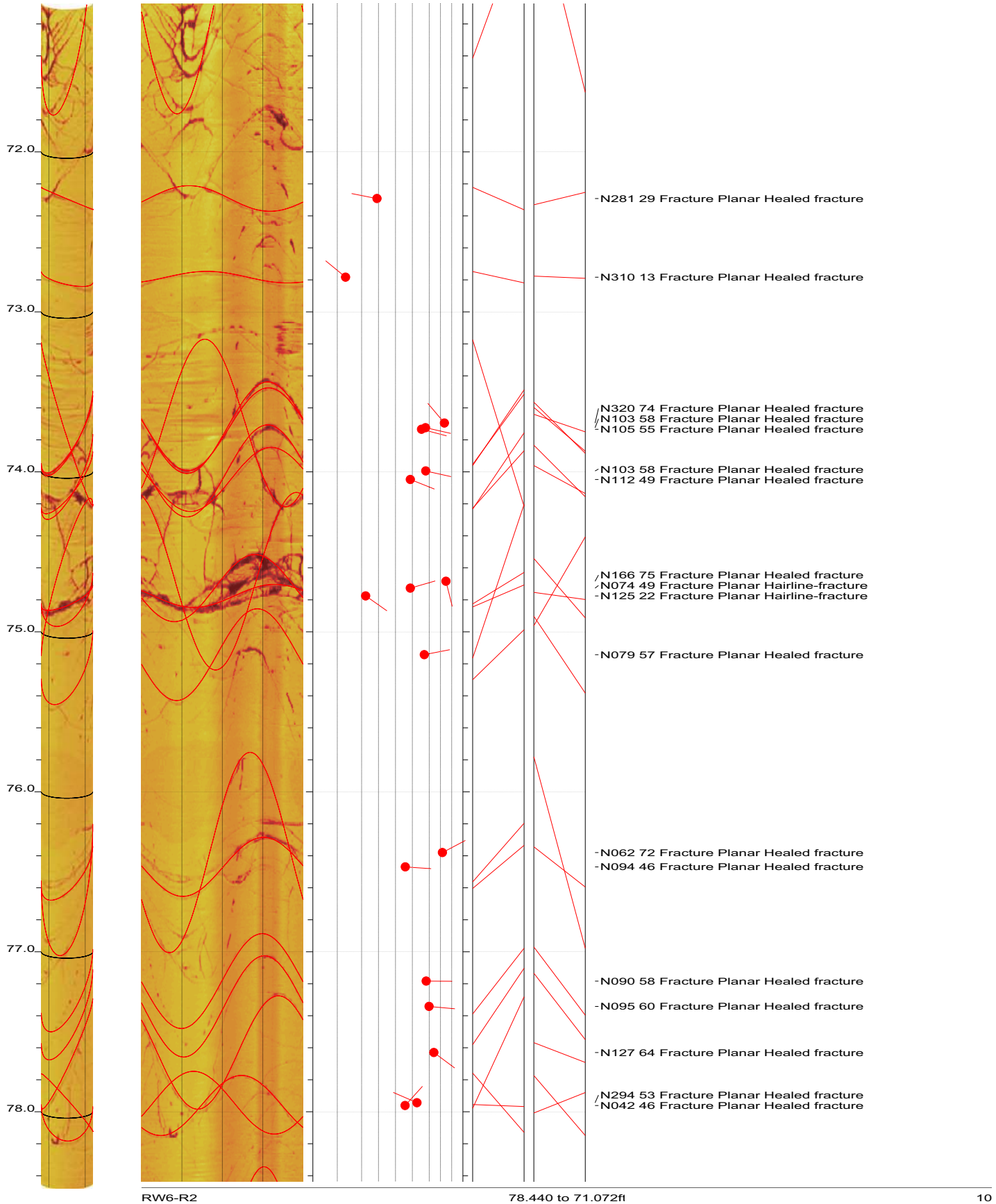
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 7 of 15



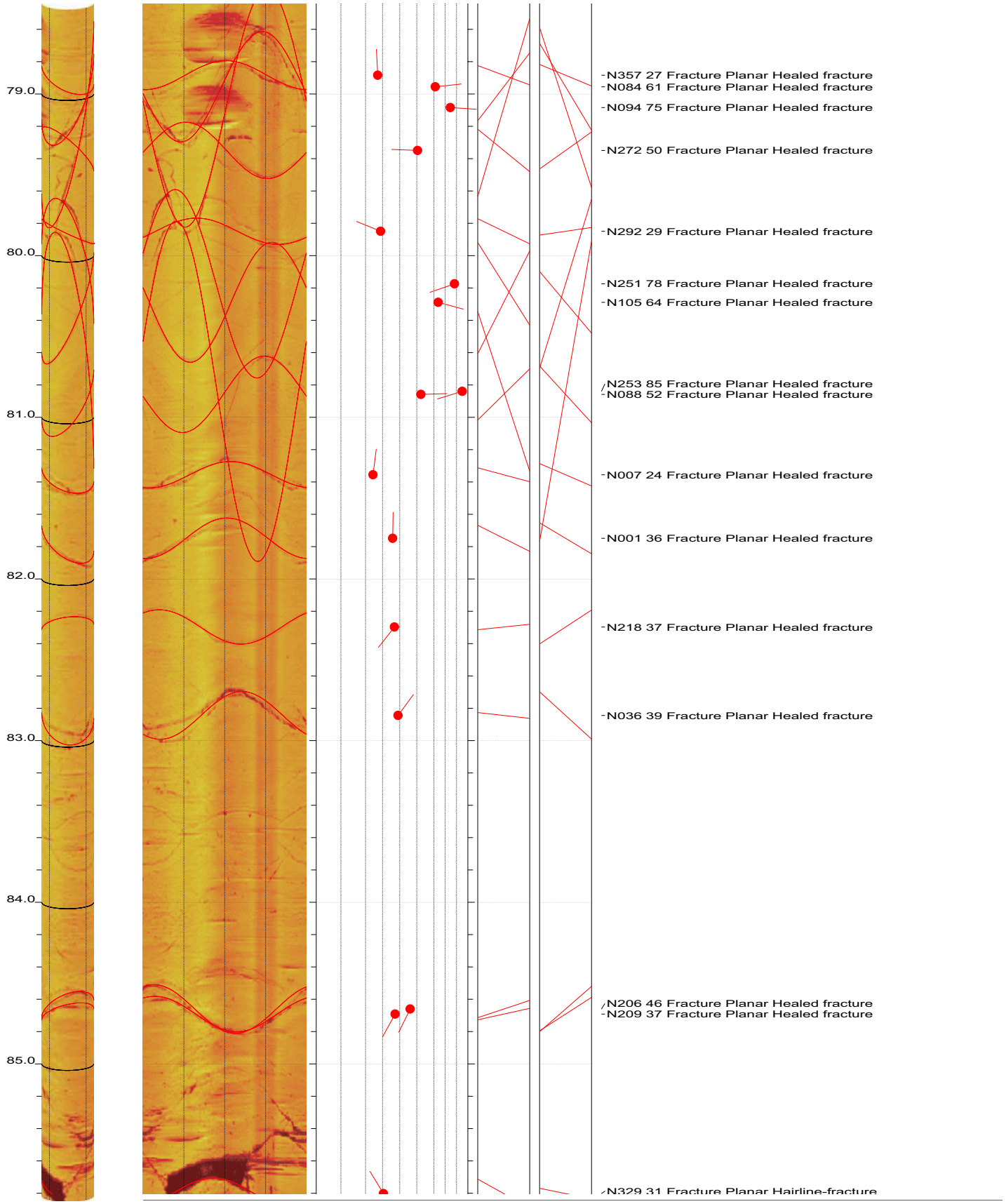
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 8 of 15



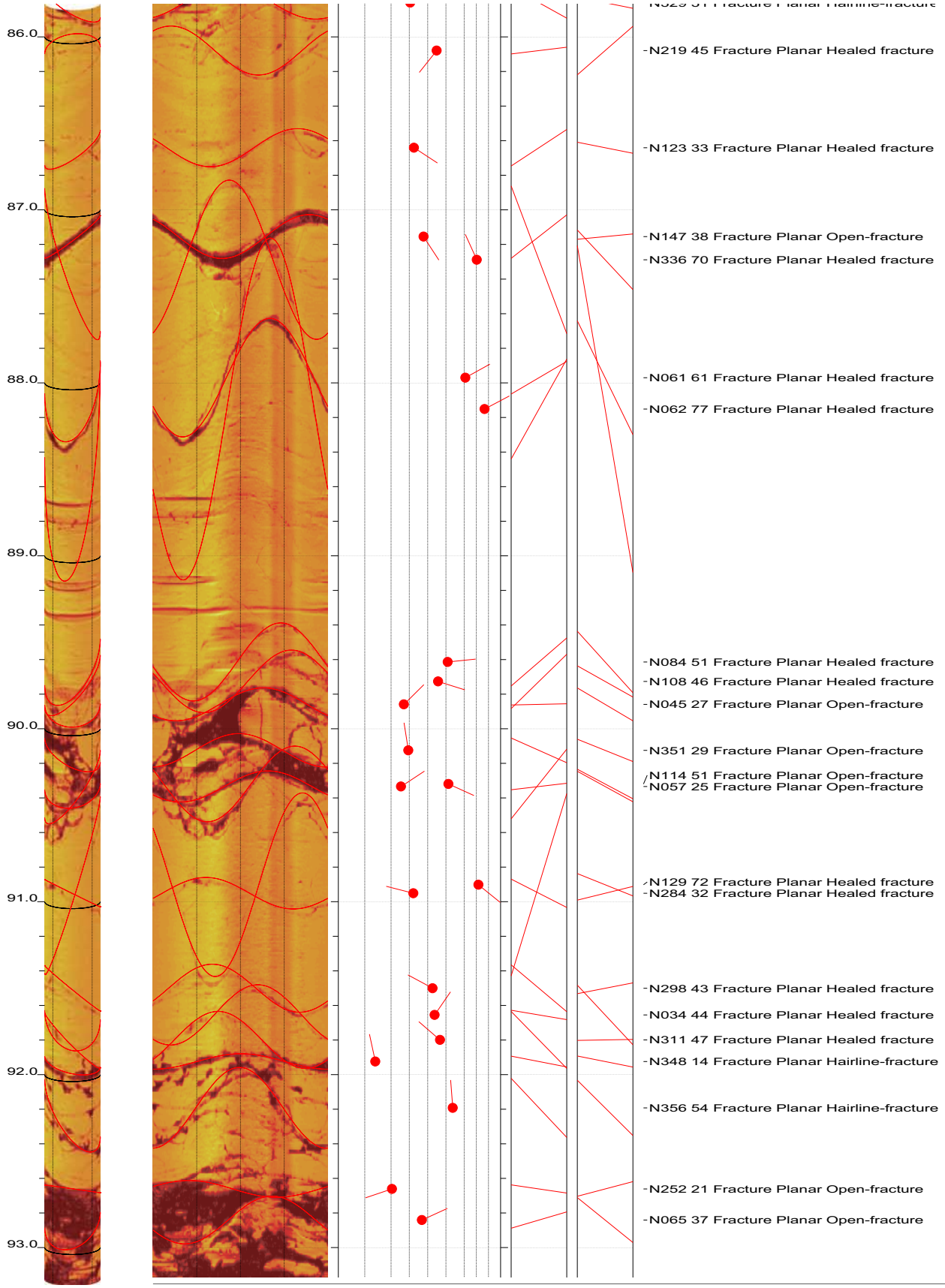
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 9 of 15



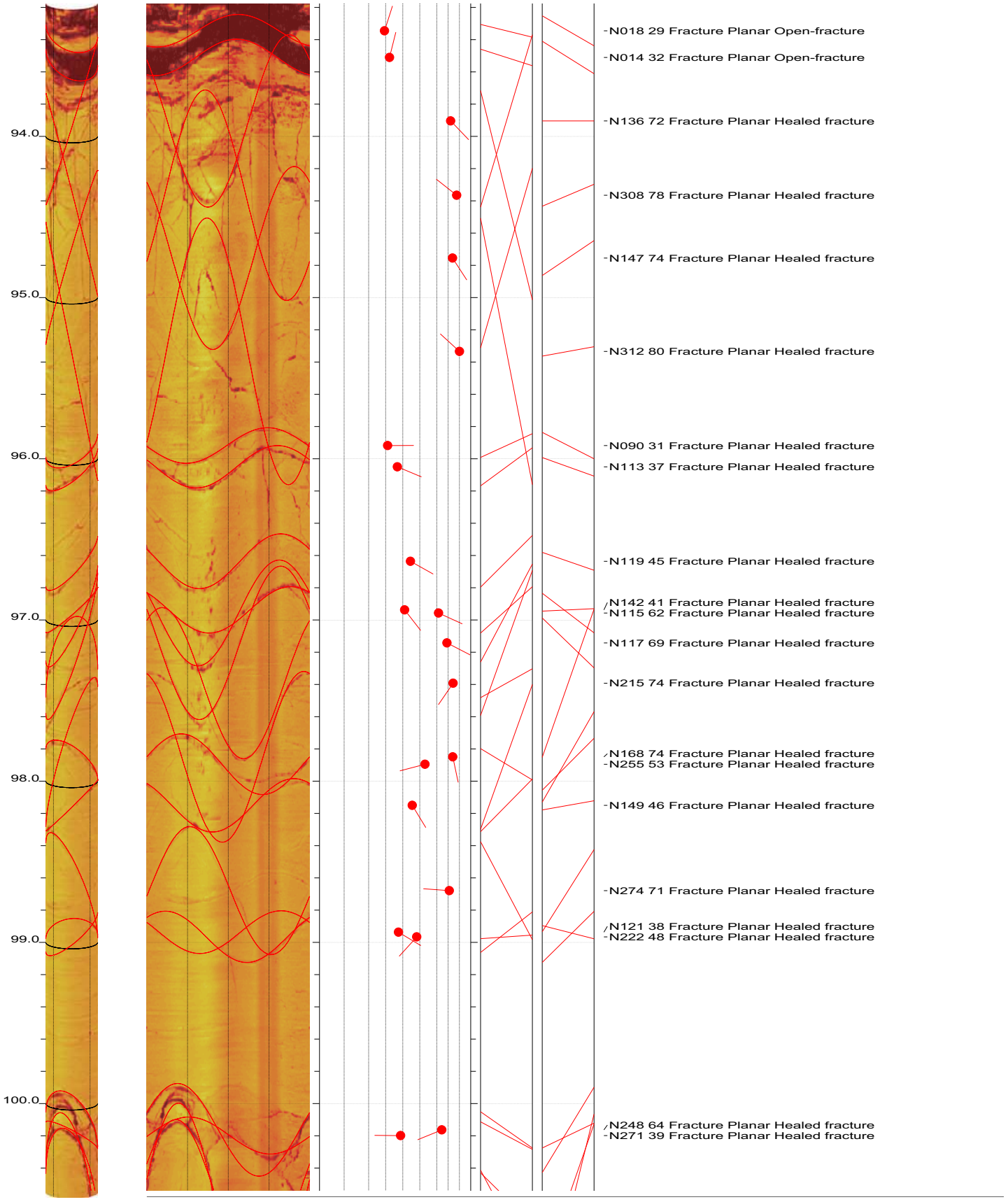
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 10 of 15



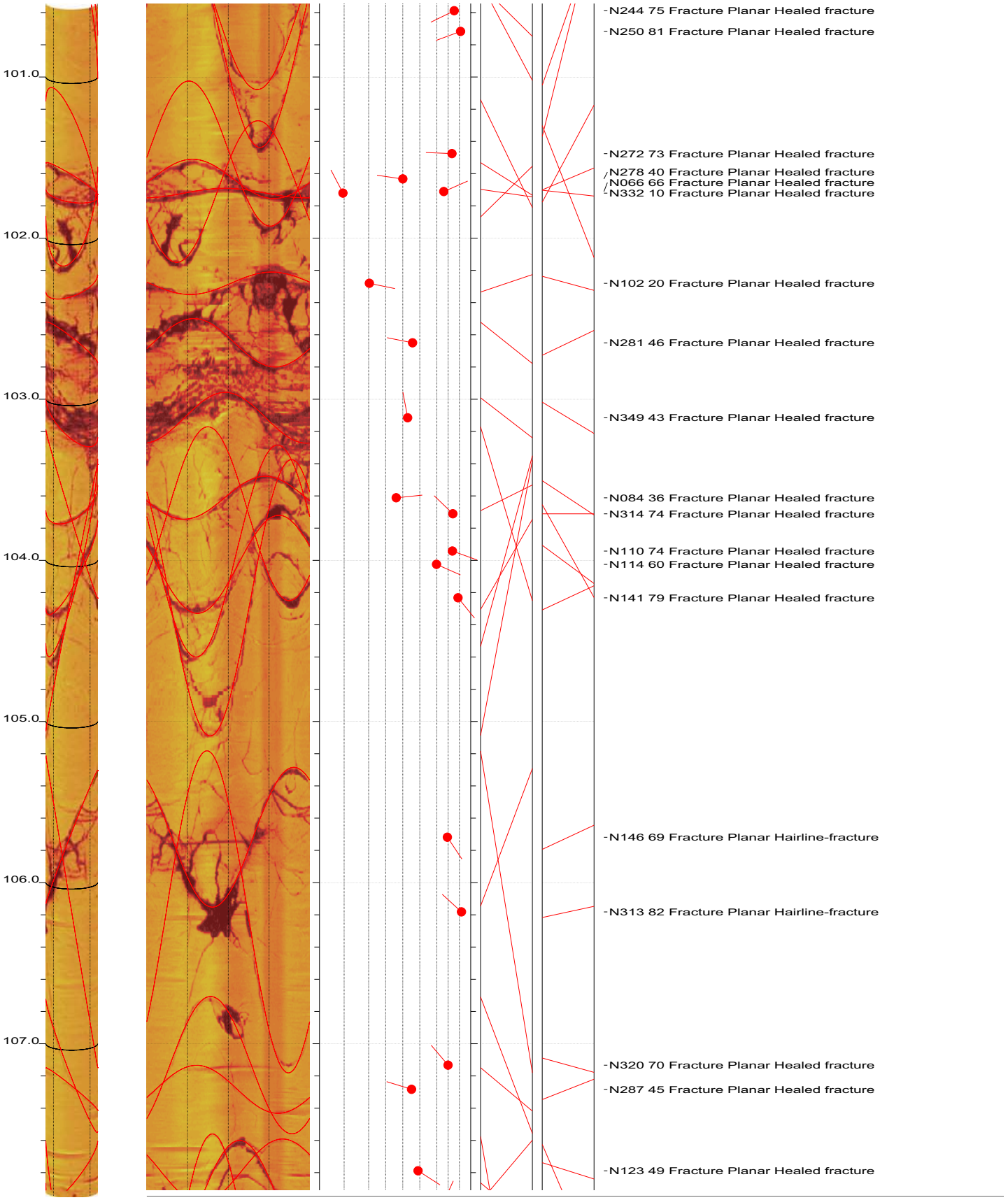
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 11 of 15



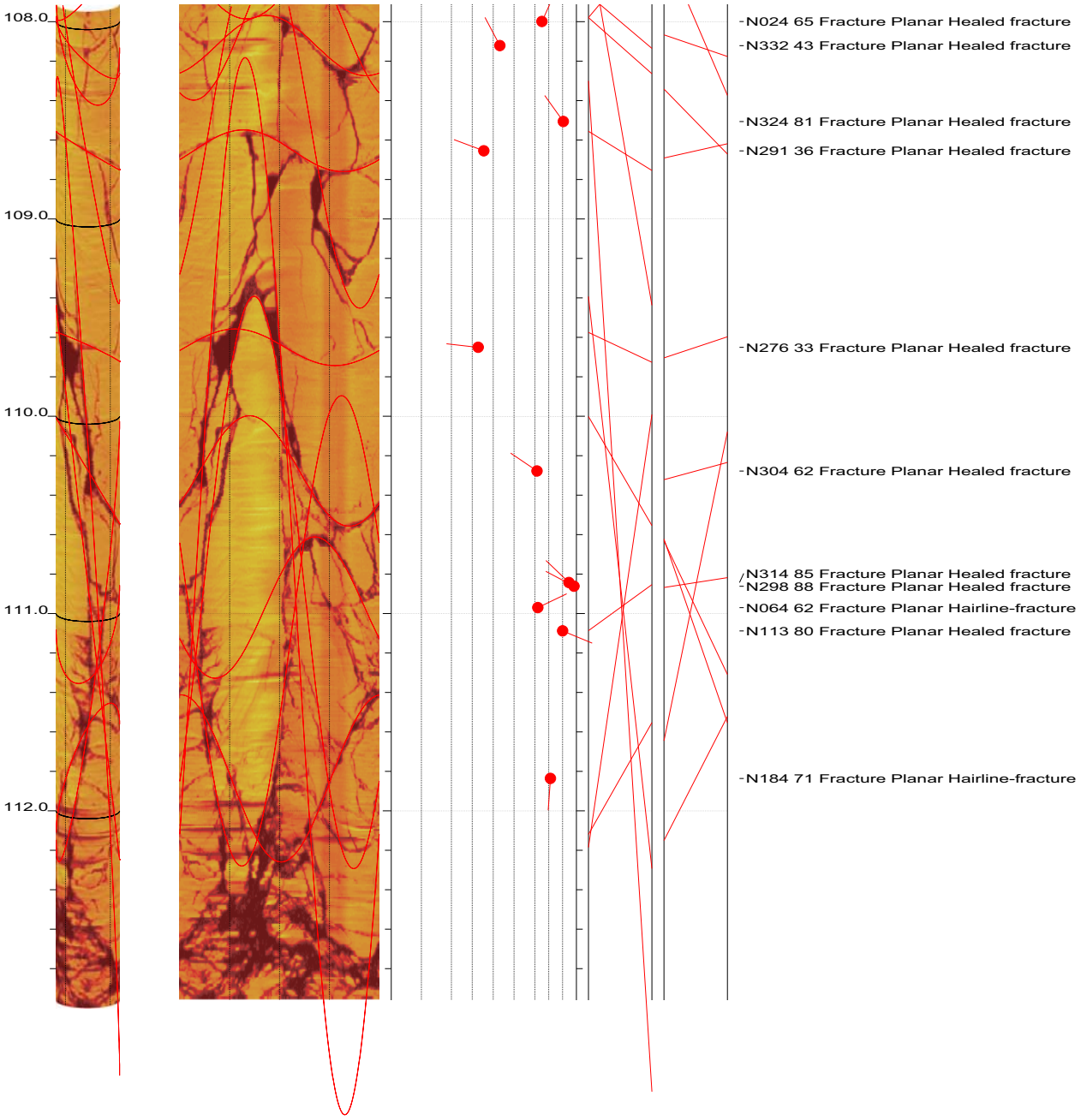
Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 12 of 15



Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 13 of 15



Doyle Drive RW6-R2 Acoustic Televiewer Dips Sheet 14 of 15


108.0
109.0
110.0
111.0
112.0
N024 65 Fracture Planar Healed fracture
N332 43 Fracture Planar Healed fracture
N324 81 Fracture Planar Healed fracture
N291 36 Fracture Planar Healed fracture
N276 33 Fracture Planar Healed fracture
N304 62 Fracture Planar Healed fracture
N314 85 Fracture Planar Healed fracture
N298 88 Fracture Planar Healed fracture
N064 62 Fracture Planar Hairline-fracture
N113 80 Fracture Planar Healed fracture
N184 71 Fracture Planar Hairline-fracture

BHTV DATA PROCESSING
RGLDIP vsn 6.2
INTERPRETED BHTV DIPS LOG

16 Jun 2008

ARUP

Borehole: RW8-R1

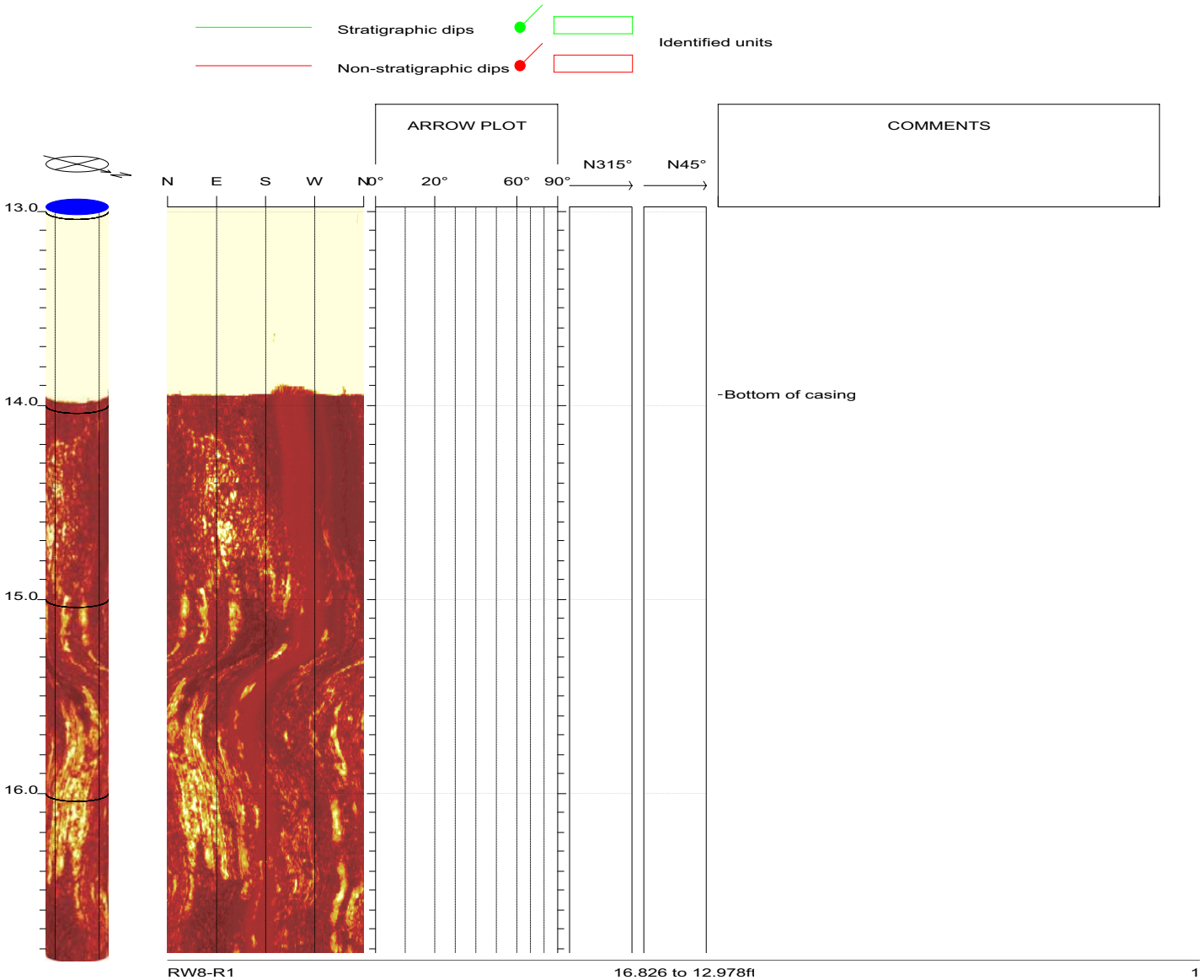
DOYLE DRIVE

top of borehole.....
East: _
North: _
Elev: _

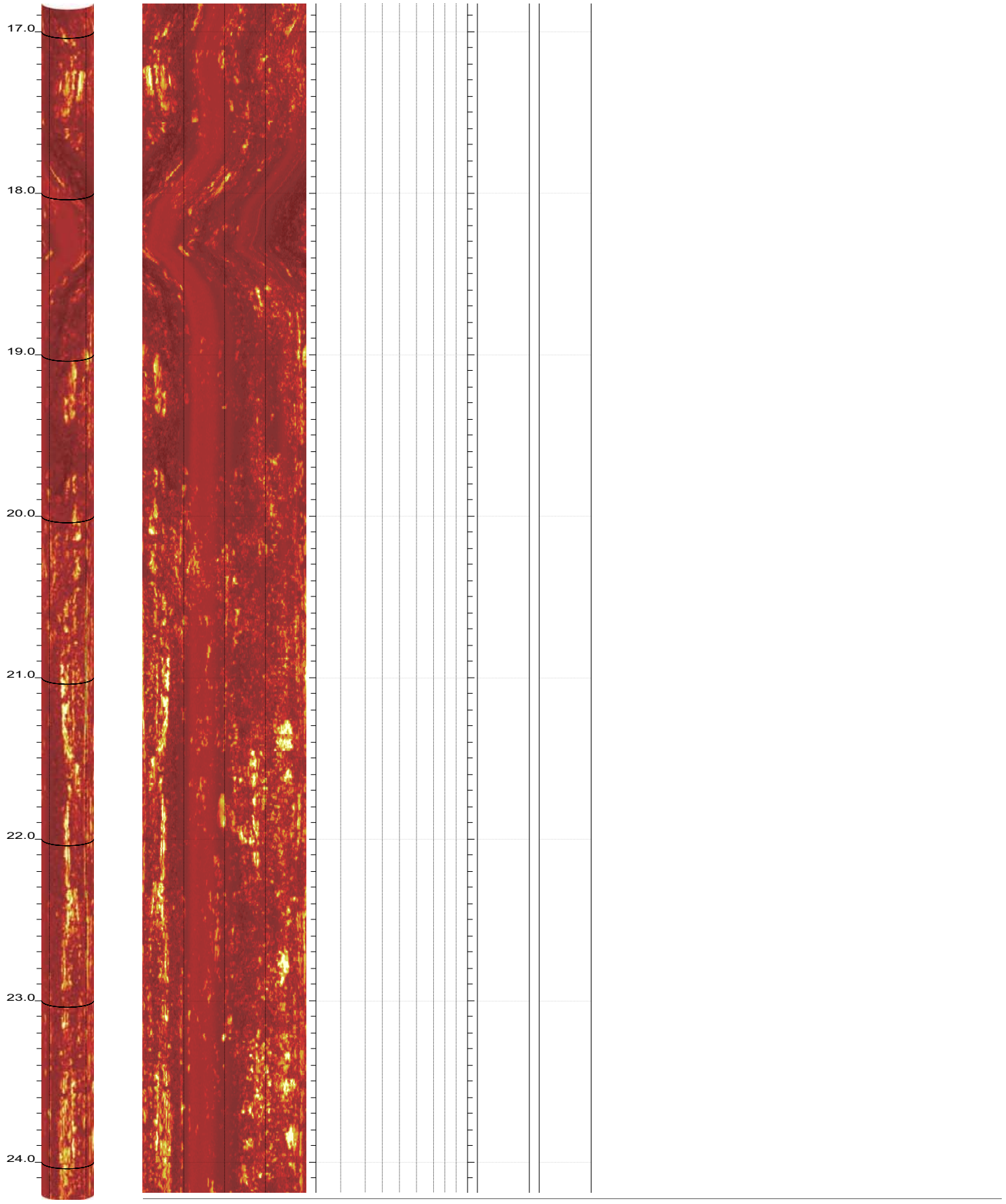
North ref. is true
Depth units are feet
Vertical scale: 1/10
Horiz scale = 1.00x Vert scale

Zone from 140.050 to 12.978ft
Format: BHTV-NESWN

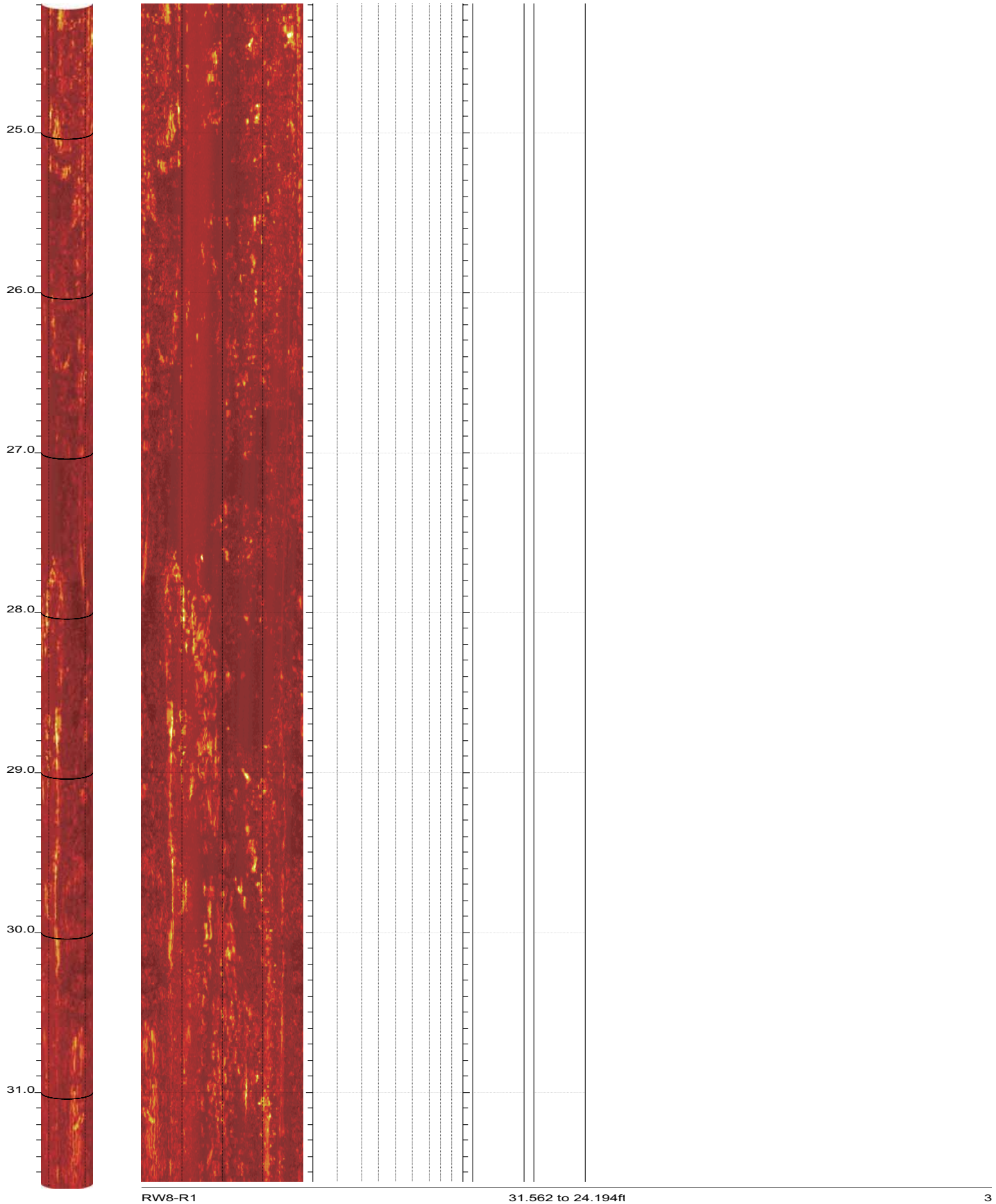
Borehole diam: 3.860inch
Vertical = borehole-axis
Image: Amplitude



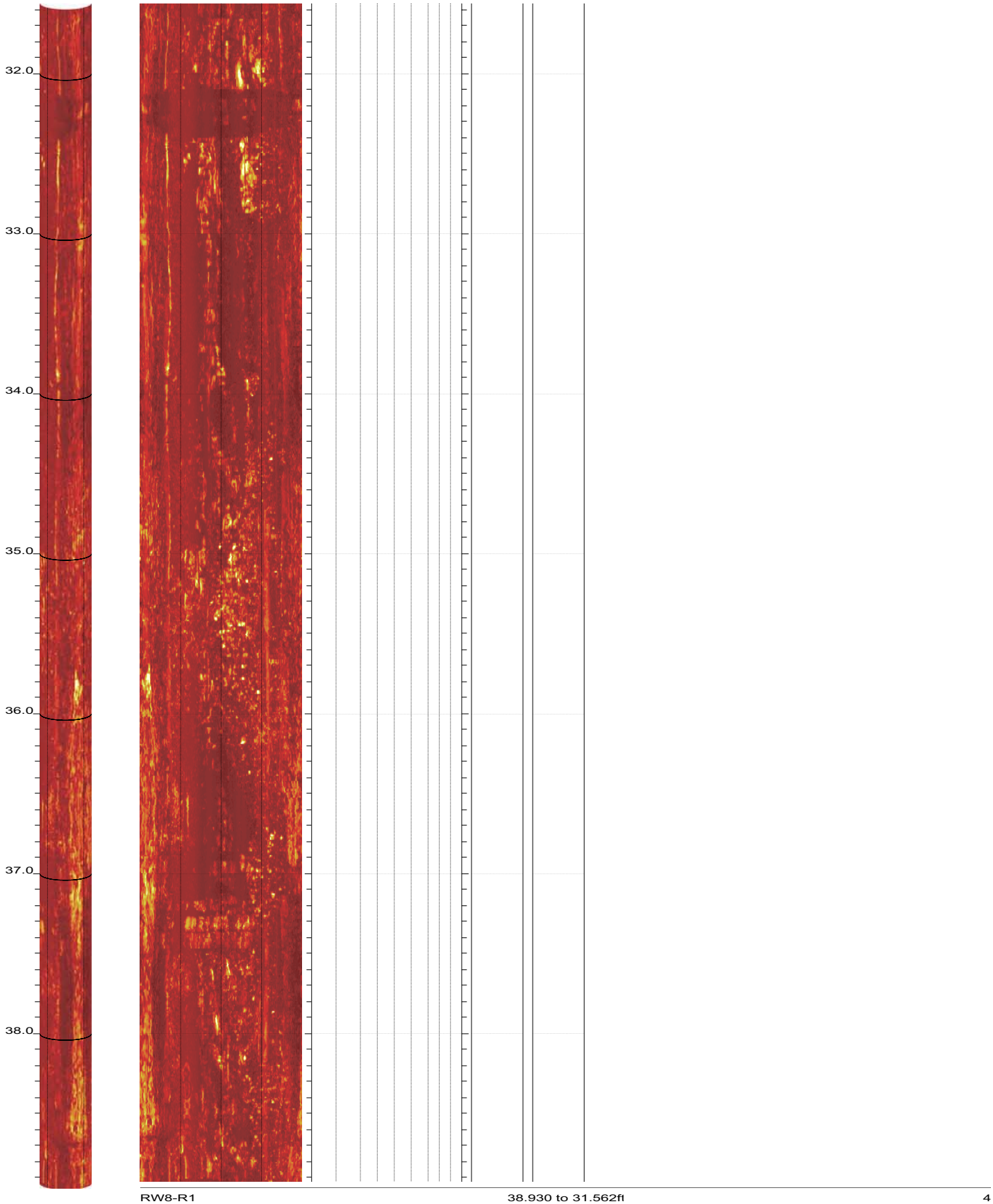
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 1 of 18



Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 2 of 18



Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 3 of 18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34.0
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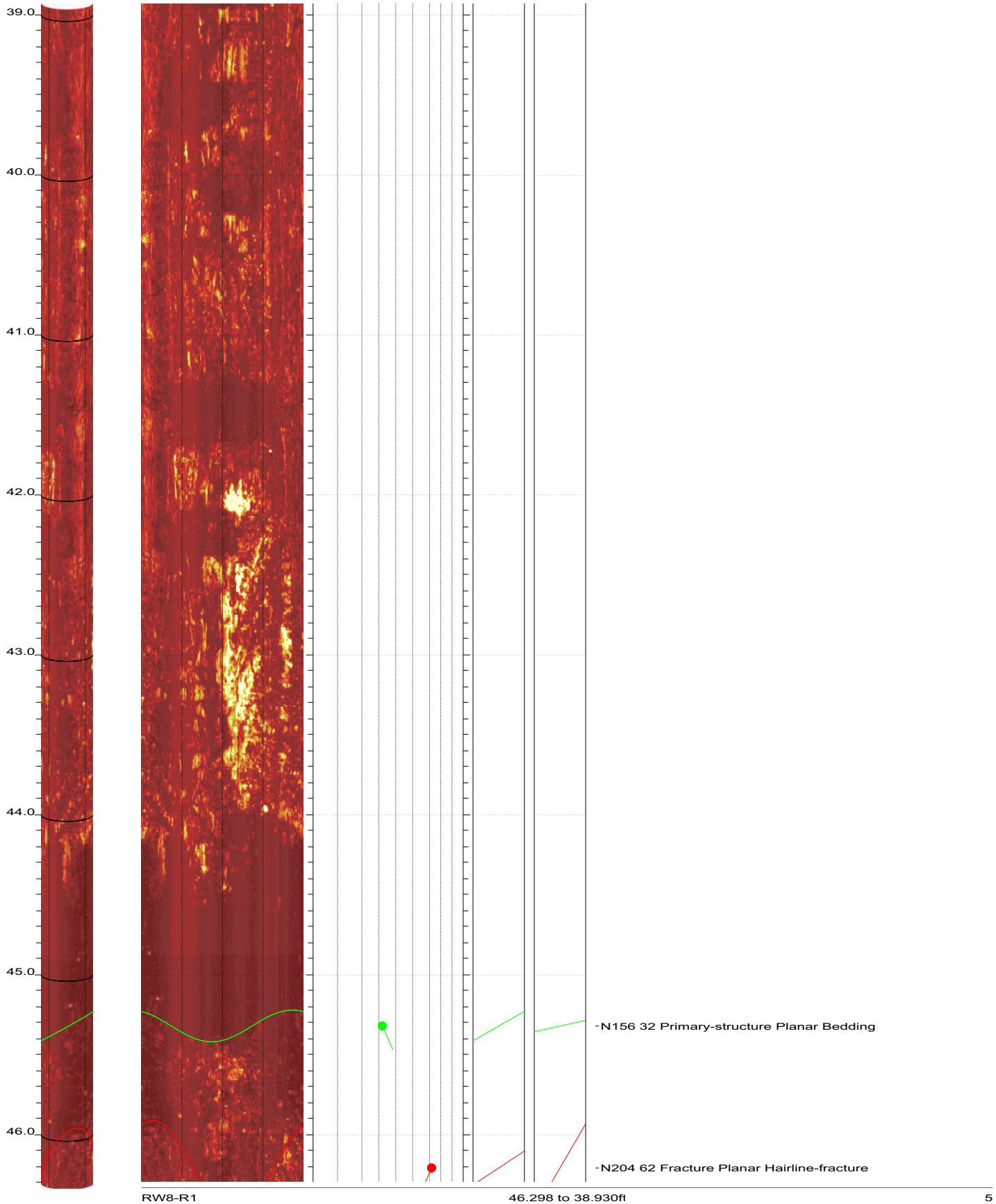
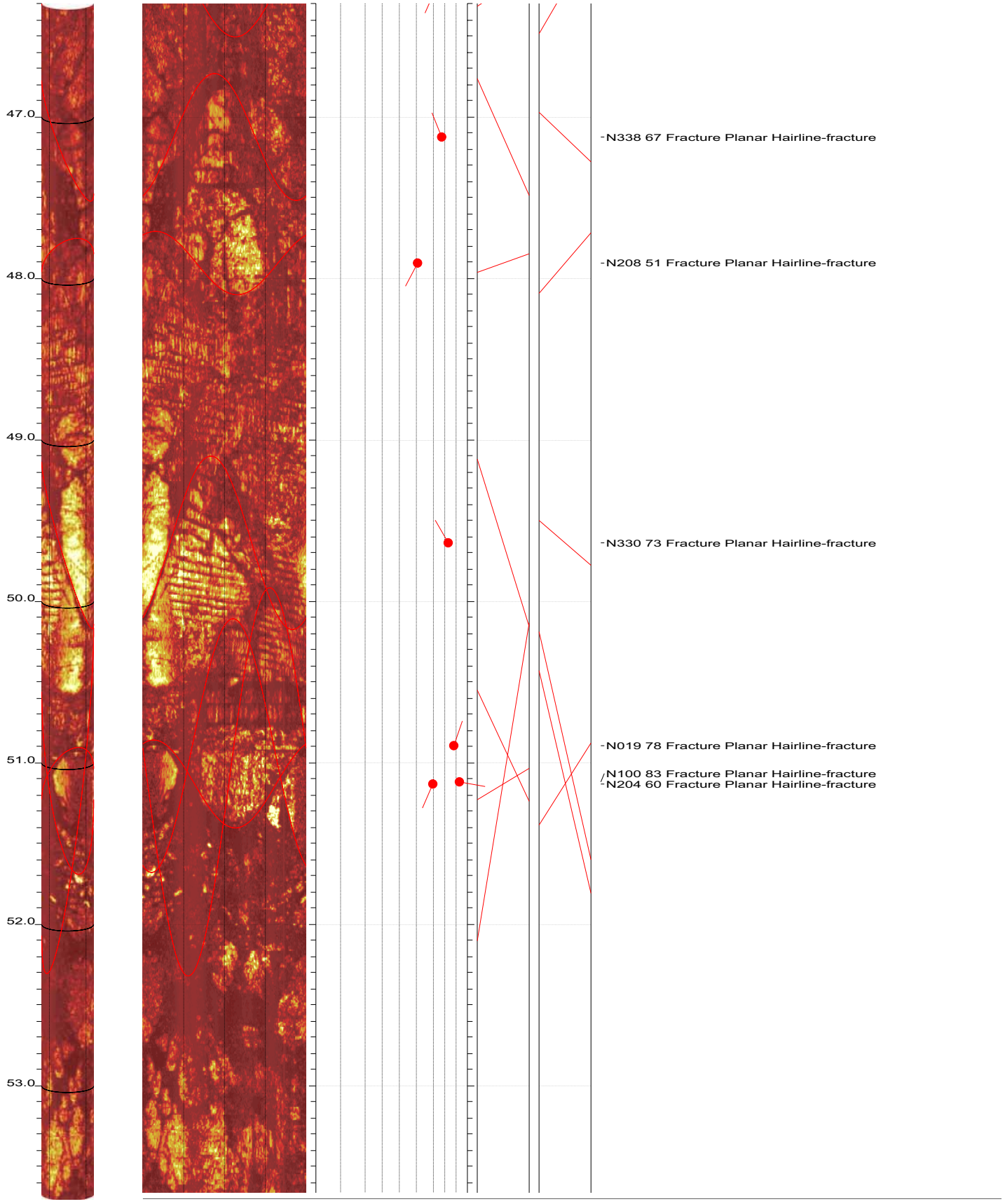
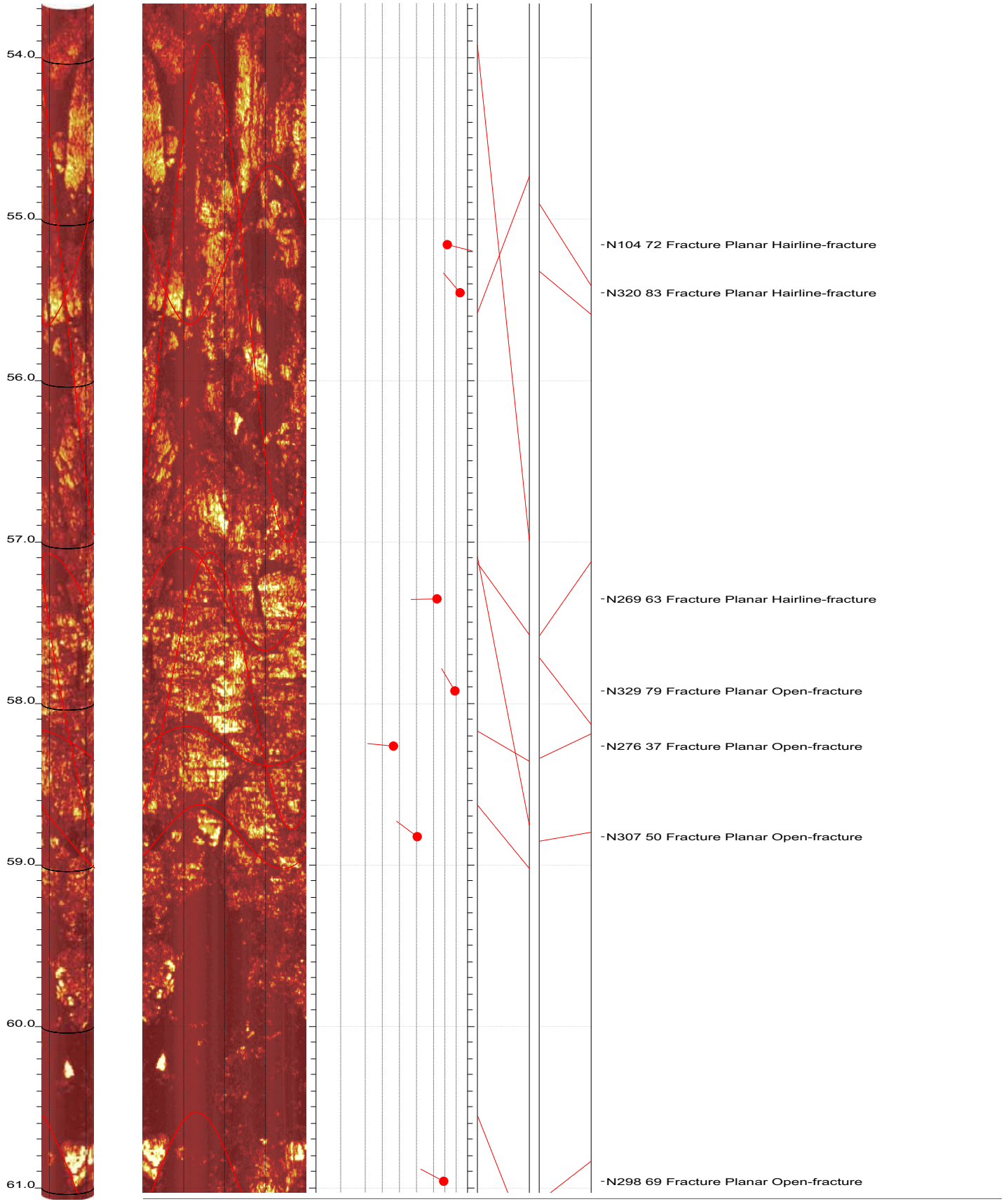
37.0
38.0
RW8-R1
38.930 to 31.562ft
4



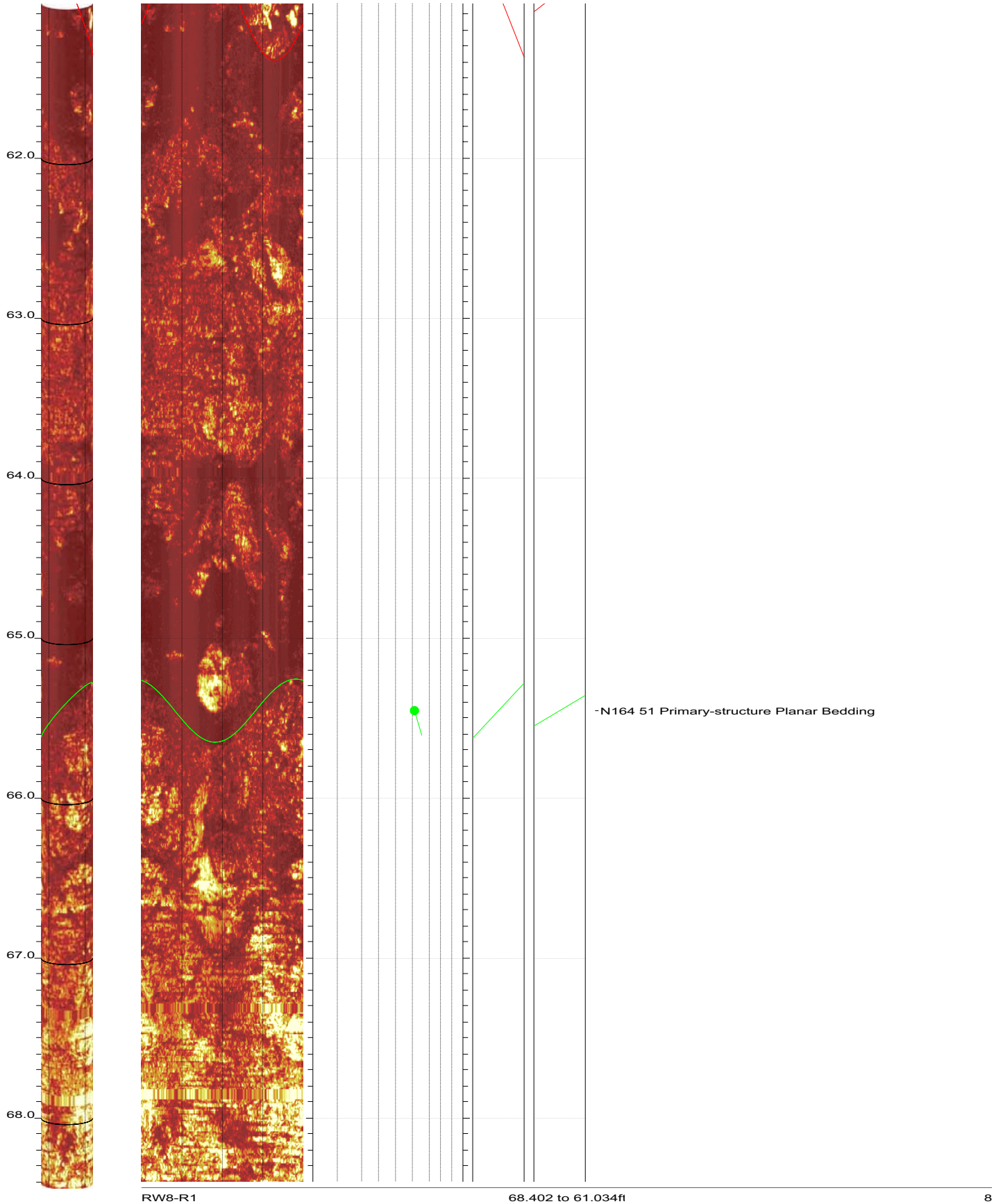
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 5 of 18



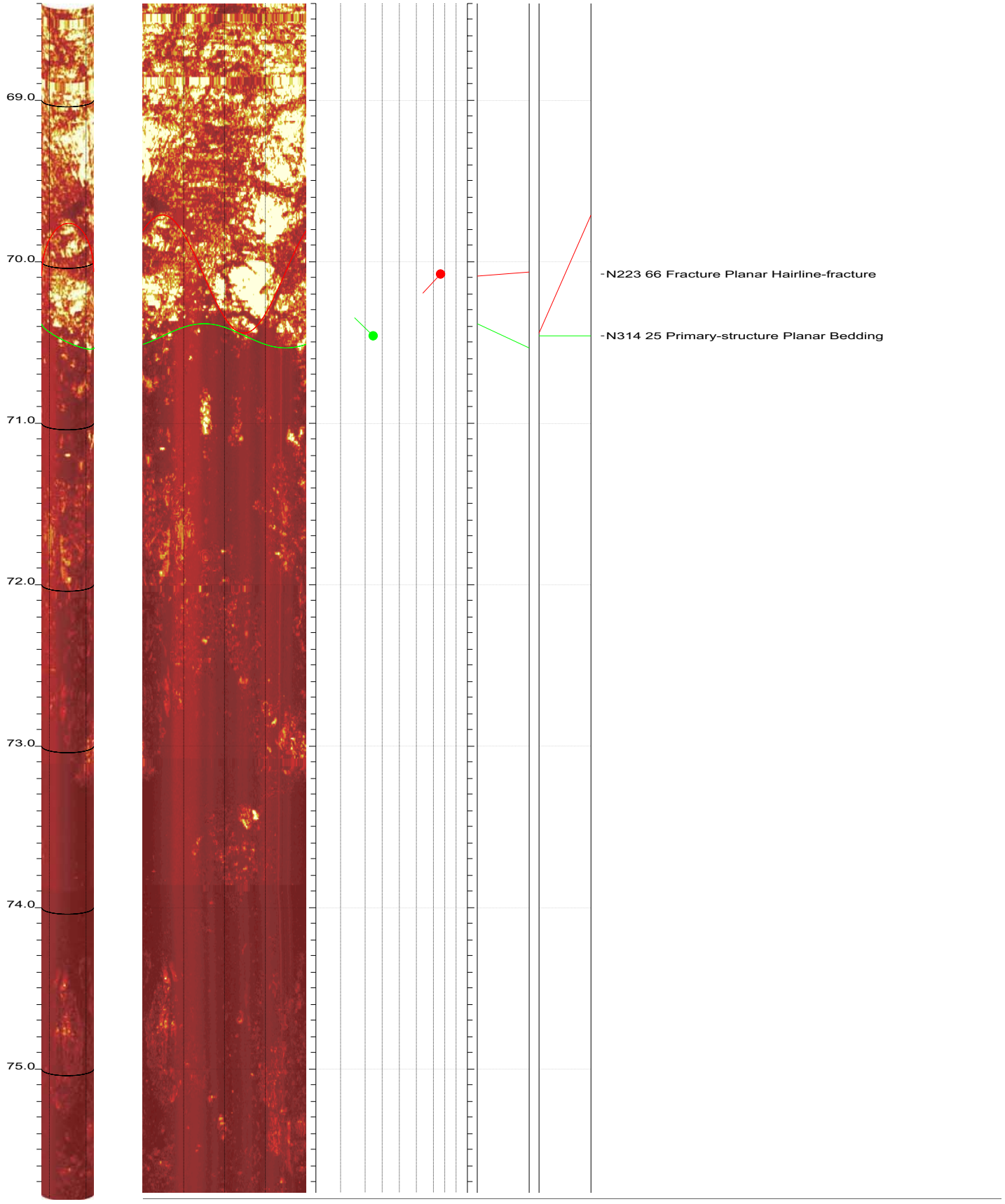
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 6 of 18



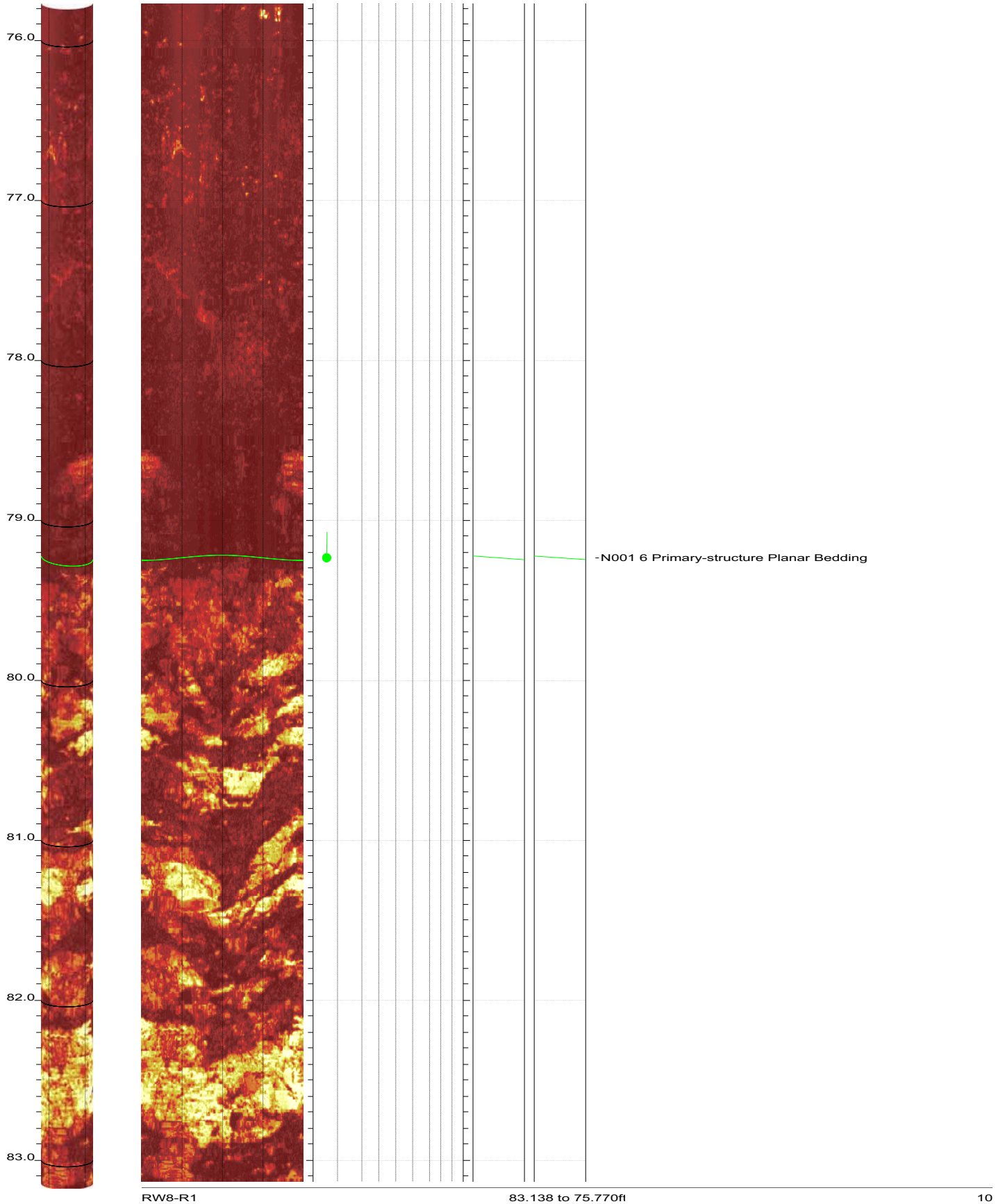
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 7 of 18



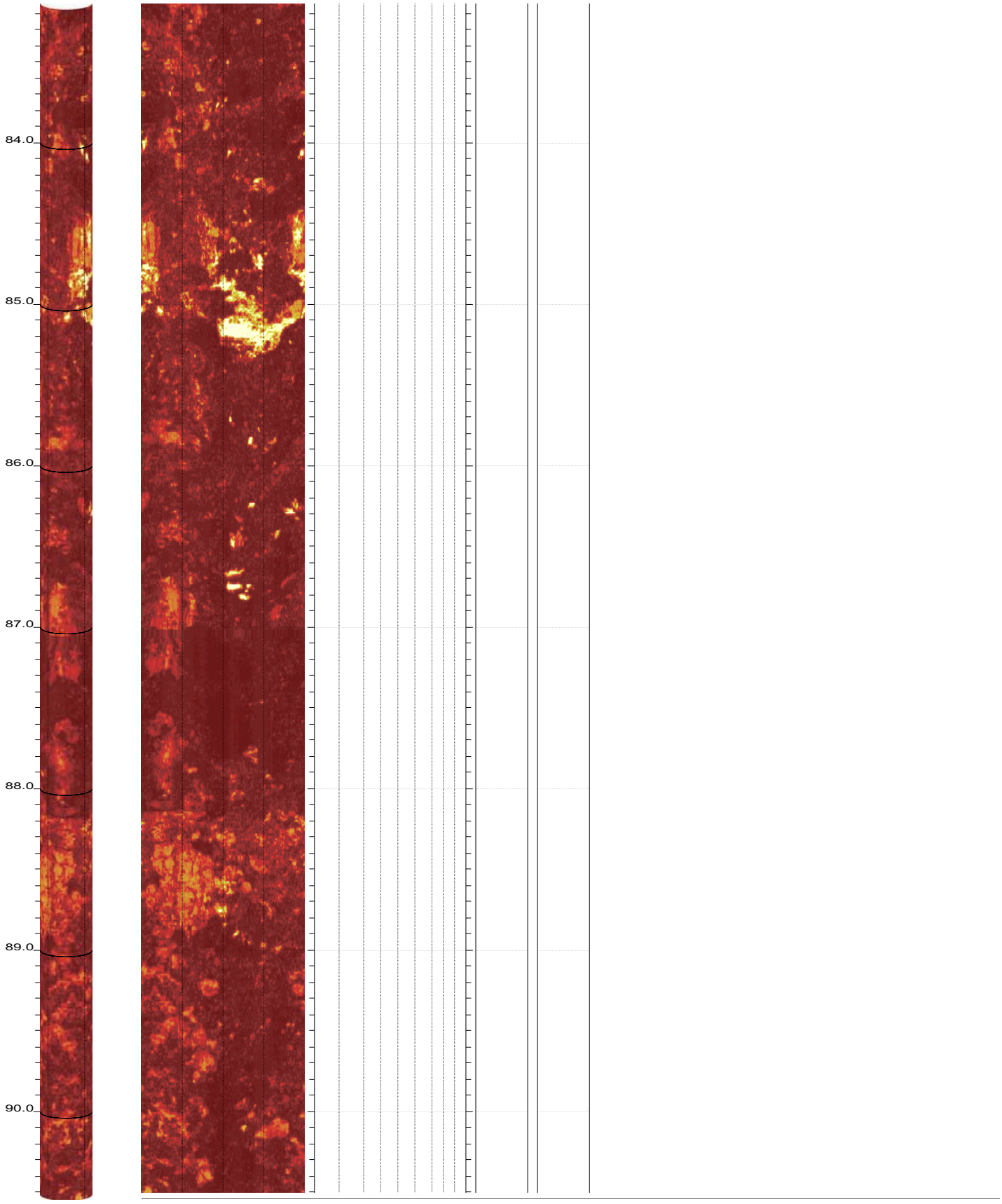
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 8 of 18



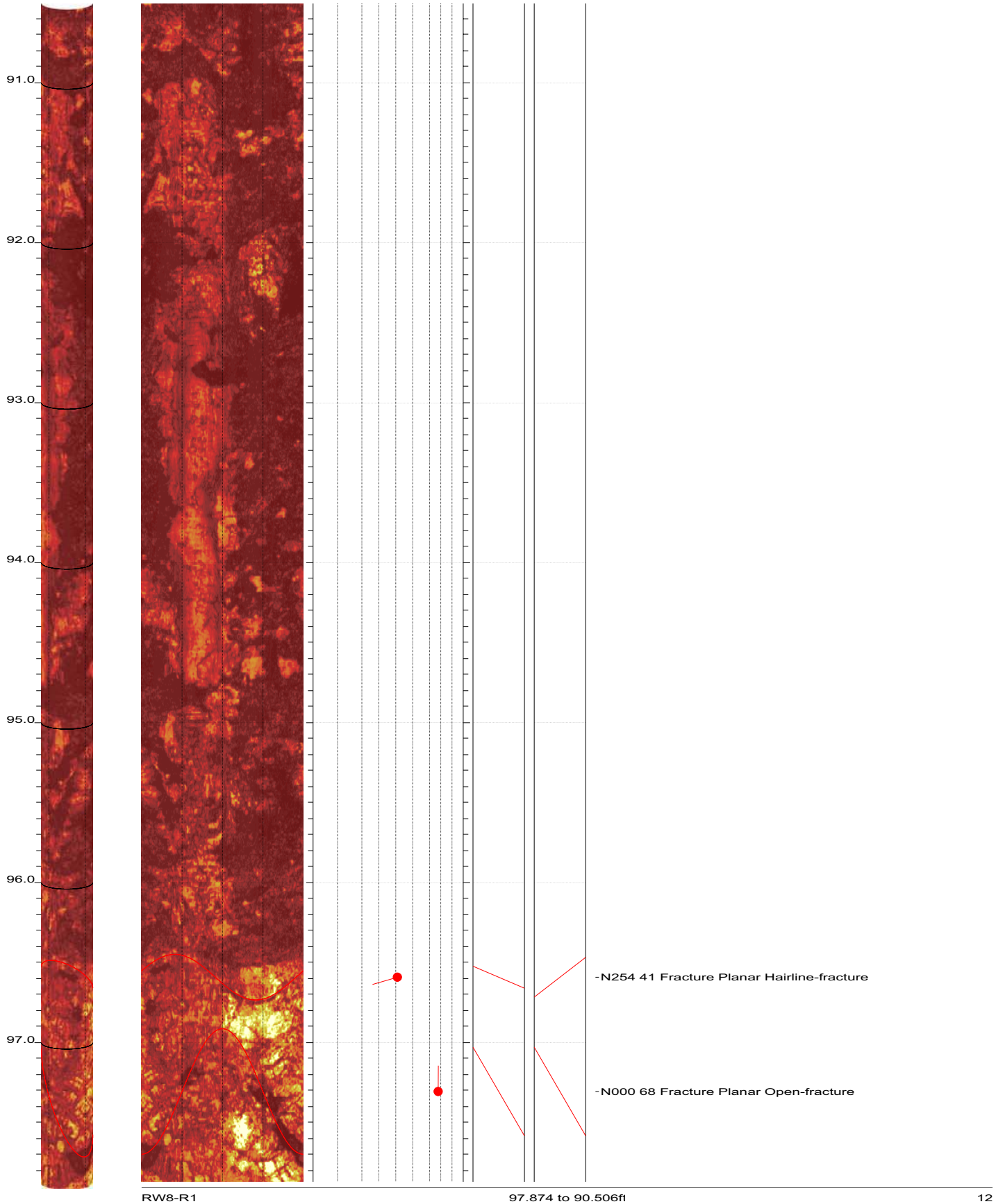
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 9 of 18



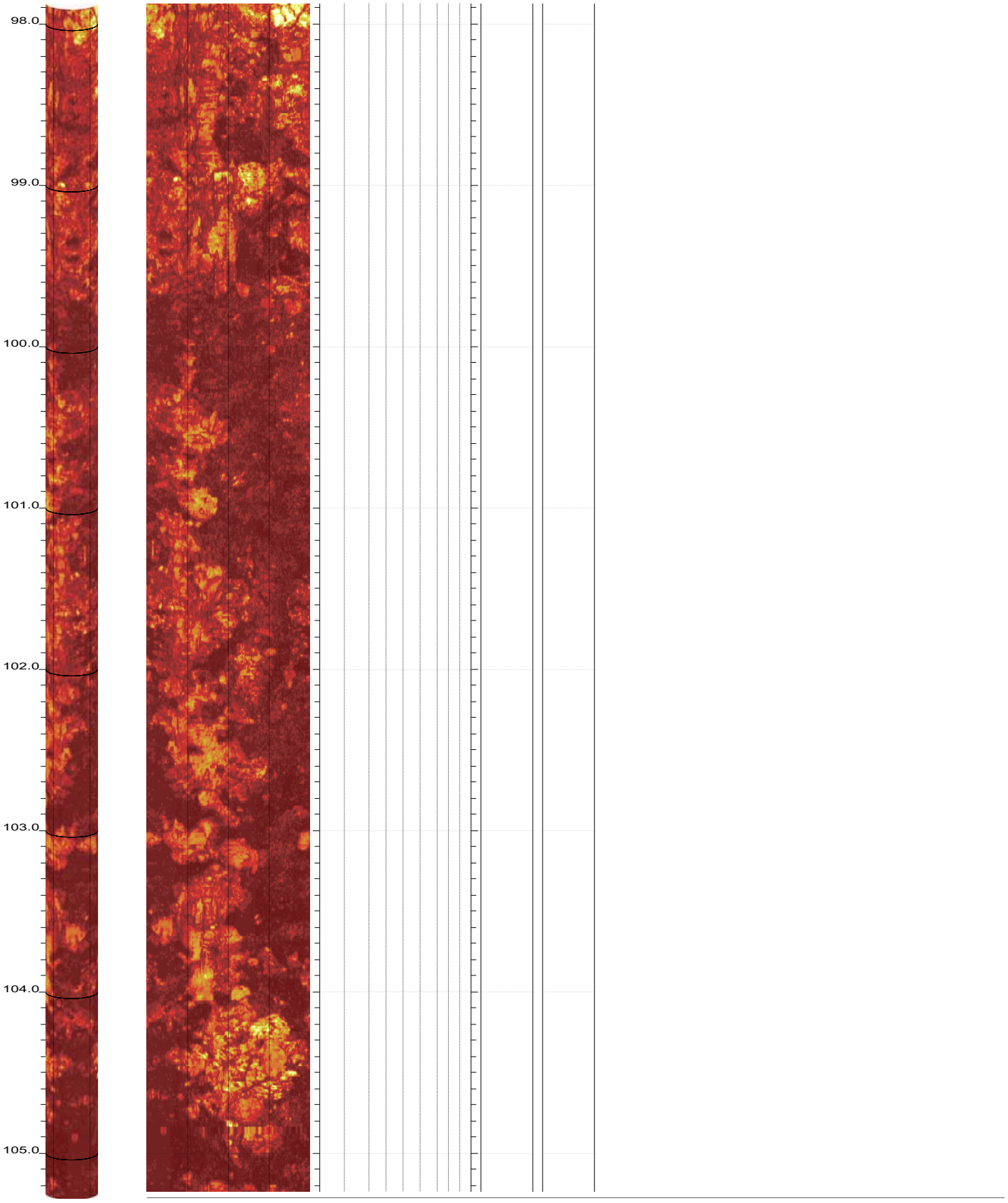
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 10 of 18



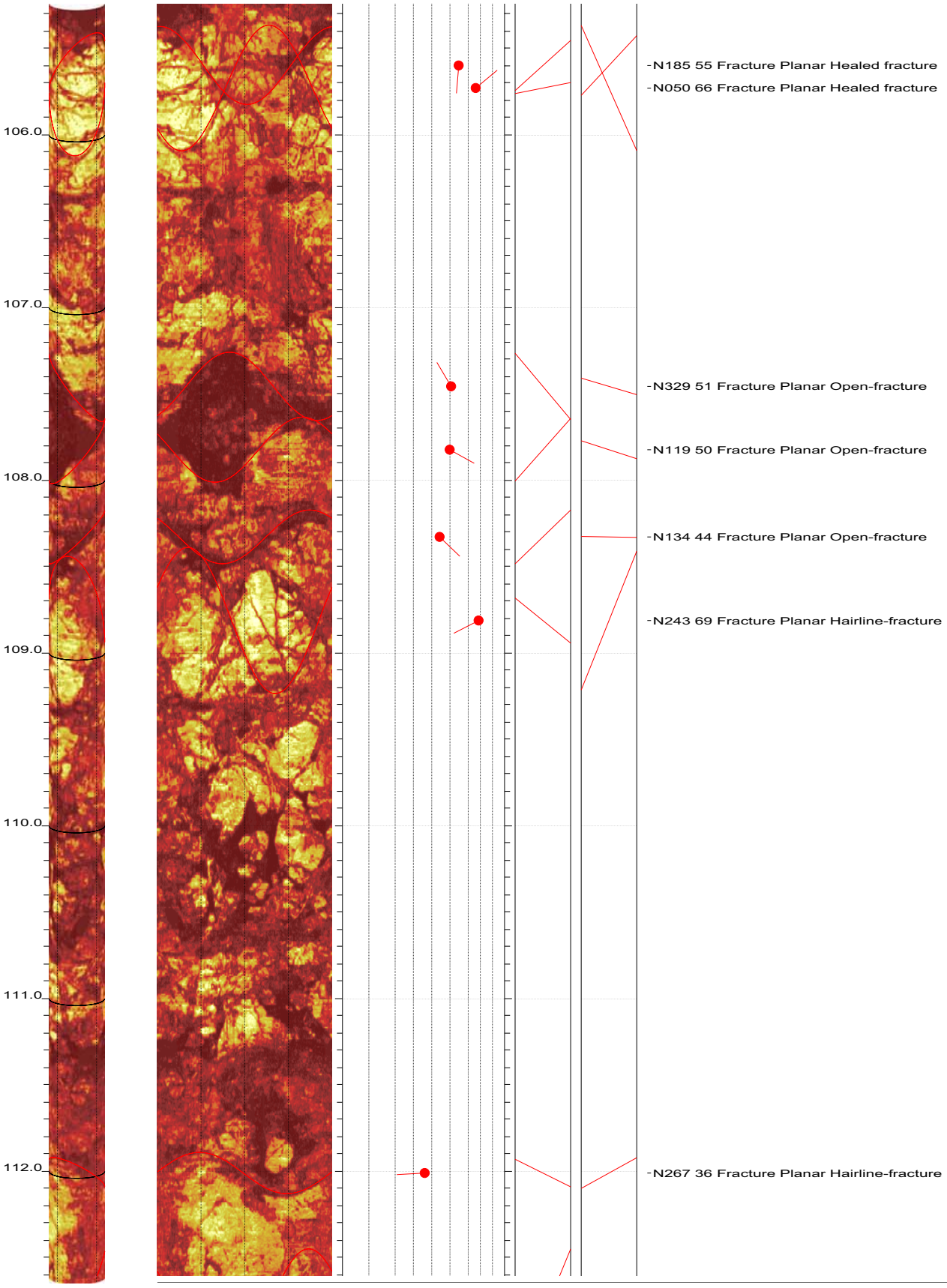
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 11 of 18



Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 12 of 18

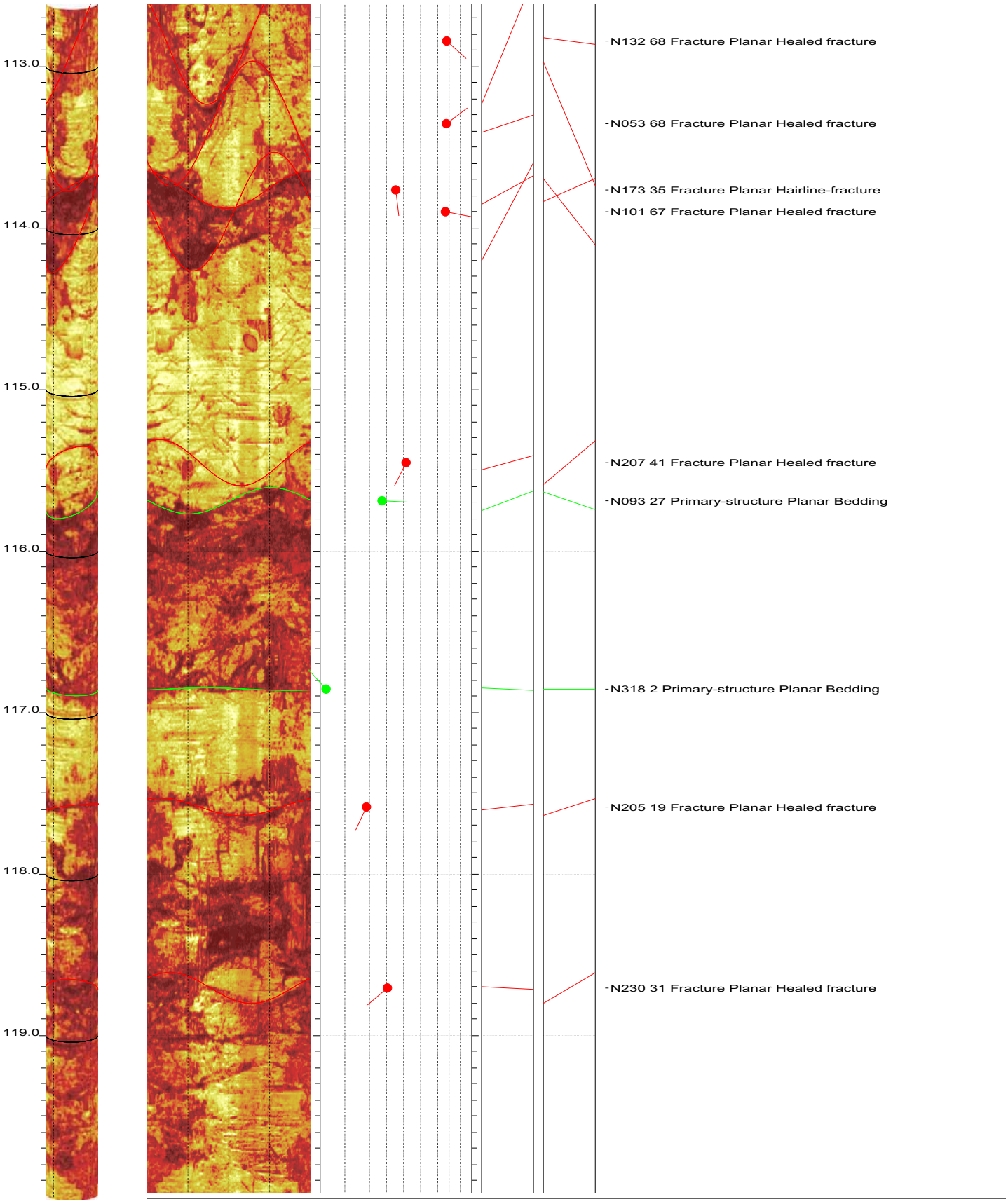


Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 13 of 18

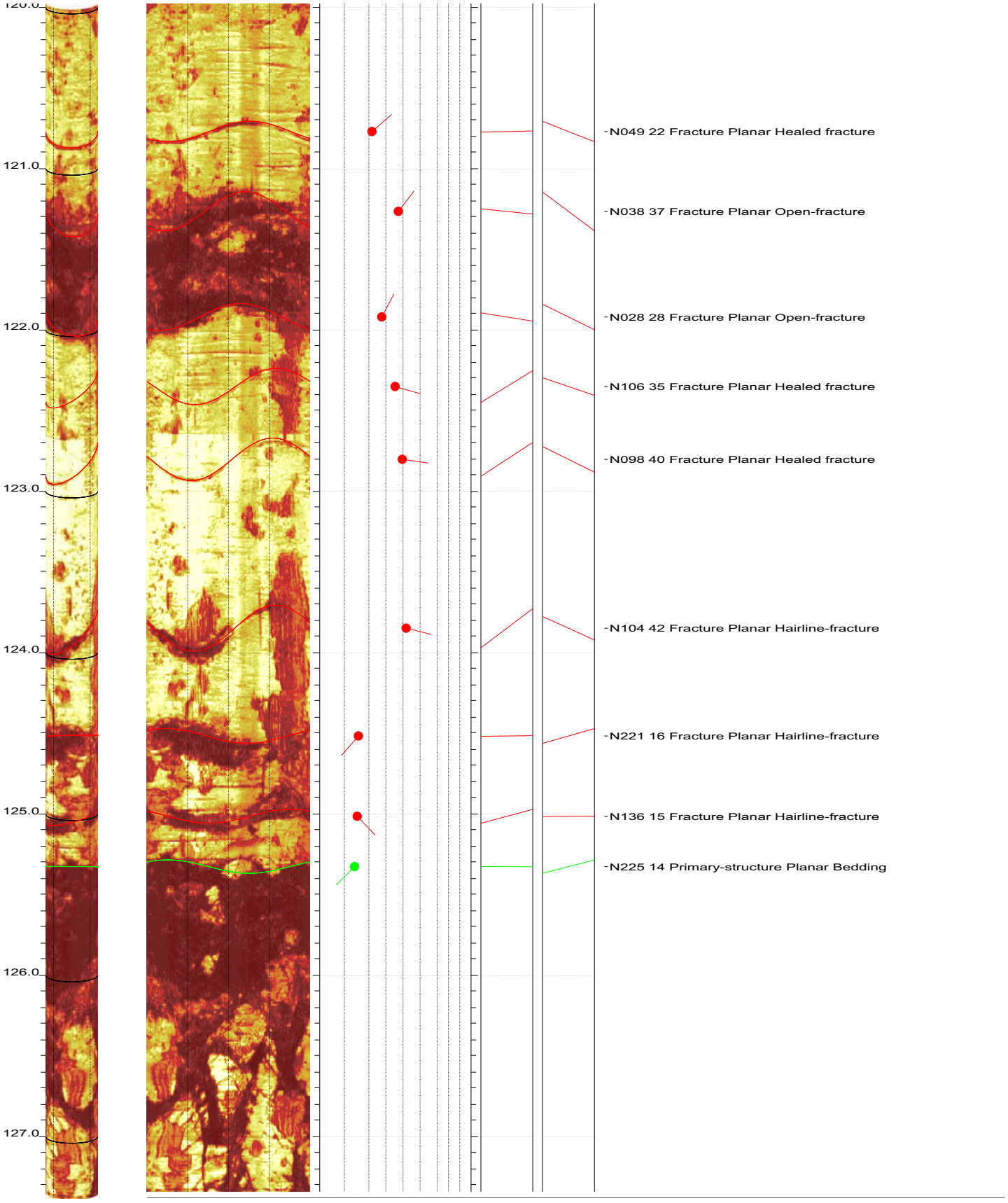


RW8-R1 112.610 to 105.242ft 14

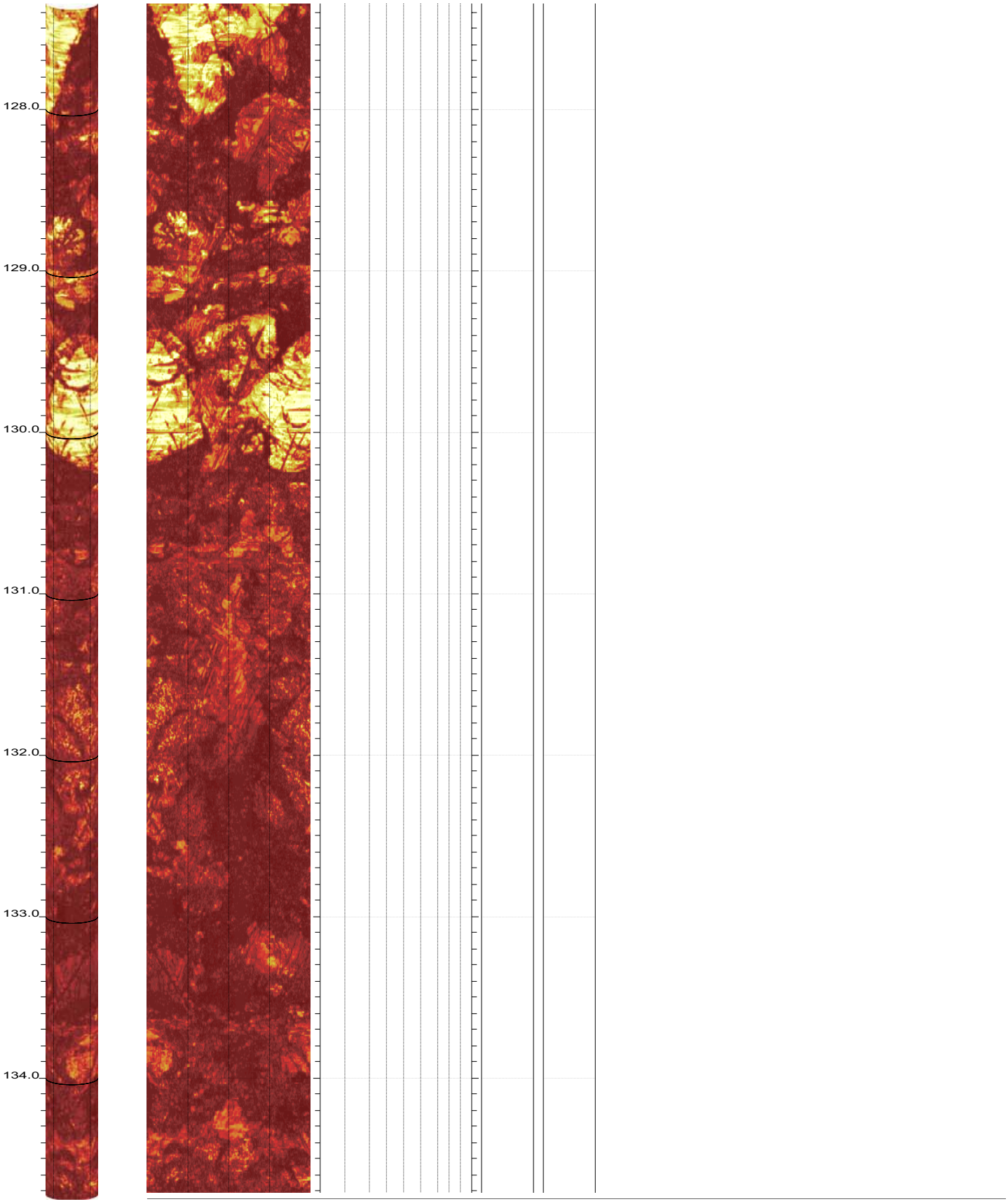
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 14 of 18



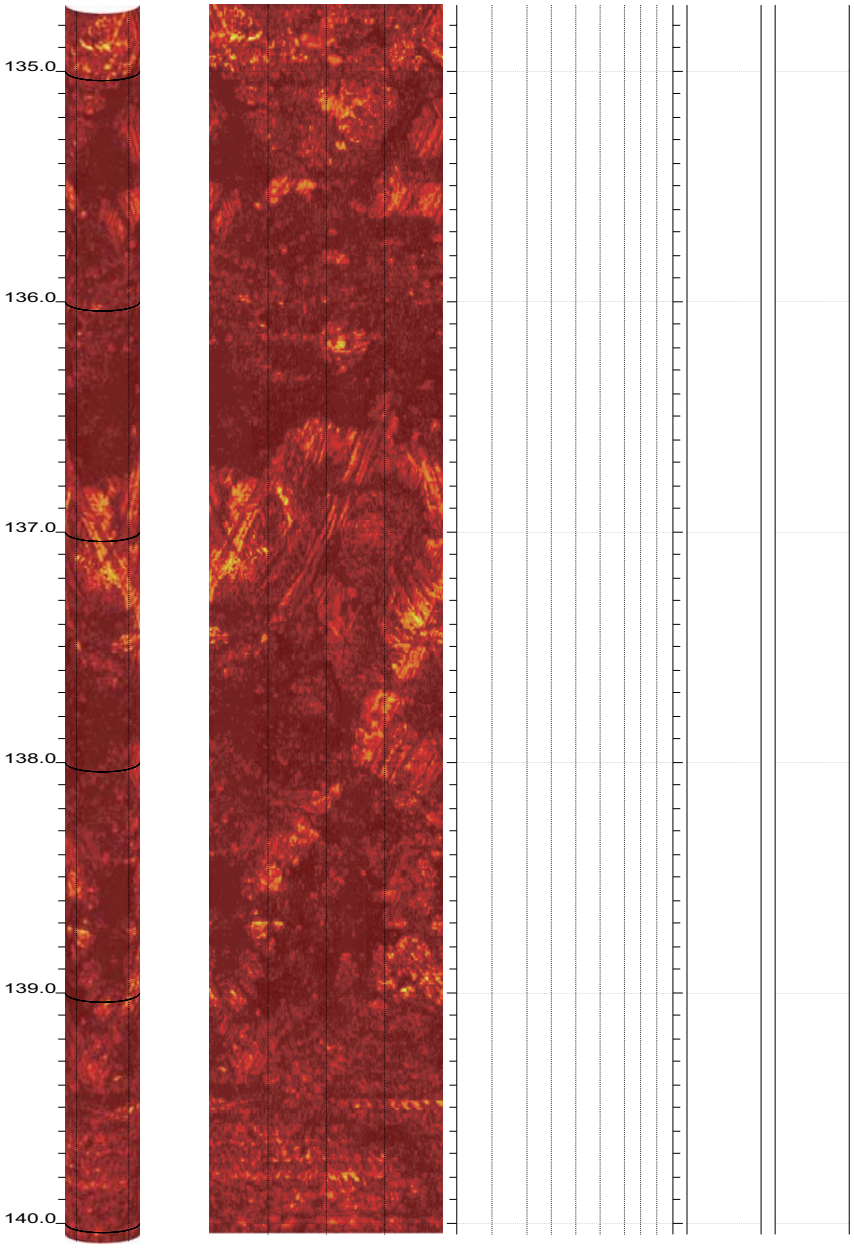
Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 15 of 18



Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 16 of 18



Doyle Drive RW8-R1 Acoustic Televiewer Dips Sheet 17 of 18


135.0
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APPENDIX D

TELEVIEWER FRACTURE DISTRIBUTION HISTOGRAMS

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS LOG

16 Jun 2008

ARUP

Borehole: BTNB-R5

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

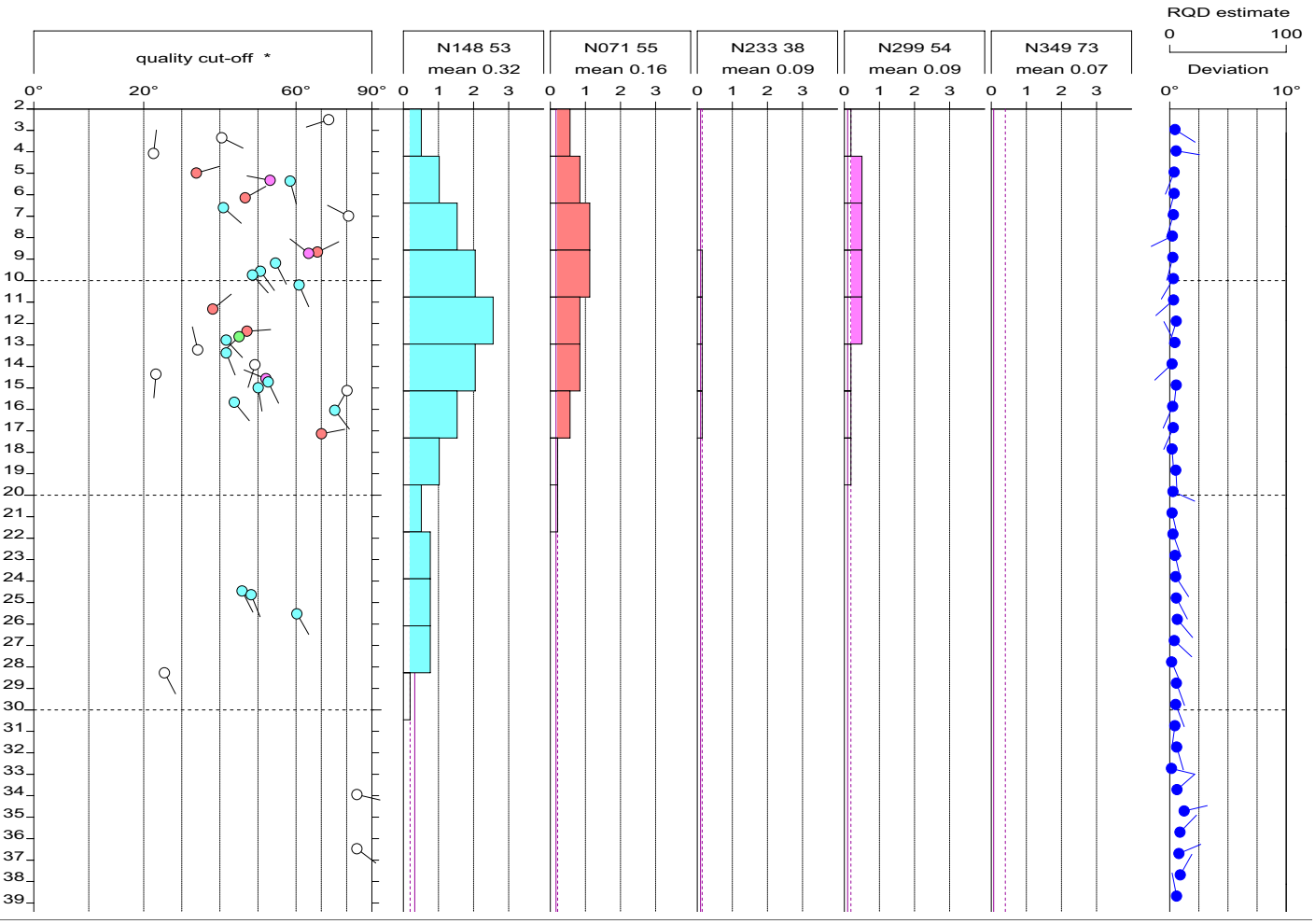
North ref: true
Depth units are feet
Vertical scale: 1/100

Zone from 105.699 to 2.007ft
Mean dip format: dip-azimuth and dip
Frequency histogram parameters:

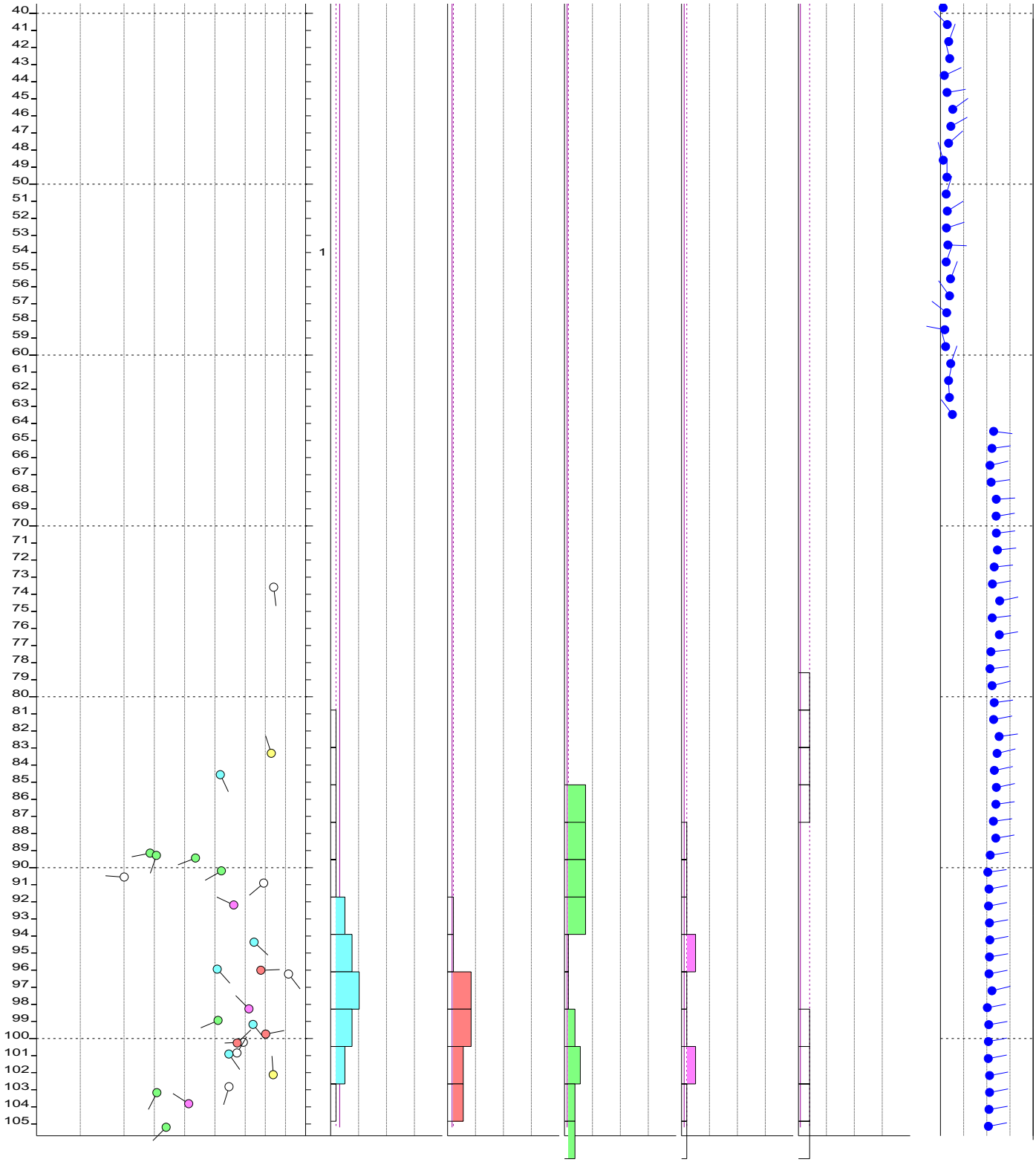
measurement distance 0.000ft
step distance 0.000ft

Interpretation 1

Dip data sets .....
BHTV dips
Highlighted dips: Fracture Planar Fresh Open-fracture
open symbols not used in mean-dip/zone-axis calculation



BTNB-R5, Interpretation 1 39.437 to 2.007ft 1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DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS LOG

14 Jun 2008

ARUP

Borehole: BTSB-R3

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

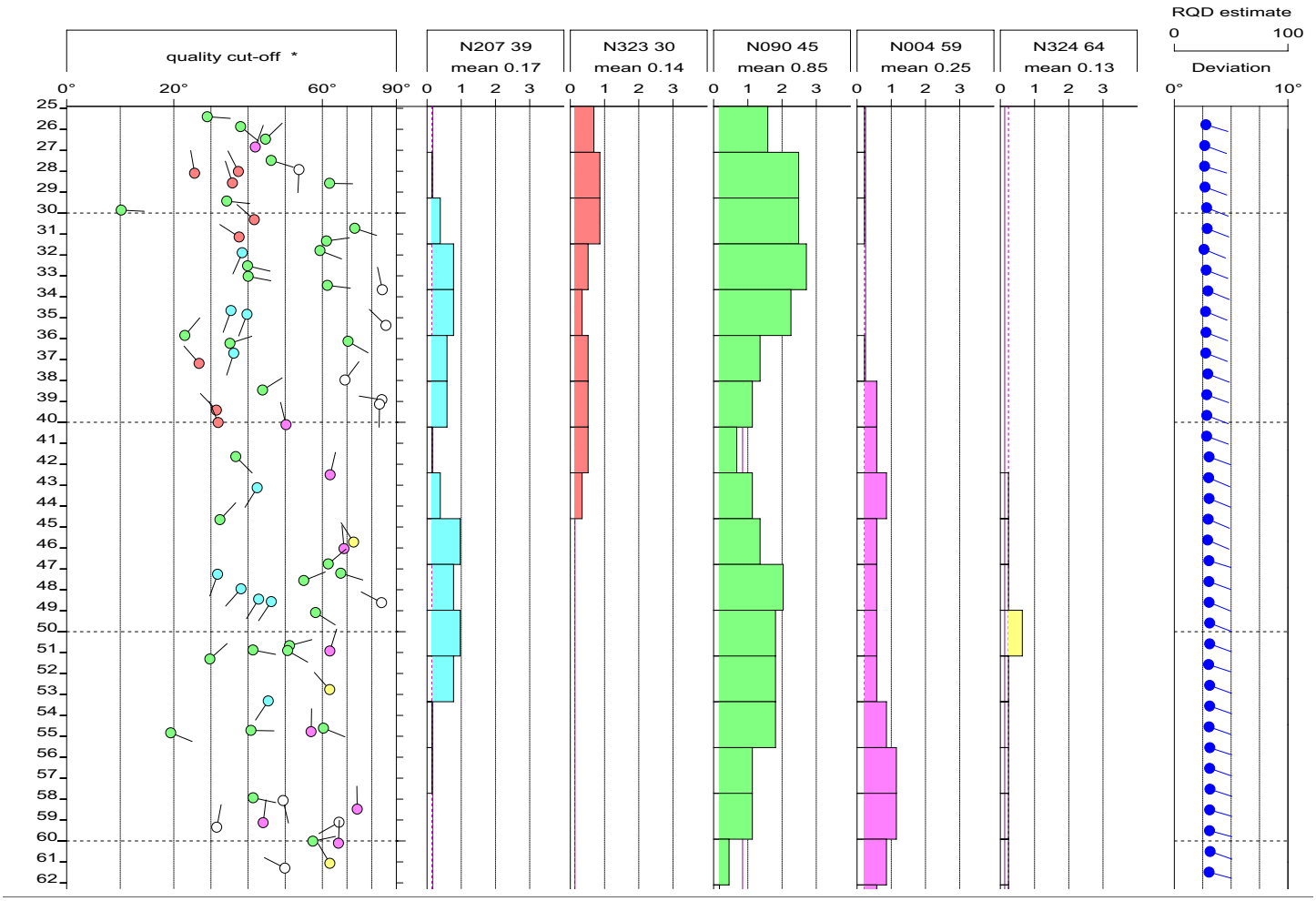
North ref: true
Depth units are feet
Vertical scale: 1/100

Zone from 107.314 to 24.900ft
Mean dip format: dip-azimuth and dip
Frequency histogram parameters:

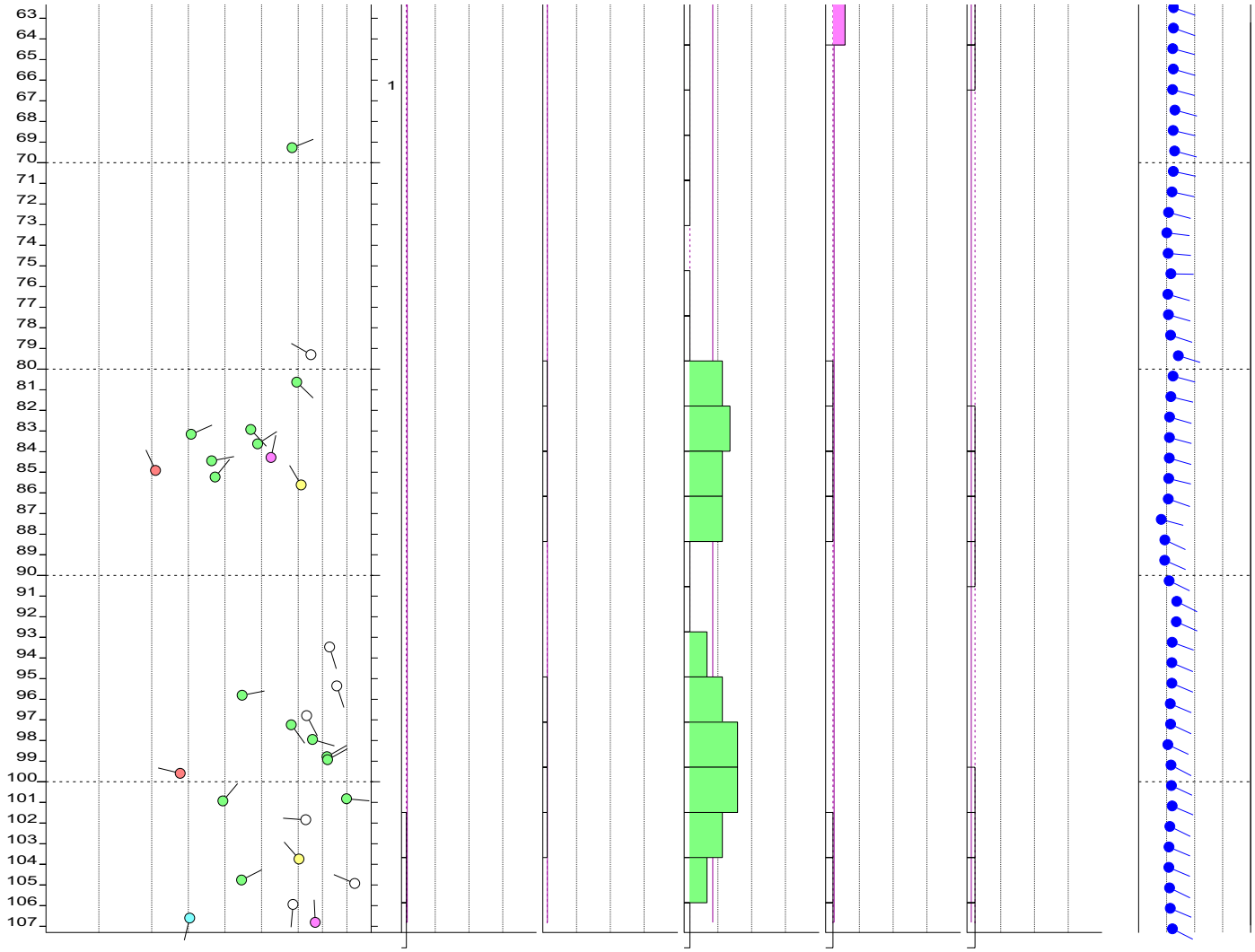
measurement distance 0.000ft
step distance 0.000ft

Interpretation 1

Dip data sets .....
BHTV dips
Highlighted dips: Fracture Planar Fresh Open-fracture
open symbols not used in mean-dip/zone-axis calculation



BTSB-R3, Interpretation 1 62.330 to 24.900ft 1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DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS LOG

15 Jun 2008

ARUP

Borehole: RW6-R1

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

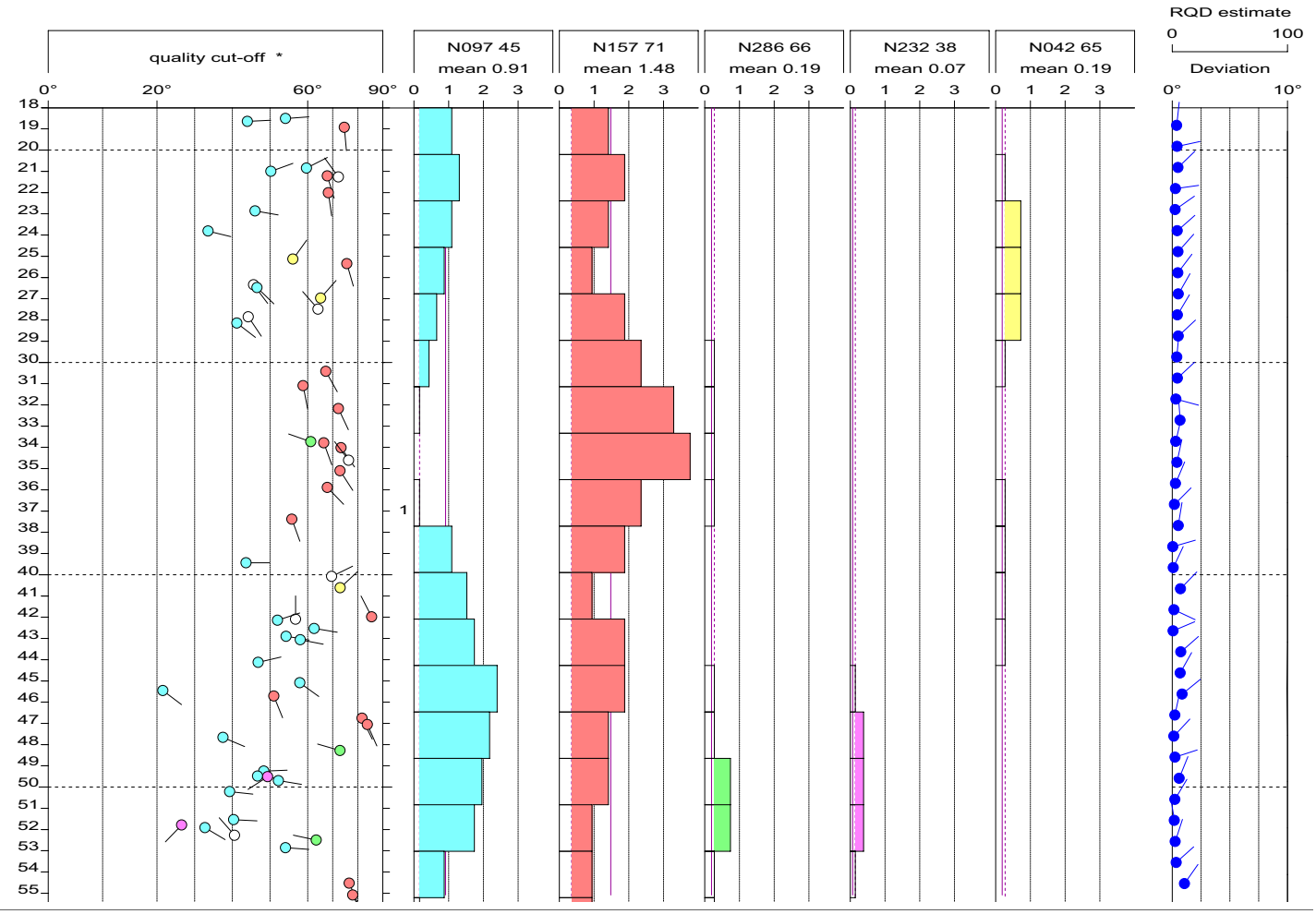
North ref: true
Depth units are feet
Vertical scale: 1/100

Zone from 55.586 to 18.009ft
Mean dip format: dip-azimuth and dip
Frequency histogram parameters:

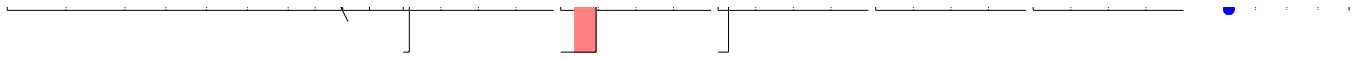
measurement distance 0.000ft
step distance 0.000ft

Interpretation 1

Dip data sets .....
BHTV dips
Highlighted dips: Fracture Planar Fresh Open-fracture
open symbols not used in mean-dip/zone-axis calculation



RW6-R1, Interpretation 1 55.439 to 18.009ft 1



DIP DATA INTERPRETATION
RGLDIP vsn 6.2
FRACTURE ANALYSIS LOG

16 Jun 2008

ARUP

Borehole: RW6-R2

DOYLE DRIVE

top of borehole.....
East:_
North:_
Elev:_

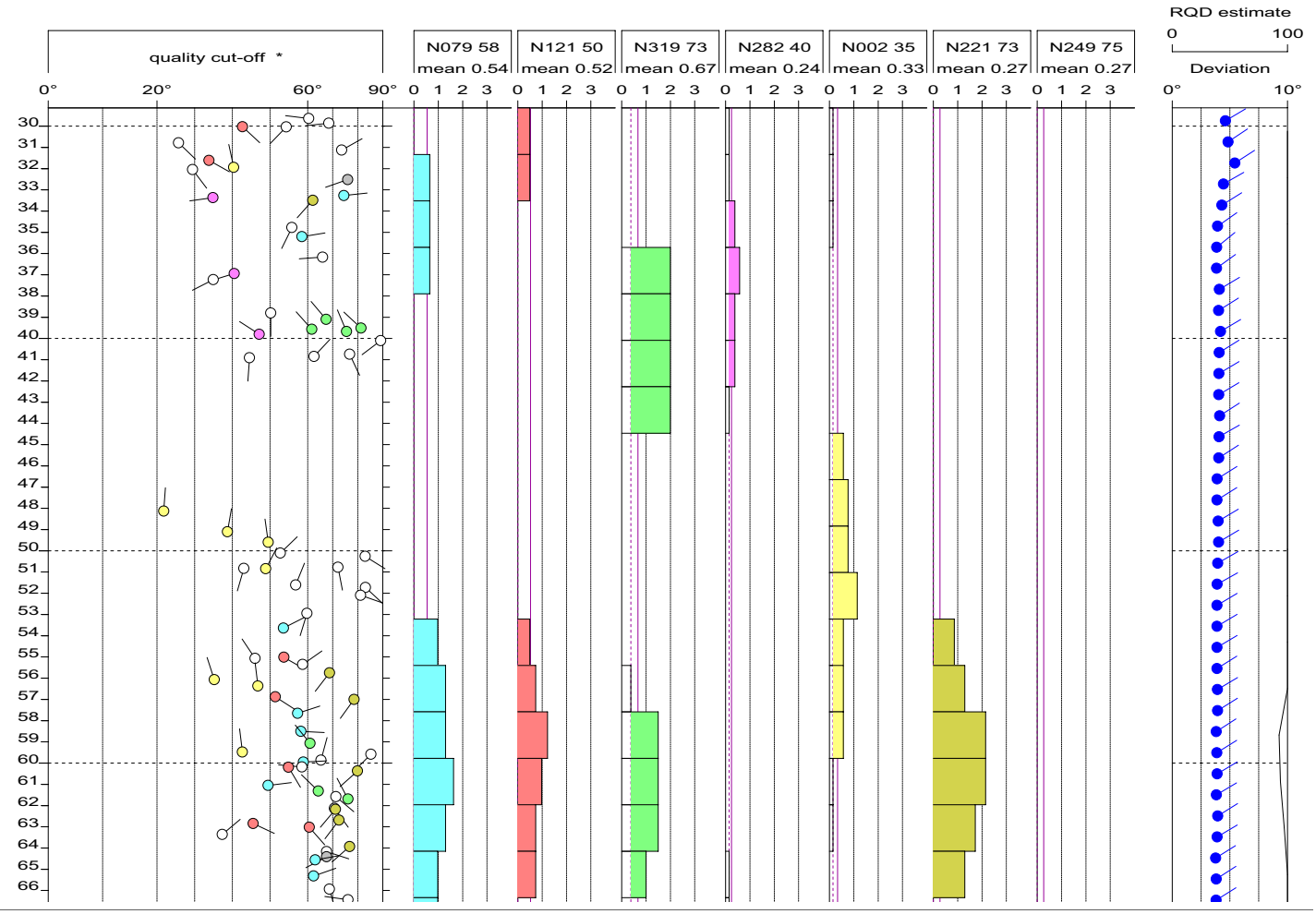
North ref: true
Depth units are feet
Vertical scale: 1/100

Zone from 112.336 to 29.137ft
Mean dip format: dip-azimuth and dip
Frequency histogram parameters:

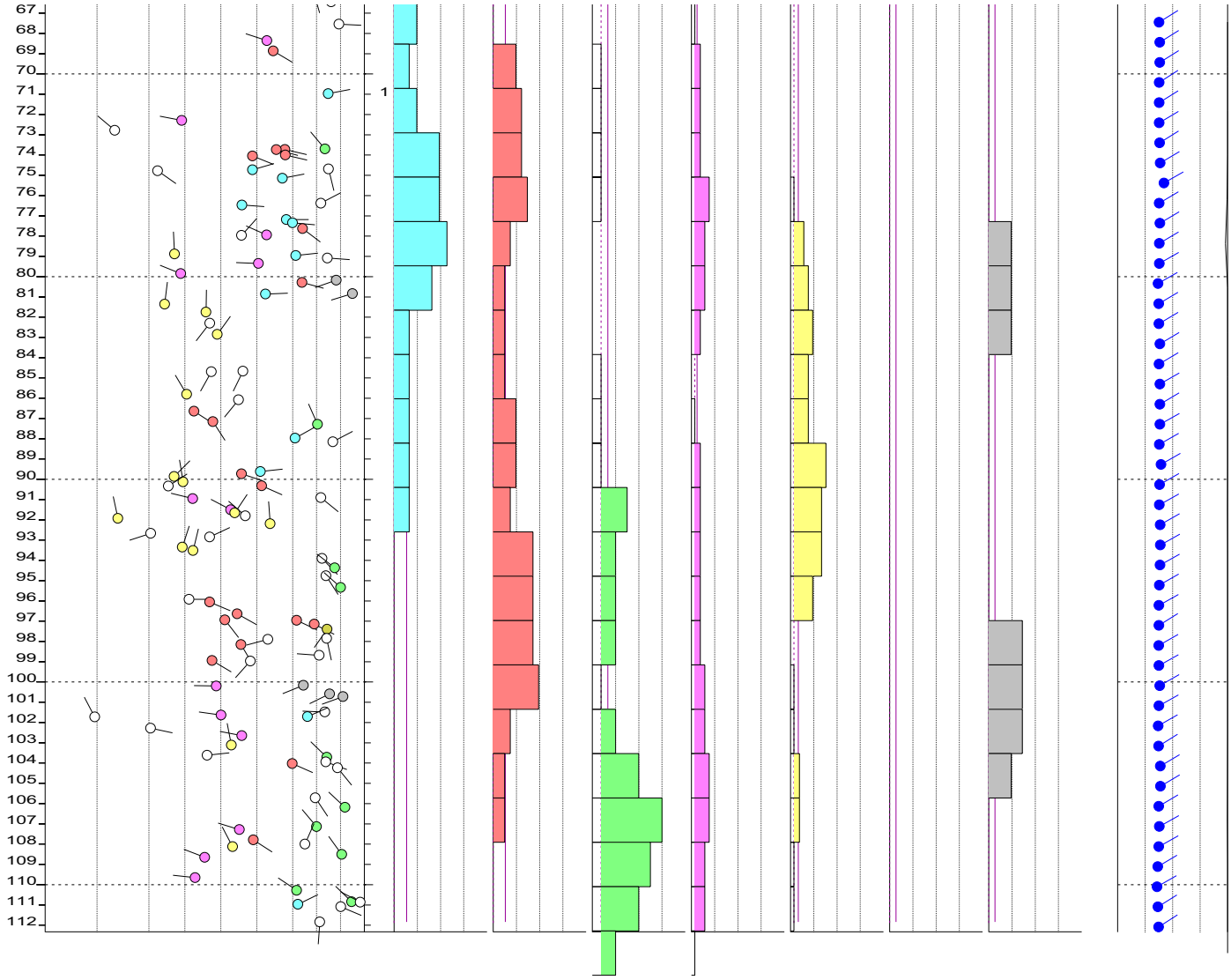
measurement distance 0.000ft
step distance 0.000ft

Interpretation 1

Dip data sets .....
BHTV dips
Highlighted dips: Fracture Planar Fresh Open-fracture
open symbols not used in mean-dip/zone-axis calculation



RW6-R2, Interpretation 1 66.567 to 29.137ft 1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APPENDIX E

TELEVIEWER ROSE DIAGRAMS

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
DIP-AZIMUTH, FRACTURE ROSE-DIAGRAM

16 Jun 2008

ARUP

Borehole: BTNB-R5

DOYLE DRIVE

top of borehole.....
East:_
North:_
Alt: _

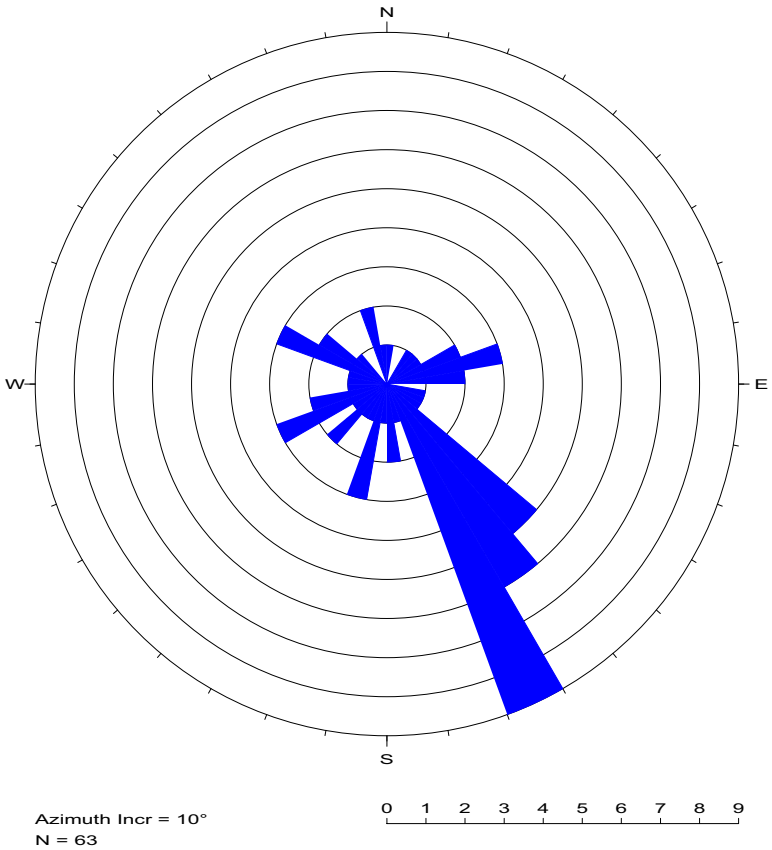
North ref. is true
Depth units are feet

Zone from 105.699 to 2.007ft

Interpretation 1

Dip data sets .....
BHTV dips

BTNB-R5
2.007 - 105.699ft
Dip-azimuth, fracture rose-diagram



Azimuth Incr = 10°
N = 63

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
DIP-AZIMUTH, FRACTURE ROSE-DIAGRAM

14 Jun 2008

ARUP

Borehole: BTSB-R3

DOYLE DRIVE

top of borehole.....
East:_
North:_
Alt: _

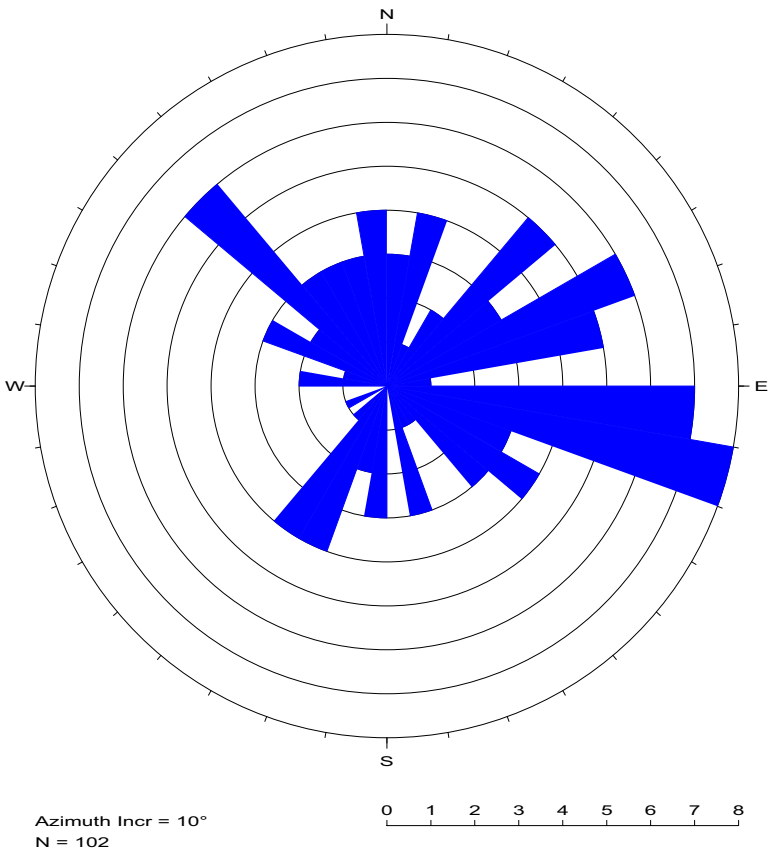
North ref. is true
Depth units are feet

Zone from 107.314 to 24.900ft

Interpretation 1

Dip data sets .....
BHTV dips

BTSB-R3
24.900 - 107.314ft
Dip-azimuth, fracture rose-diagram



Azimuth Incr = 10°
N = 102

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
DIP-AZIMUTH, FRACTURE ROSE-DIAGRAM

15 Jun 2008

ARUP

Borehole: RW6-R1

DOYLE DRIVE

top of borehole.....
East:_
North:_
Alt: _

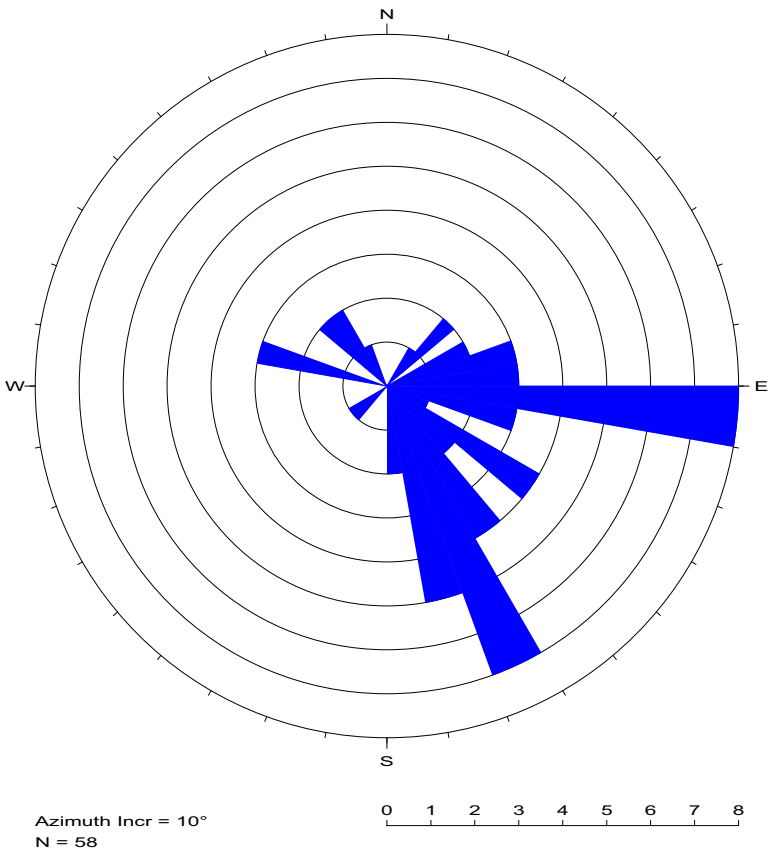
North ref. is true
Depth units are feet

Zone from 55.586 to 18.009ft

Interpretation 1

Dip data sets .....
BHTV dips

RW6-R1
18.009 - 55.586ft
Dip-azimuth, fracture rose-diagram



Azimuth Incr = 10°
N = 58

DIP DATA INTERPRETATION
RGLDIP vsn 6.2
DIP-AZIMUTH, FRACTURE ROSE-DIAGRAM

16 Jun 2008

ARUP

Borehole: RW6-R2

DOYLE DRIVE

top of borehole.....
East:_
North:_
Alt: _

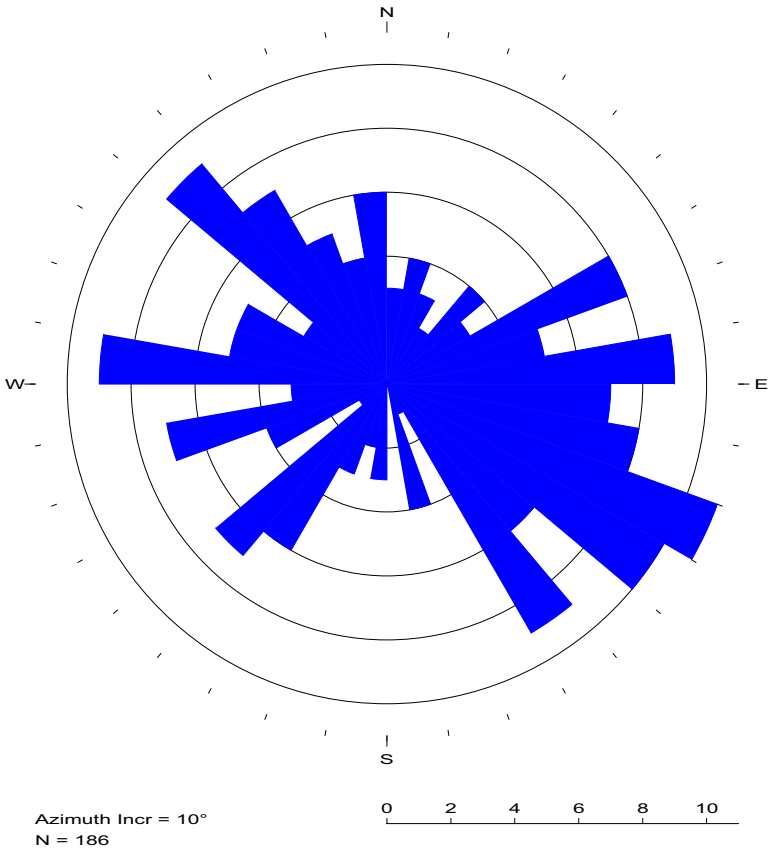
North ref. is true
Depth units are feet

Zone from 112.336 to 29.137ft

Interpretation 1

Dip data sets .....
BHTV dips

RW6-R2
29.137 - 112.336ft
Dip-azimuth, fracture rose-diagram



Azimuth Incr = 10°
N = 186

APPENDIX F

GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION PROCEDURES AND CALIBRATION RECORDS

CALIBRATION PROCEDURE FOR

GEOVision SEISMIC RECORDER/LOGGER

Reviewed 4/6/06

Objective

The timing/sampling accuracy of seismic recorders or data loggers is required for several GEOVision field procedures including Seismic Refraction, Downhole Seismic Velocity Logging, and P-S Suspension Logging. This procedure describes the method for measuring the timing accuracy of a seismic data logger, such as the OYO Model 170, OYO/Robertson Model 3403, Geometrics Strataview or Geometrics Geode. The objective of this procedure is to verify that the timing accuracy of the recorder is accurate to within 1%.

Frequency of Calibration

The calibration of each GEOVision seismic data logger is twelve (12) months. In the case of rented seismic data loggers, calibration must be performed prior to use.

Test Equipment Required

The following equipment is required. Item #2 must have current NIST traceable calibration.

1. Function generator, Krohn Hite 5400B or equivalent
2. Frequency counter, HP 5315A or equivalent
3. Test cables, from item 1 to item 2, and from item 1 to subject data logger.

Procedure

This procedure is designed to be performed using the accompanying Seismograph Calibration Data Sheet with the same revision number. All data must be entered and the procedure signed by the technician performing the test.

1. Record all identification data on the form provided.
2. Connect function generator to data logger (such as OYO Model 170) using test cable
3. Connect the function generator to the frequency counter using test cable.

4. Set up generator to produce a 100.0 Hz, 0.25 volt (amplitude is approximate, modify as necessary to yield less than full scale waveforms on logger display) peak square wave or sine wave. Verify frequency using the counter and initial space on the data sheet.

5. Initialize data logger and record a data record of at least 0.1 second using a 100 microsecond or less sample period.

6. Measure the recorded square wave frequency by measuring the duration of 9 cycles of data. This measurement can be made using the data logger display device, or by printing out a paper tape. If a paper tape can be printed, the resulting printout must be attached to this procedure. Record the data in the space provided.

7. Repeat steps 5 and 6 three more times using separate files.

Criteria

The duration for 9 cycles in any file must be 90.0 milliseconds plus or minus 0.9 milliseconds, corresponding to an average frequency for the nine cycles of 100.0 Hz plus or minus 1 Hz (obtained by dividing 9 cycles by the duration in milliseconds).

If the results are outside this range, the data logger must be marked with a GEOVision REJECT tag until it can be repaired and retested.

If results are acceptable affix label indicating the initials of the person performing the calibration, the date of calibration, and the due date for the next calibration (12 months).

Procedure Approval

Approved by:

John G. Diehl	President
Name	Title
Signature	April 6, 2006
	Date

Client Approval (if required):

_____	_____
Name	Title
_____	_____
Signature	Date

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Metrology
7300 Fenwick Lane
Westminster, CA 92683
Phone: 866-723-2257

Calibration Report

NVLAP Accredited
Calibration

GEOVision Geophysical Services
1151 Pomona Road, Unit P
Corona, CA 92882

TEST NUMBER
550392

NVLAP®
Lab Code:105014-0

Manufacturer:	Oyo Corporation	**Condition As Found:**	In Tolerance
Model Number:	3331-A	**Condition As Left:**	In Tolerance
Description:	Logger, Suspension,	**Calibration Date:**	01/25/2008
Asset Number:	19029	**Calibration Due Date:**	01/25/2009
Serial Number:	19029	**Calibration Interval:**	12 Months
PO Number:	8200-080122-01		

Remarks:

The UUT (unit under test) was calibrated using the customer's procedure. The UUT was operated by the customer's personnel and data collection was observed by SCE personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in compliance with ISO/IEC 17025:1999 and laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0. Frequency is accredited. Measurement uncertainity is 0.2 x E-12 Hz. Please see attached data.

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal,	12/28/2007	06/28/2008
S1-01347	Hewlett Packard	3325A	Generator, Function, Synthesizer	10/09/2007	04/09/2008
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/22/2008	01/22/2009

Procedure: Customer
Temperature: 23° C
Humidity: 37% RH
Test No.: 550392

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A CAB	Metrologist	714-895-0714		1/25/08
Name	Title	Phone	Name	Date

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GEOVision
geophysical services

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR: OYO		MODEL NO.:	3331A
SERIAL NO.:	19029	CALIBRATION DATE:	01/25/2008
BY:	ROBERT STELLER	DUE DATE:	01/25/2009
COUNTER MFR: HEWLETT PACKARD		MODEL NO.:	5335A
SERIAL NO.:	2626A09881	CALIBRATION DATE:	12/28/2007
BY:	SCE #S1-01252	DUE DATE:	6/28/2008
FCTN GEN MFR: HEWLETT PACKARD		MODEL NO.:	3325A
SERIAL NO.:	2652A25647	CALIBRATION DATE:	10/9/2007
BY:	SCE #S1-01347	DUE DATE:	4/9/2008

SYSTEM SETTINGS:

GAIN:	10
FILTER:	20 KHZ
RANGE:	100 MILLISEC
DELAY:	0
STACK: 1 (STD)	1
PULSE:	1.6
DISPLAY:	NA
SYSTEM: DATE = CORRECT DATE & TIME	01/25/2008, 09:50AM

PROCEDURE:

SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 AS LEFT 100.0

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	201	100.0	90.0	90.0	90.0	100.0
SQUARE	202	100.0	90.0	90.0	90.0	100.0
SINE	203	100.0	90.0	90.0	90.1	100.0
SINE	204	100.0	90.0	90.0	90.0	100.0

CALIBRATED BY: ROBERT STELLER 1/25/2008 Robt Steller

NAME DATE SIGNATURE

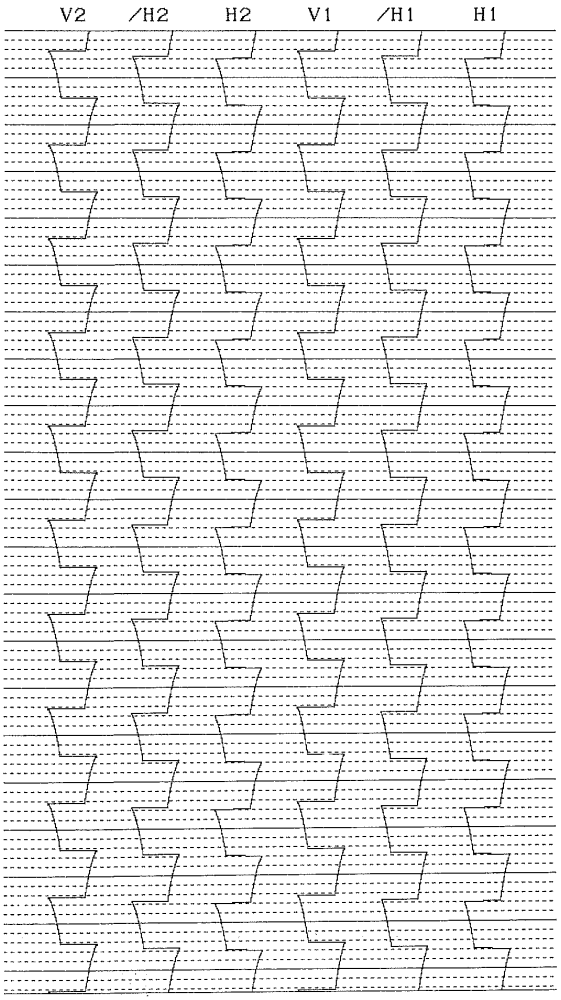
OYO

Suspension 170 4.25 S/N 19029

ID_NO. : 201
HOLE NO. : 0
DEPTH : 0.0 [m]
DATE : 25/01/08 09:54:06 AM
H-SAMPLE RATE: 100 [μSEC]
V-SAMPLE RATE: 100 [μSEC]
PULSE WIDTH : 1.6 [mSEC]
DELAY TIME : 0 [mSEC]

	H1	/H1	V1	H2	/H2	V2
GAIN	X 10	X 10	X 10	X 10	X 10	X 10
LCF[Hz]	5	5	5	5	5	5
HCF[Hz]	20K	20K	20K	20K	20K	20K
STACK	1	1	1	1	1	1

TRACE SIZE : 1
H-TIME SCALE: 1.00 [mSEC/LINE]
V-TIME SCALE: 1.00 [mSEC/LINE]



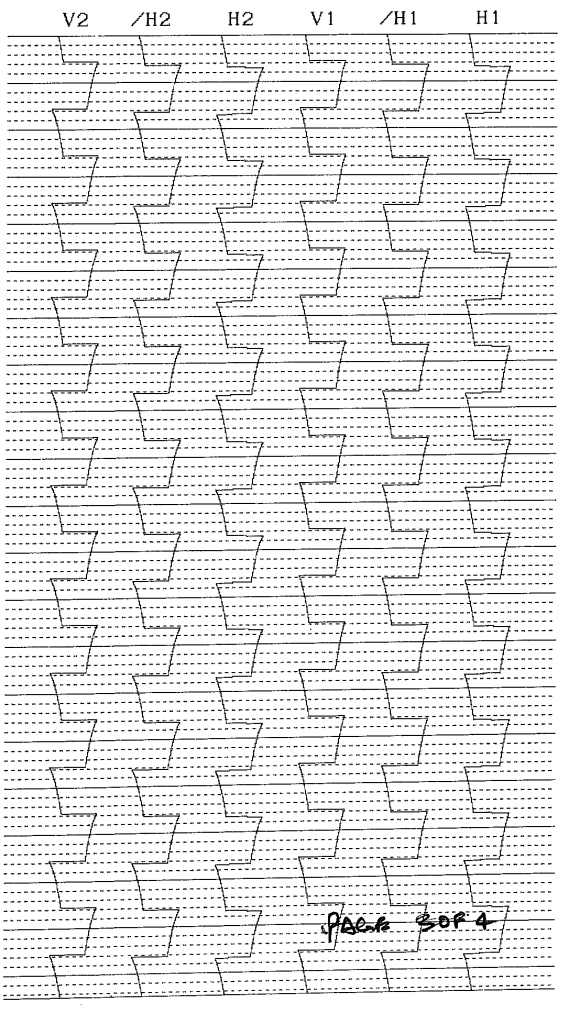
OYO

Suspension 170 4.25 S/N 19029

ID_NO. : 202
HOLE NO. : 0
DEPTH : 0.0 [m]
DATE : 25/01/08 09:55:24 AM
H-SAMPLE RATE: 100 [μSEC]
V-SAMPLE RATE: 100 [μSEC]
PULSE WIDTH : 1.6 [mSEC]
DELAY TIME : 0 [mSEC]

	H1	/H1	V1	H2	/H2	V2
GAIN	X 10	X 10	X 10	X 10	X 10	X 10
LCF[Hz]	5	5	5	5	5	5
HCF[Hz]	20K	20K	20K	20K	20K	20K
STACK	1	1	1	1	1	1

TRACE SIZE : 1
H-TIME SCALE: 1.00 [mSEC/LINE]
V-TIME SCALE: 1.00 [mSEC/LINE]



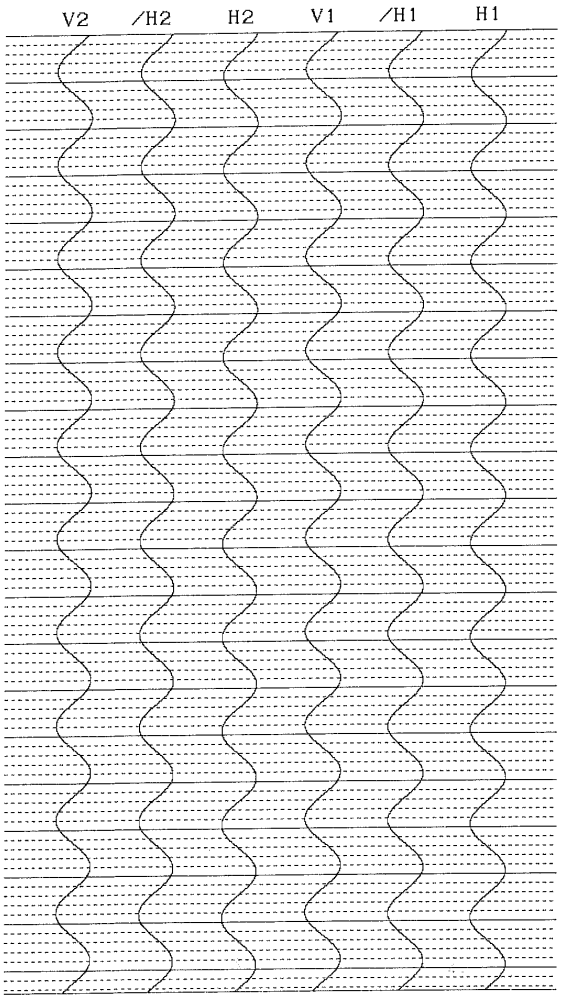
OYO

Suspension 170 4.25 S/N 19029

ID_NO. : 203
HOLE NO. : 0
DEPTH : 0.0 [m]
DATE : 25/01/08 09:58:54 AM
H-SAMPLE RATE: 100 [μSEC]
V-SAMPLE RATE: 100 [μSEC]
PULSE WIDTH : 1.6 [mSEC]
DELAY TIME : 0 [mSEC]

	H1	/H1	V1	H2	/H2	V2
GAIN	X 10	X 10	X 10	X 10	X 10	X 10
LCF[Hz]	5	5	5	5	5	5
HCF[Hz]	20K	20K	20K	20K	20K	20K
STACK	1	1	1	1	1	1

TRACE SIZE : 1
H-TIME SCALE: 1.00 [mSEC/LINE]
V-TIME SCALE: 1.00 [mSEC/LINE]



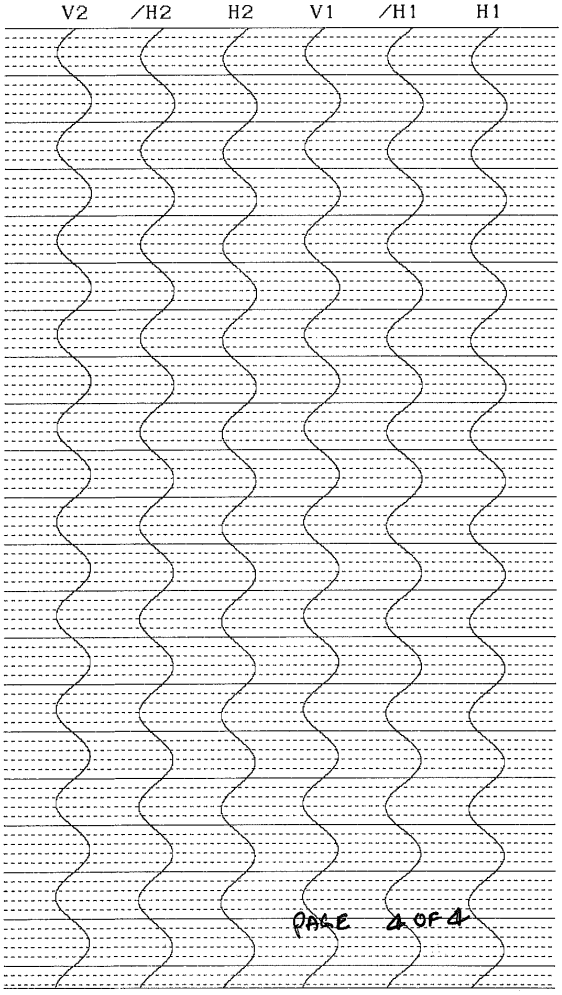
OYO

Suspension 170 4.25 S/N 19029

ID_NO. : 204
HOLE NO. : 0
DEPTH : 0.0 [m]
DATE : 25/01/08 09:59:57 AM
H-SAMPLE RATE: 100 [μSEC]
V-SAMPLE RATE: 100 [μSEC]
PULSE WIDTH : 1.6 [mSEC]
DELAY TIME : 0 [mSEC]

	H1	/H1	V1	H2	/H2	V2
GAIN	X 10	X 10	X 10	X 10	X 10	X 10
LCF[Hz]	5	5	5	5	5	5
HCF[Hz]	20K	20K	20K	20K	20K	20K
STACK	1	1	1	1	1	1

TRACE SIZE : 1
H-TIME SCALE: 1.00 [mSEC/LINE]
V-TIME SCALE: 1.00 [mSEC/LINE]



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Phone: 866-723-2257

Calibration Report

NVLAP Accredited
Calibration
GEOVision Geophysical Services
1151 Pomona Road, Unit P
Corona, CA 92882

TEST NUMBER 550393

NVLAP® Lab Code:105014-0

Manufacturer:	Oyo
Model Number:	3403
Description:	Unit, Suspension Telemetry,
Asset Number:	160023
Serial Number:	160023
PO Number:	8200-080122-01

Condition As Found:	In Tolerance
Condition As Left:	In Tolerance
Calibration Date:	01/25/2008
Calibration Due Date:	01/25/2009
Calibration Interval:	12 Months

Remarks:

The UUT (unit under test) was calibrated using the customer's procedure. The UUT was operated by the customer's personnel and data collection was observed by SCE personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in compliance with ISO/IEC 17025:1999 and laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0. Frequency is accredited. Measurement uncertainity is 0.2 x E-12 Hz. Please see attached data.

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal,	12/28/2007	06/28/2008
S1-01347	Hewlett Packard	3325A	Generator, Function, Synthesizer	10/09/2007	04/09/2008
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/22/2008	01/22/2009

Procedure: Customer
Temperature: 23° C
Humidity: 37% RH
Test No.: 550393

Calibration Performed By:			Quality Reviewer:	
Branson, Craig A CAB	Metrologist	714-895-0714		1/25/08
Name	Title	Phone	Name	Date

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GEOVision geophysical services

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR: OYO		MODEL NO.:	3403
SERIAL NO.:	160023	CALIBRATION DATE:	01/25/2008
BY:	ROBERT STELLER	DUE DATE:	01/25/2009
COUNTER MFR: HEWLETT PACKARD		MODEL NO.:	5335A
SERIAL NO.:	2626A09881	CALIBRATION DATE:	12/28/2007
BY:	SCE #S1-01252	DUE DATE:	6/28/2008
FCTN GEN MFR: HEWLETT PACKARD		MODEL NO.:	3325A
SERIAL NO.:	2652A25647	CALIBRATION DATE:	10/9/2007
BY:	SCE #S1-01347	DUE DATE:	4/9/2008

SYSTEM SETTINGS:

GAIN:	10
FILTER:	20 KHZ
RANGE:	100 MILLISEC
DELAY:	0
STACK: 1 (STD)	1
PULSE:	1.6
DISPLAY:	NA
SYSTEM: DATE = CORRECT DATE & TIME	01/25/2008, 12:20PM

PROCEDURE:

SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 AS LEFT 100.0

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	301	100.0	90.0	90.0	90.0	100.0
SQUARE	302	100.0	90.0	90.0	90.0	100.0
SINE	303	100.0	90.0	90.0	90.0	100.0
SINE	304	100.0	90.0	90.0	90.0	100.0

CALIBRATED BY: ROBERT STELLER 1/25/2008 Rob Steller

NAME DATE SIGNATURE

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Phone: 866-723-2257

Calibration Report

NVLAP Accredited
Calibration

GEOVision Geophysical Services
1151 Pomona Road, Unit P
Corona, CA 92882

TEST NUMBER
550394

NVLAP®
Lab Code:105014-0

Manufacturer:	Oyo
Model Number:	3403
Description:	Unit, Suspension Telemetry,
Asset Number:	160024
Serial Number:	160024
PO Number:	8200-080122-01

Condition As Found:	In Tolerance
Condition As Left:	In Tolerance
Calibration Date:	01/25/2008
Calibration Due Date:	01/25/2009
Calibration Interval:	12 Months

Remarks:

The UUT (unit under test) was calibrated using the customer's procedure. The UUT was operated by the customer's personnel and data collection was observed by SCE personnel. The UUT was found to be in tolerance to customer supplied specifications. The reference standards used are in compliance with ISO/IEC 17025:1999 and laboratory accreditation criteria established by NIST/NVLAP under the specific scope of accreditation for lab code 105014-0. Frequency is accredited. Measurement uncertainity is 0.2 x E-12 Hz. Please see attached data.

Standards Utilized

I.D. No.	Mfg.	Model No.	Description	Cal. Date	Due Date
S1-01252	Hewlett Packard	5335A OPT 010,203040	Counter, Universal,	12/28/2007	06/28/2008
S1-01347	Hewlett Packard	3325A	Generator, Function, Synthesizer	10/09/2007	04/09/2008
S1-03686	Fluke	910	Standard, Frequency, Controlled, Gps	01/22/2008	01/22/2009

Procedure: Customer
Temperature: 23° C
Humidity: 37% RH
Test No.: 550394

Calibration Performed By:			Quality Reviewer:
Branson, Craig A CAB	Metrologist	714-895-0714	1/25/08
Name	Title	Phone	Name / Date

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GEOVision geophysical services

SEISMOGRAPH CALIBRATION DATA SHEET REV 4/6/06

INSTRUMENT DATA

SYSTEM MFR:	OYO	MODEL NO.:	3403
SERIAL NO.:	160024	CALIBRATION DATE:	01/25/2008
BY:	ROBERT STELLER	DUE DATE:	01/25/2009
COUNTER MFR:	HEWLETT PACKARD	MODEL NO.:	5335A
SERIAL NO.:	2626A09881	CALIBRATION DATE:	12/28/2007
BY:	SCE #S1-01252	DUE DATE:	6/28/2008
FCTN GEN MFR:	HEWLETT PACKARD	MODEL NO.:	3325A
SERIAL NO.:	2652A25647	CALIBRATION DATE:	10/9/2007
BY:	SCE #S1-01347	DUE DATE:	4/9/2008

SYSTEM SETTINGS:

GAIN:	10
FILTER:	20 KHZ
RANGE:	100 MILLISEC
DELAY:	0
STACK: 1 (STD)	1
PULSE:	1.6
DISPLAY:	NA
SYSTEM: DATE = CORRECT DATE & TIME	01/25/2008, 12:20PM

PROCEDURE:

SET FREQUENCY TO 100.0HZ SQUAREWAVE WITH AMPLITUDE APPROXIMATELY 0.25 VOLT PEAK. RECORD BOTH ON DISK AND PAPER TAPE, IF AVAILABLE. ANALYZE AND PRINT WAVEFORMS FROM ANALYSIS UTILITY. ATTACH PAPER COPIES OF PRINTOUT AND PAPER TAPES, IF AVAILABLE, TO THIS FORM. AVERAGE FREQUENCY MUST BE BETWEEN 99.0 AND 101.0 HZ.

AS FOUND 100.0 AS LEFT 100.0

WAVEFORM	FILE NO	FREQUENCY	TIME FOR 9 CYCLES Hn	TIME FOR 9 CYCLES Hr	TIME FOR 9 CYCLES V	AVERAGE FREQ.
SQUARE	401	100.0	90.0	90.0	90.0	100.0
SQUARE	402	100.0	90.0	90.0	90.0	100.0
SINE	403	100.0	90.0	90.0	90.0	100.0
SINE	404	100.0	90.1	90.0	90.0	100.0

CALIBRATED BY: ROBERT STELLER 1/25/2008 Robt Steller

NAME DATE SIGNATURE

National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

Southern California Edison Company
7300 Fenwick Lane
Westminster, CA 92683
Ms. Jennifer E. Smith
Phone: 714-895-0133 Fax: 714-895-0781
E-mail: Jennifer.Smith@sce.com
URL: http://www.edisonmetrology.com

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**
Scope Revised : 2007-04-20

NVLAP Code: 20/A01 ANSI/NCSL Z540-1-1994; Part 1 Compliant

DIMENSIONAL

NVLAP Code: 20/D03
Gage Blocks

Nominal Length in in	*Best Uncertainty (±) in µin* [note 1]
0.01 to < 0.05	1.9
0.05 to < 0.1	1.7
0.1 to < 1.0	1.2
1.0	1.4
2.0	1.8
3.0	2.2
4.0	2.9
5.0	5.4
6.0	5.6
7.0	5.8
8.0	6.0
10.0	6.8
12.0	7.2
16.0	8.1
20.0	9.4

2007-04-01 through 2008-03-31
Effective dates

Sally S. Bruce
For the National Institute of Standards and Technology

NVLAP-01S (REV. 2004-10-31)

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**
Scope Revised : 2007-04-20

Nominal Length in mm	*Best Uncertainty (±) in nm* [note 1]
0.5 to < 1.0	52
1.0 to < 2.5	44
2.5 to < 25.0	39
25.0	44
50.0	47
75.0	60
100.0	80

NVLAP Code: 20/D11
Spherical Diameter; Ring Gages

Range in inches	*Best Uncertainty (±) in µin* [note 1]	*Remarks*
0.040 to 0.825	10	Comparison to gage blocks
> 0.825 to 1.510	8	Comparison to gage blocks
> 1.510 to 2.510	9	Comparison to gage blocks
> 2.510 to 4.510	14	Comparison to gage blocks
> 4.510 to 6.510	21	Comparison to gage blocks
> 6.510 to 9.010	29	Comparison to gage blocks
> 9.010 to 12.010	40	Comparison to gage blocks
> 12.010 to 13.25	44	Comparison to gage blocks

ELECTROMAGNETICS - DC/LOW FREQUENCY

NVLAP Code: 20/E02
AC Current

	Best Uncertainty (±) in ppm [note 1] *Frequency in Hz*			
Range	*10*	*20*	*40*	*400 to 10 k*
10 mA	278	209	142	132
20 mA	278	209	142	132
30 mA	278	209	142	132
50 mA	300	202	124	109
100 mA	278	209	142	132

2007-04-01 through 2008-03-31
Effective dates

Sally S. Bruce
For the National Institute of Standards and Technology

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**
Scope Revised : 2007-04-20

200 mA		278		209	142		132
300 mA		278		209	142		132
500 mA		300		203	124		109
	10	***20***	***40***	***400 to 5 k***	***10 k***		
1A	300	203	125	110	112		
	10	***20***	***40***	***400 to 10 k***			
2A	305	200	127	113			
3A	305	200	127	113			
	10	***20***	***40***	***400 to 5 k***	***10 k***		
5A	309	210	134	120	123		
	10	***20***	***40***	***400***	***1 k***	***5 k***	***10 k***
10A	318	216	140	127	127	127	128
							400 to 10 k
20A							135

NVLAP Code: 20/E05
DC Current

Range	***Best Uncertainty (±) in ppm*** [note 1]
10 nA	4.0
100 nA	3.6
1 µA	3.0
10 µA	2.3
100 µA	1.9
1 mA	1.9
10 mA	1.9
100 mA	1.9
1 A	10.4
10 A	10.4
30 A	20.6

2007-04-01 through 2008-03-31
Effective dates

Sally S. Bruce
For the National Institute of Standards and Technology

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**
Scope Revised : 2007-04-20

DC Resistance

Nominal Value in Ω	*Best Uncertainty (±) in ppm* [note 1]	*Remarks*
100 μ	6.1	Automated DC Resistance Calibration System
1 m	4.1	Automated DC Resistance Calibration System
10 m	3.1	Automated DC Resistance Calibration System
100 m	0.3	Automated DC Resistance Calibration System
1	0.2	Automated DC Resistance Calibration System
10	0.2	Automated DC Resistance Calibration System
25	0.3	Automated DC Resistance Calibration System
100	0.3	Automated DC Resistance Calibration System
1 k	0.3	Automated DC Resistance Calibration System
10 k	0.4	Automated DC Resistance Calibration System
100 k	1.2	Automated DC Resistance Calibration System
1 M	1.7	Automated DC Resistance Calibration System
10 M	2.1	Automated DC Resistance Calibration System
100 M	2.6	Automated DC Resistance Calibration System

NVLAP Code: 20/E06
DC Voltage

Range	*Best Uncertainty (±) in ppm* [notes 1,2]	*Remarks*
1.018 V	1.1	Automated DC Calibration System
10.00 V	0.4	Automated DC Calibration System
1.000 V	1.1	Automated DC Calibration System
1 mV to 100 mV	1.3 [note 6]	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
100 mV	0.7	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
1.0 V	0.4	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage

2007-04-01 through 2008-03-31

Effective dates

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For the National Institute of Standards and Technology

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Scope Revised : 2007-04-20

10.0 V	0.4	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
20.0 V	0.6	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
100.0 V	0.4	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage
1000.0 V	0.8	Ratiometric Measurement Techniques performed by voltage transfer utilizing a high precision voltage

NVLAP Code: 20/E09
LF AC Voltage

Best Uncertainty (±) in ppm [notes 1,3,4]
Frequency in Hz

Range	***10***	***20***	***40***	***100***	***1 k***	***5 kHz***	***10 k***	***15 kHz***	***20 k***	***25 kHz***
2 mV	306	893	835	873	376	599	854	889	854	825
10 mV	109	166	96	176	188	180	166	169	166	175
20 mV	79	69	65	65	65	66	66	69	66	81
30 mV	131	123	84	105	65	72	86	75	70	78
100 mV	33	37	22	33	33	32	31	32	32	34
190 mV	35	27	29	21	24	23	23	20	19	22
300 mV	47	47	23	23	27	23	19	22	26	27
1 V	120	34	18	9	12	12	12	12	11	12
1.9 V	36	22	19	10	8	8	8	8	8	9
3 V	31	34	25	17	16	15	15	15	15	17
10 V	21	33	19	11	10	10	11	11	12	11
19 V	31	23	20	11	10	10	10	10	11	11
30 V	29	34	25	16	16	17	18	18	18	20
100 V	85	36	20	16	15	15	16	14	12	15
190 V	45	24	20	19	13	13	13	15	17	16
300 V			36	29	18	22	27	24	22	23
500 V			30	25	17	18	19	19	19	21

2007-04-01 through 2008-03-31

Effective dates

Sally S. Bruce

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CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Scope Revised : 2007-04-20

700 V			27	23	18	18	18	18	18	22
1000 V			26	25	22	21	21	21	22	25

Range	***30 kHz***	***50 k***	***60 kHz***	***100 k***	***300 k***	***500 K***	***700 kHz***	***800 k***	***1M***
2 mV	730	395	529	1020	1237	2090	2308	2419	2419
10 mV	182	205	233	299	234	631	459	373	403
20 mV	94	128	167	202	301	451	371	333	373
30 mV	87	127	144	216	342	515	560	590	643
100 mV	35	42	49	76	156	201	247	271	192
190 mV	26	41	49	81	137	119	208	252	191
300 mv	29	37	42	64	120	155	172	189	152
1 V	13	18	18	11	70	90	103	95	75
1.9 V	10	15	14	14	90	95	85	81	82
3 V	19	27	24	24	90	94	96	97	112
10 V	11	11	11	12	70	95	99	104	100
19 V	11	11	12	16	84	91	89	93	104
30 V	22	31	31	31	91				
100 V	18	31	28	17					
190 V	16	18	18	21					
300 V	24	28	31	43					
500 V	24	35	37	51					
700 V	25	40	42	58					
1 kV	29								

TIME AND FREQUENCY

NVLAP Code: 20/F01
Frequency Dissemination

Range	***Best Uncertainty (±)*** [note 1]	***Remarks***
10 MHz	1.2×10^{-12}	GPS Receiver

2007-04-01 through 2008-03-31

Effective dates

Sally S. Bruce

For the National Institute of Standards and Technology

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**
Scope Revised : 2007-04-20

MECHANICAL

NVLAP Code: 20/M05
Flow Rate

Nominal Flow Rate	*Best Uncertainty (±) in percent* [notes 1, 5]
(0.8 to 30) L/s	0.3
(0.1 to 800) mL/s	0.4

NVLAP Code: 20/M06
Force

Nominal Force in lb	*Best Uncertainty (±)* [note 1]	*Remarks*
2 to 200	0.025 %	Dead Weight
> 200 to 300	0.086 lb	Proving Ring
> 300 to 500	0.14 lb	Proving Ring
> 500 to 1000	0.28 lb	Proving Ring
> 1000 to 2000	0.55 lb	Proving Ring
> 2000 to 5000	0.84 lb	Proving Ring
> 5000 to 10 000	1.7 lb	Proving Ring
> 10 000 to 20 000	5.5 lb	Proving Ring
> 20 000 to 35 000	5.8 lb	Proving Ring
> 35 000 to 50 000	13 lb	Proving Ring
> 50 000 to 60 000	16 lb	Proving Ring
> 60 000 to 100 000	26 lb	Proving Ring
> 100 000 to 300 000	113 lb	Proving Ring

NVLAP Code: 20/M08
Mass

Range	*Best Uncertainty (±) in mg* [notes 1,2]	*Remarks*
10 kg	2.3	Echelon I
5 kg	0.93	Echelon I
3 kg	0.65	Echelon I
2 kg	0.43	Echelon I

2007-04-01 through 2008-03-31
Effective dates

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For the National Institute of Standards and Technology

NVLAP-01S (REV. 2004-10-31)

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Scope Revised : 2007-04-20

1 kg	0.052	Echelon I
500 g	0.043	Echelon I
300 g	0.041	Echelon I
200 g	0.034	Echelon I
100 g	0.020	Echelon I
50 g	0.013	Echelon I
30 g	0.013	Echelon I
20 g	0.0095	Echelon I
10 g	0.0073	Echelon I
5 g	0.0048	Echelon I
3 g	0.0038	Echelon I
2 g	0.0029	Echelon I
1 g	0.0030	Echelon I
500 mg	0.0017	Echelon I
300 mg	0.0013	Echelon I
200 mg	0.0010	Echelon I
100 mg	0.0009	Echelon I
50 mg	0.0007	Echelon I
30 mg	0.0007	Echelon I
20 mg	0.0005	Echelon I
10 mg	0.0005	Echelon I
5 mg	0.0006	Echelon I
3 mg	0.0006	Echelon I
2 mg	0.0005	Echelon I
1 mg	0.0005	Echelon I
30 kg	56	Echelon II
20 kg	22	Echelon II

2007-04-01 through 2008-03-31

Effective dates

Sally S. Bruce

For the National Institute of Standards and Technology

National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Scope Revised : 2007-04-20

THERMODYNAMIC

NVLAP Code: 20/T05
Pressure

Range in psi	*Best Uncertainty (±) in ppm* [note 1]	*Remarks*
0 to 50	25	Gas
> 50 to 1450	48	Gas
> 1450 to 16 000	90	Gas
> 1000 to 10 000	62	Oil
> 10 000 to 30 000	113	Oil
> 30 000 to 50 000	213	Oil

NVLAP Code: 20/T07
Resistance Thermometry

Range		*Best Uncertainty (±) in mK* [note 1]	*Remarks*
77.348 K	-195.80 °C	4.0	BP LN_2 by Comparison
234.3156 K	-38.83 °C	0.7	TPHg
273.16 K	0.01 °C	0.6	TPW
505.078 K	231.93 °C	1.6	FPSn
692.77 K	419.53 °C	2.3	FPZn

2007-04-01 through 2008-03-31

Effective dates

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For the National Institute of Standards and Technology

CALIBRATION LABORATORIES **NVLAP LAB CODE 105014-0**

Scope Revised : 2007-04-20

1. Represents an expanded uncertainty using a coverage factor, k = 2, at an approximate level of confidence of 95 %.
2. Approximate value. Actual value determined by the test statistics.
3. All ACV measurements performed via AC/DC transfer system.
4. Uncertainties listed are representative of the laboratory's accredited capabilities within the stated ranges. Accreditation is not limited to only those fixed values shown.
5. Dependent upon principle of operation of device being calibrated and its performance relative to standards at the time of the test.
6. The equation: uncert. = $(A + B/mVDC^2)^{0.5}$ (where A = 0.16 and B = 0.013333) is provided in order for potential customers to calculate approximate uncertainties for values down to 1 mV. Example: uncertainty at 1 mVDC would calculate to approximately ±115.47 ppm.
7. The laboratory maintains Echelon II capability for ranges 20 kg to 1 mg and separate Echelon III for all ranges.
8. Avoirdupois mass calibration services are available by comparison to equivalent metric standards. Uncertainties may be appropriately larger.

2007-04-01 through 2008-03-31

Effective dates

Sally S. Bruce

For the National Institute of Standards and Technology

GEOVision Borehole Geophysics depth wheel verification

Performed by Robert Steller on September 23, 2006

	Depth reading in #1	Depth reading out	Depth reading in #2
Depth wheel S/N 101 500 pulse/revolution Circumference = 983mm (3225.07 millifeet)	100.1 feet (30.51 m)	99.95 feet (30.46 m)	100.05 feet (30.50 m)
Depth wheel S/N 102 500 pulse/revolution Circumference = 994mm (3261.15 millifeet)	100.00 feet (30.48) m	100.05 feet (30.50 m)	100.00 feet (30.48) m
Aries winch 200 pulse/revolution Circumference = 305.9mm (1003.51 millifeet)	100.05 feet (30.50) m	100.05 feet (30.50 m)	100.00 feet (30.48) m
Depth wheel S/N 103 500 pulse/revolution Circumference = 1000mm (3.281 feet)			
Comprobe winch 500 pulse/revolution Circumference = 1000mm (3.281 feet)			

All measurements taken with a Stanley 100ft flexible stainless steel tape model number 34-130, and a Keeson 300 foot fiberglass tape, both marked in feet, inches and 1/8ths of inches. Enough cable was spooled off of the winch to allow the cable and tape measures to be laid flat on the parking lot surface side-by-side. A permanent marker was used to mark a 100.0 foot interval on the cable, and the marks were also tagged with electrical tape for visibility. The cable was then spooled back onto the winch. When the first mark was at the top of the measuring wheel, a matching permanent mark was placed, and the recording system (Robertson Micrologger) was set to 0.0 feet depth. The cable was spooled in to the second mark, and the distance was recorded. The recording system was set to 0.0 feet again, and the cable spooled out to the first mark again, and the distance was recorded. The process was repeated one more time to spool the cable back onto the winch, and the distance was recorded.

Estimated accuracy is of these measurements is +/- 0.1 foot or +/- 0.03m.

GEOVision Suspension PS probe Receiver 1–Receiver 2 (R1-R2) spacing verification

Performed by Robert Steller on September 23, 2006

	R2 center to R1 center hanging dry	R2 center to R1 center hanging submerged	R1 bottom to source center hanging submerged with 1m isolation tube S/N 280068
Receiver S/N 30086	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m
Receiver S/N 20042	39.8in 1.01m	39.6in 1.01m	75.7in 1.92m
Receiver S/N 12008	40.2in 1.02m	40.0in 1.02m	76.0in 1.93m

All measurements taken with a Lufkin 3.7m flexible steel tape model number HV1034DM, marked in mm and 100th of feet. Probe suspended in 3-inch diameter clear PVC pipe, using chain clamp placed between bottom and center of Receiver 2 hard section (See Figure). Probe "bounced" to establish unrestricted hanging length before measurement. Probe allowed to relax for 5 minutes prior to each measurement. Water level set to submerge bottom of Receiver 2 hard section.. Estimated accuracy due to hysterisis in rubber section approximately +/- 0.01' or +/- 0.003m.

Reviewed For Adequacy (RFA)

By: TC

Date: 7/10/2008

RECD JUL 10 2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

SPLITTING TENSILE STRENGTH

By Method of Brazilian Disk

ASTM D 3967

SPLITTING TENSILE STRENGTH
By Method of Brazilian Disk
ASTM D 3967

CLIENT: ARUP PB

JOB NO.: 2653-13

LOCATION:

DATE TESTED: 6/19/08 HN

PROJECT: Doyle Drive Replacement

Specimen ID Borehole, Depth (ft.), Rock	Diameter (In.)	Length (In.)	Mass (gms)	Wet Density (pcf)	Failure Load (lb)	Failure Type *	Splitting Tensile Strength (psi)
BTSB-R1, 36.50-36.75, Sandstone	2.385	1.209	234.40	165.3	2,753	S	610
BTSB-R3, 44.75-44.95, Sandstone	2.388	1.379	270.30	166.7	4,071	S	790
M9/RW7-A1A, 47.20-47.35, Gabro	2.370	1.328	246.10	160.0	3,103	S	630
BTNB-R5A, 25.0-25.2, Sandstone	2.389	1.215	239.50	167.5	3,165	S	690
RW6-R1, 49.8-49.9, Sandstone	2.369	1.126	216.90	166.5	4,584	S	1,090

Notes and Comments: Splitting Tensile Strength=2P/piLD.
P=Failure Load
pi = 3.1415926....
D = Sample Diameter
L = Sample Length

* Failure Type: S: Single Failure Plane, M: Multiple Failure Planes

Data Entered By: HN Date: 06/20/2008
Data Checked By: CJ Date: 06/20/08
Filename: ARBRAZC3

ADVANCED TERRA TESTING, Inc.
ATT

ARUP PB
36.50-36.75
BT
AR2653\ARDP3650.jpg
06-16-08

5.5
5.6
5.7
5.8
5.9
ARUP PB
BTSB-R3
44.75-44.95
BT
AR2653/ARDP4475
8-12-08

ARUP PB
M-9/RW-7-A1A
47.20-47.35
BT
AR2653\ARDP4720.jpg
06-16-08

5 5 5 6 5 7 5 8 5 9 5
ARUP PB
BTNB - R5A
25.0 - 25.2
BT
AR2653\ARDP2502.jpg
06-16-08

5 6 7 8 9
ARUP PB
RW6-R1, 49.80-
49.90
BT
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06-16-08

ARUP PB
BT SB-R1, 36.5-38.75
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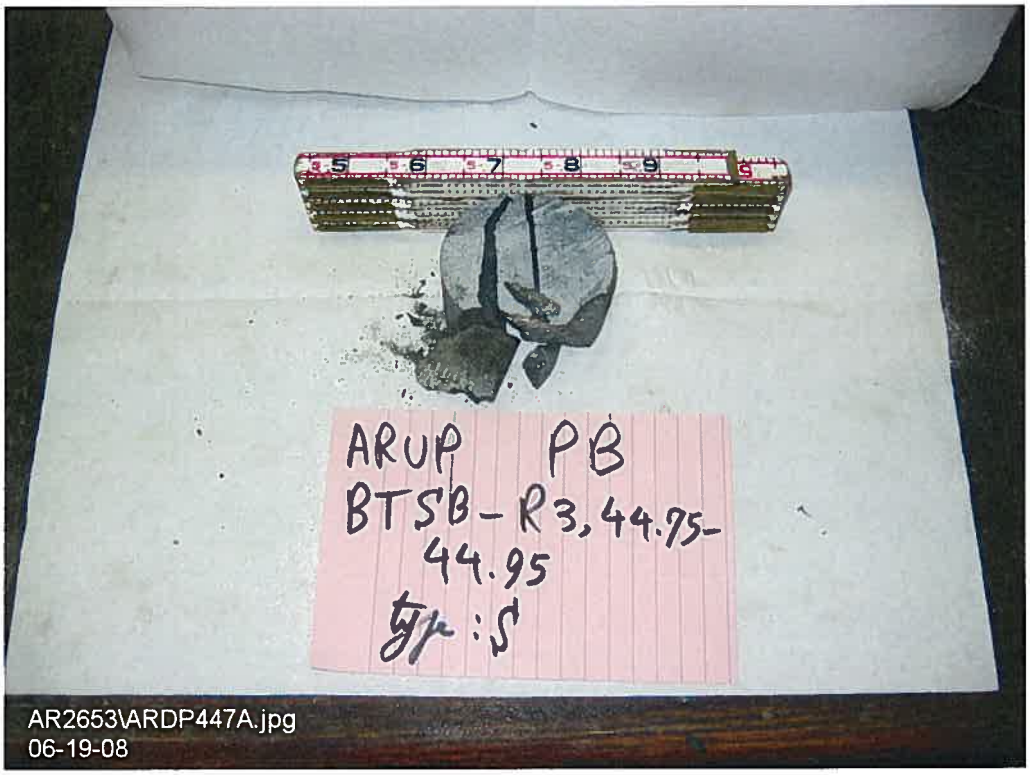
06-19-08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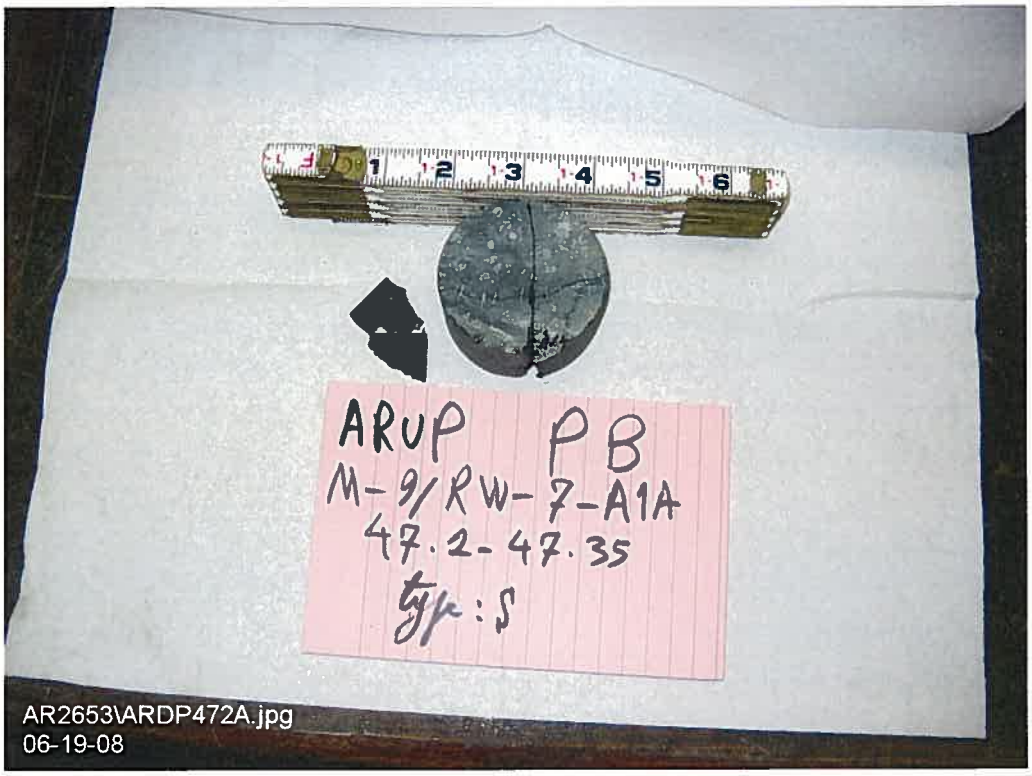
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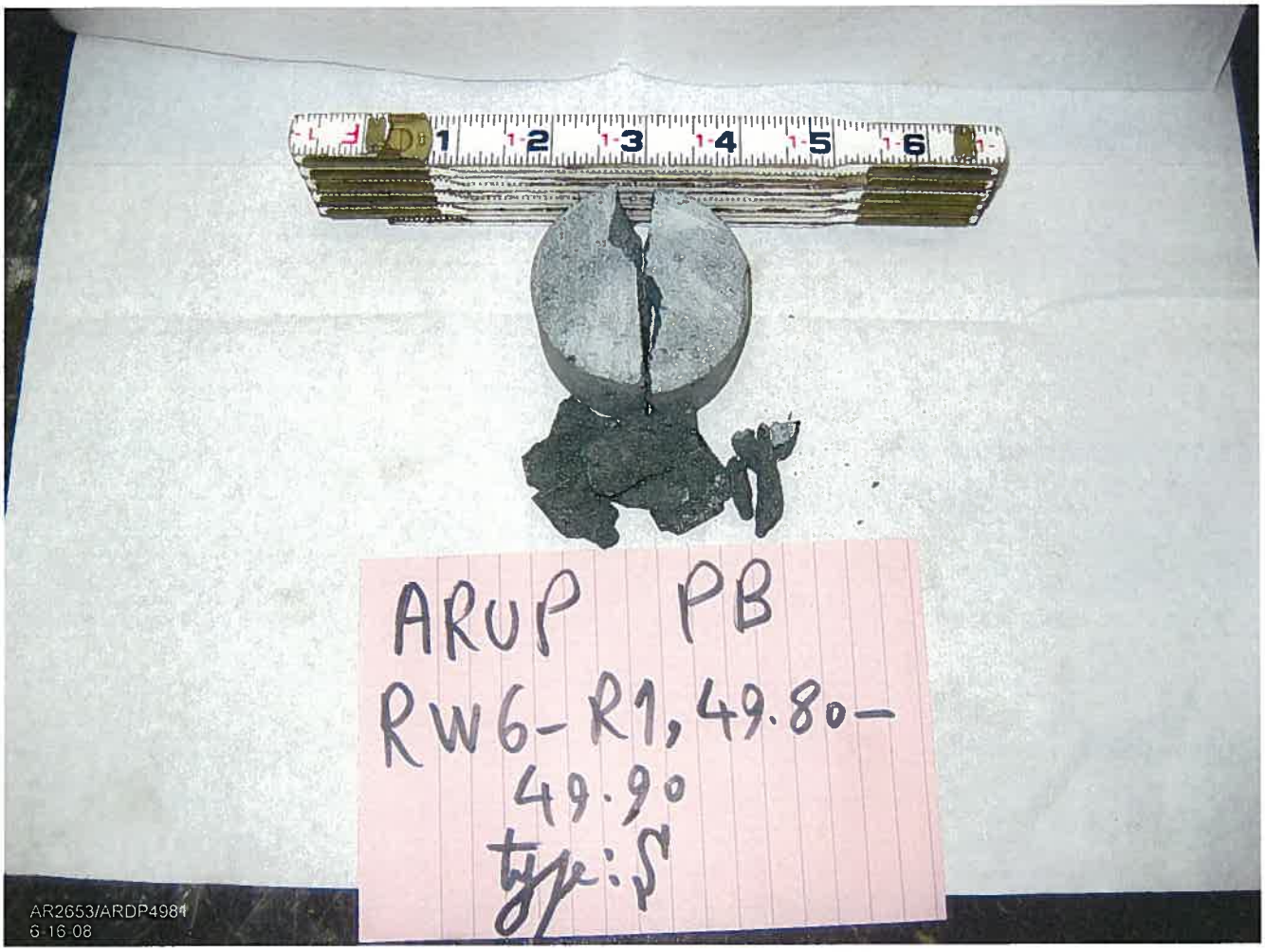
06-19-08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type: S
AR2653/ARDP4984
6-16-08

Reviewed For Adequacy (RFA)

By: TC

Date: 7/10/2008

RECD JUL 10 2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

Earth Mechanics Institute

Colorado School of Mines

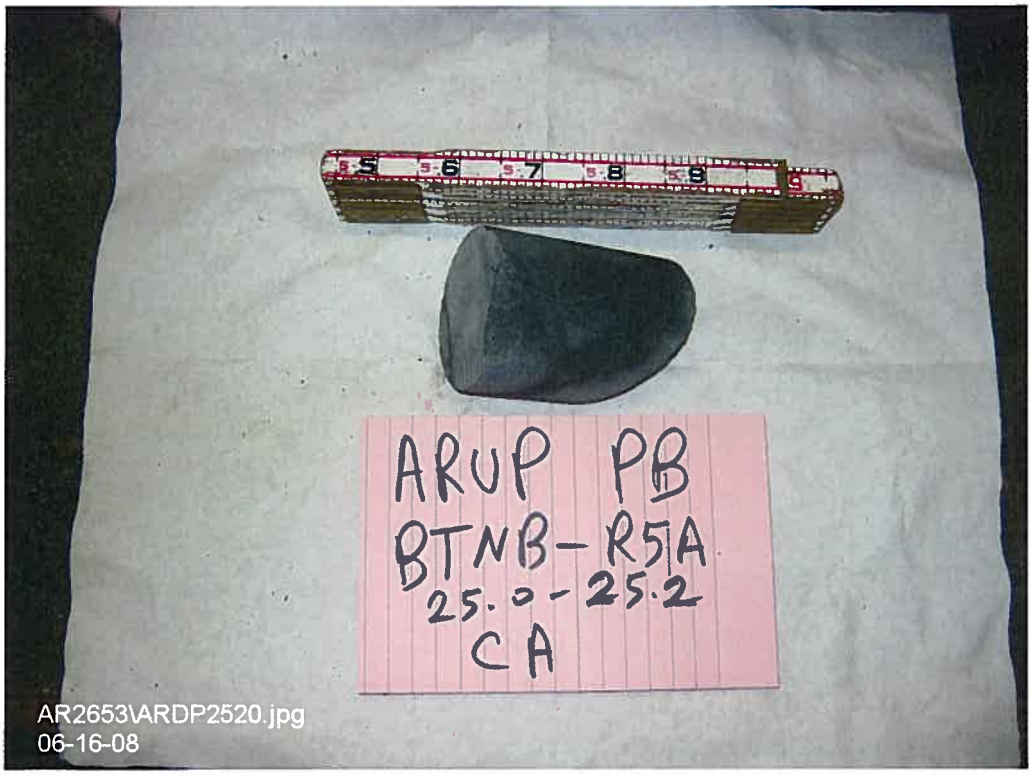
Project Name : Doyle Drive Replacement

Mining Engineering Department

Location: n/a

Client: Advanced Terra Testing, Inc.

Date: 6/17/2008 Sample ID	Rock Type	Cerchar Abrasivity Index
BTSB-R3@24.75-24.8	Sedimentary	1.0
BTNB-R5A@25.0-25.2	Sedimentary	1.2
RW6-R1@26.55-26.60	Sedimentary	0.4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25.0-25.2
CA
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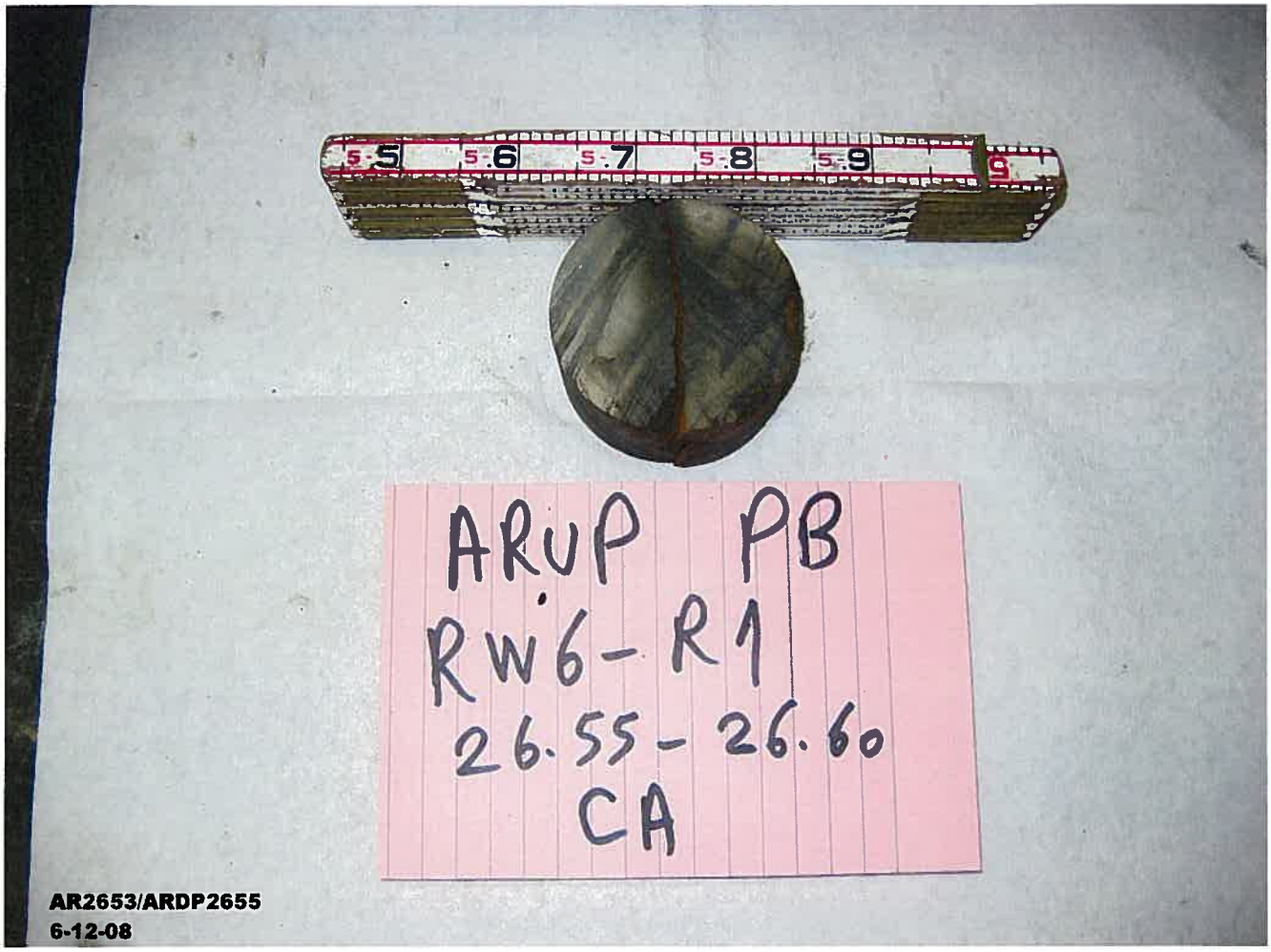
06-16-08


5.5
5.6
5.7
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5.9
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26.55-26.60
CA
AR2653/ARDP2655
6-12-08

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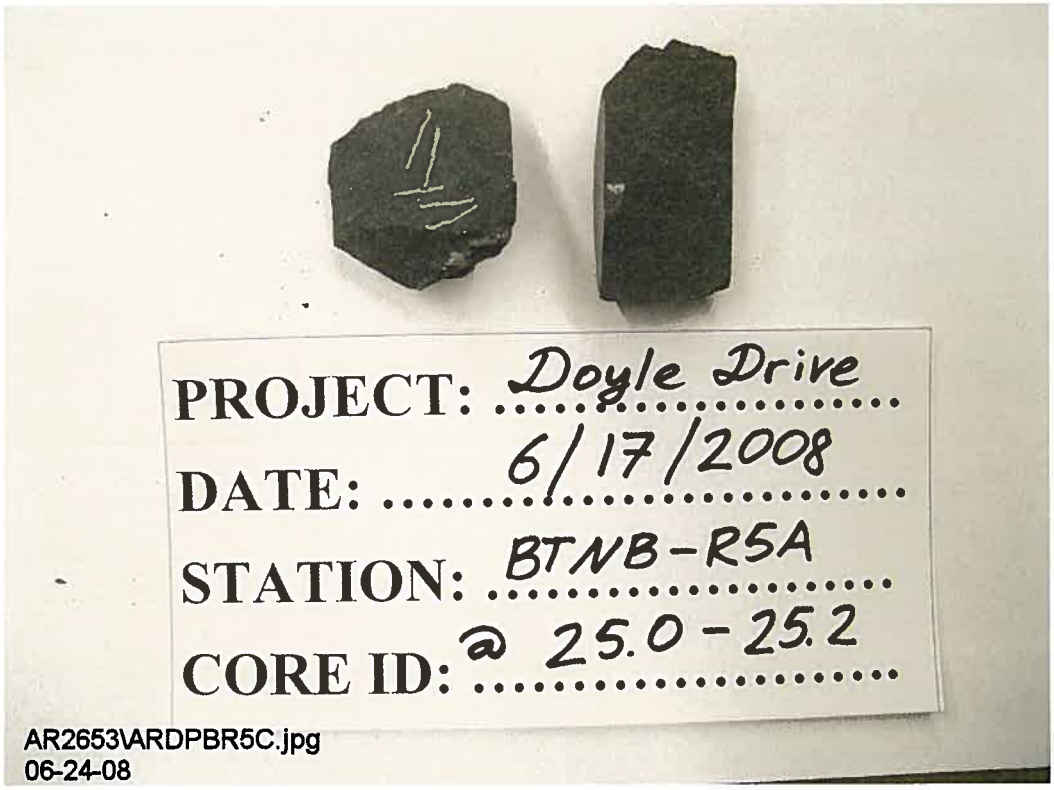
06-16-08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DATE: 6/17/2008
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CORE ID: @ 25.0 - 25.2
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06-24-08

PROJECT: Doyle Drive
DATE: 6/17/08
STATION: BTSB-R3
CORE ID: @24.75-24.80
AR2653\ARDPSBRB.jpg
06-24-08

PROJECT: Doyle Drive

DATE: 6/17/2008

STATION: RW6-R1

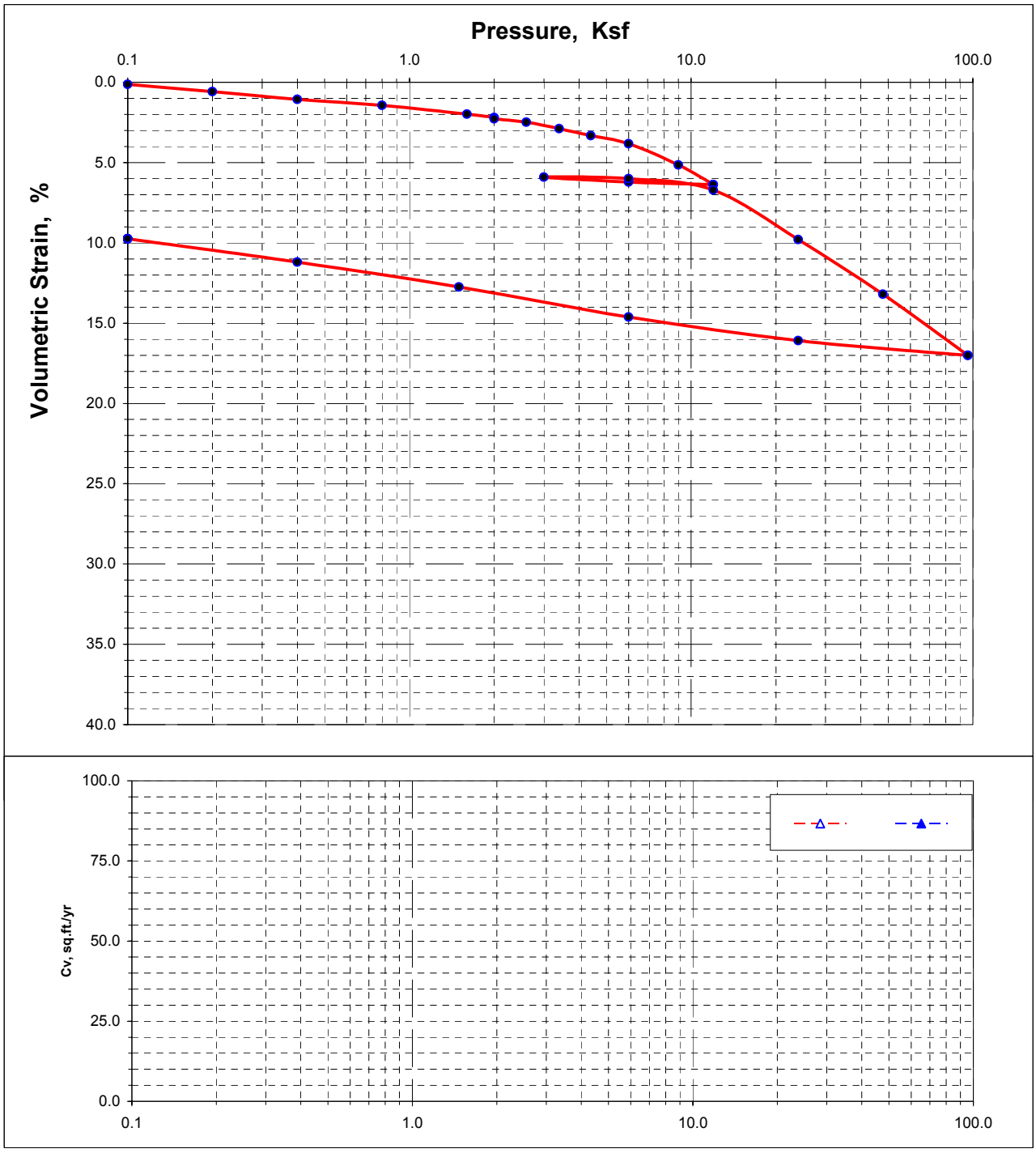
CORE ID: 26.55-26.60

AR2653\ARDPW6R1.jpg
06-24-08

CONSOLIDATION TEST

Boring Number	BTSB-R1	Sample Number	11 BOTTOM	Depth (ft)	27.5-30	
Soil Description	Olive brown clay with sand					

	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	22.8	123.5	0.677	91.0	1.00	2.420	(assumed) 2.70	39	21
Final	20.2	133.9	0.514	106.3	0.903				

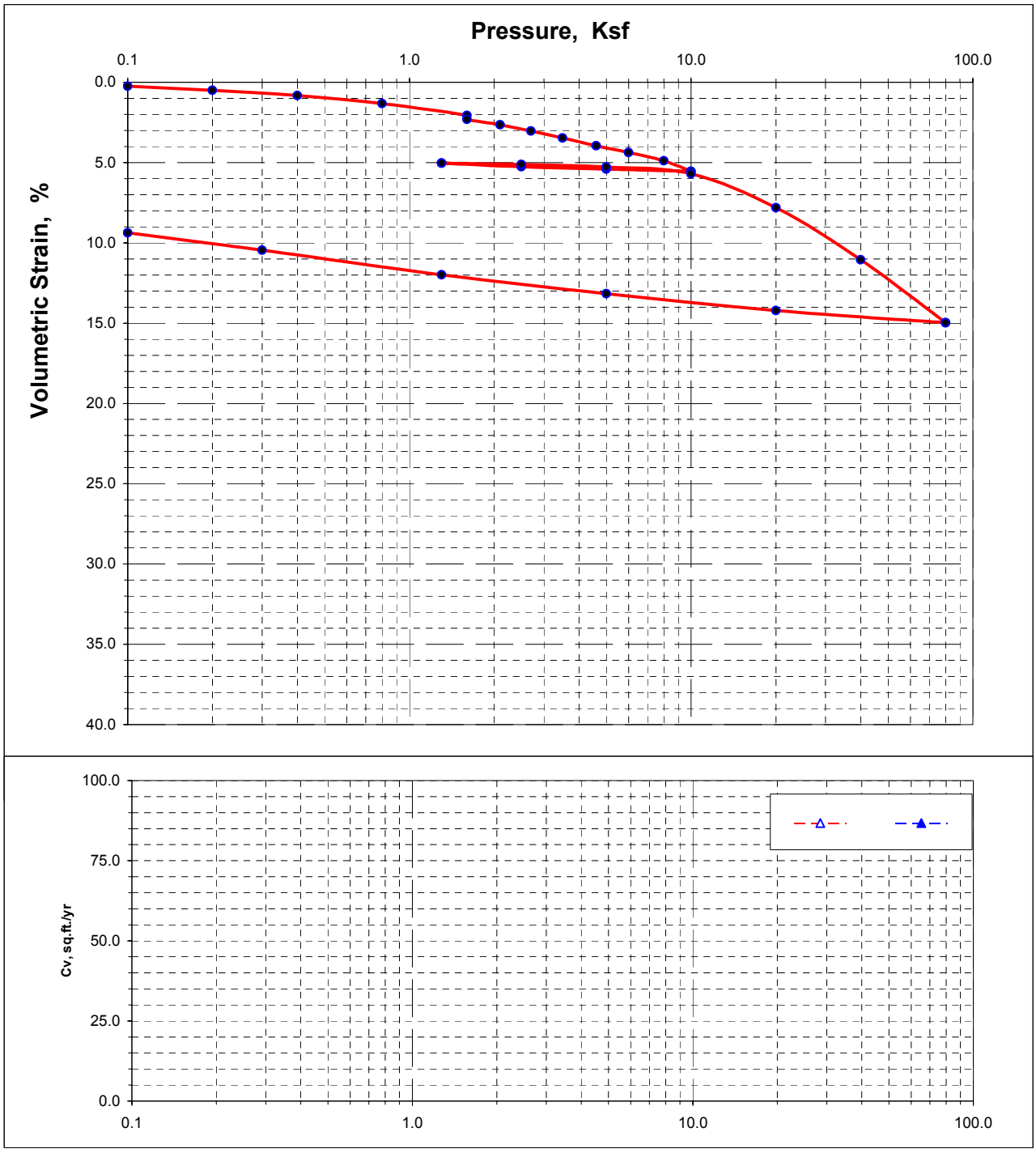


131558

CONSOLIDATION TEST

Boring Number	RW8-R1	Sample Number	9 (TOP)	Depth (ft)	22.5-25.2	
Soil Description	Brown sandy clay					

	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	19.8	124.5	0.623	85.9	1.00	2.420	(assumed) 2.70	25	12
Final	17.6	134.8	0.471	101.0	0.906				

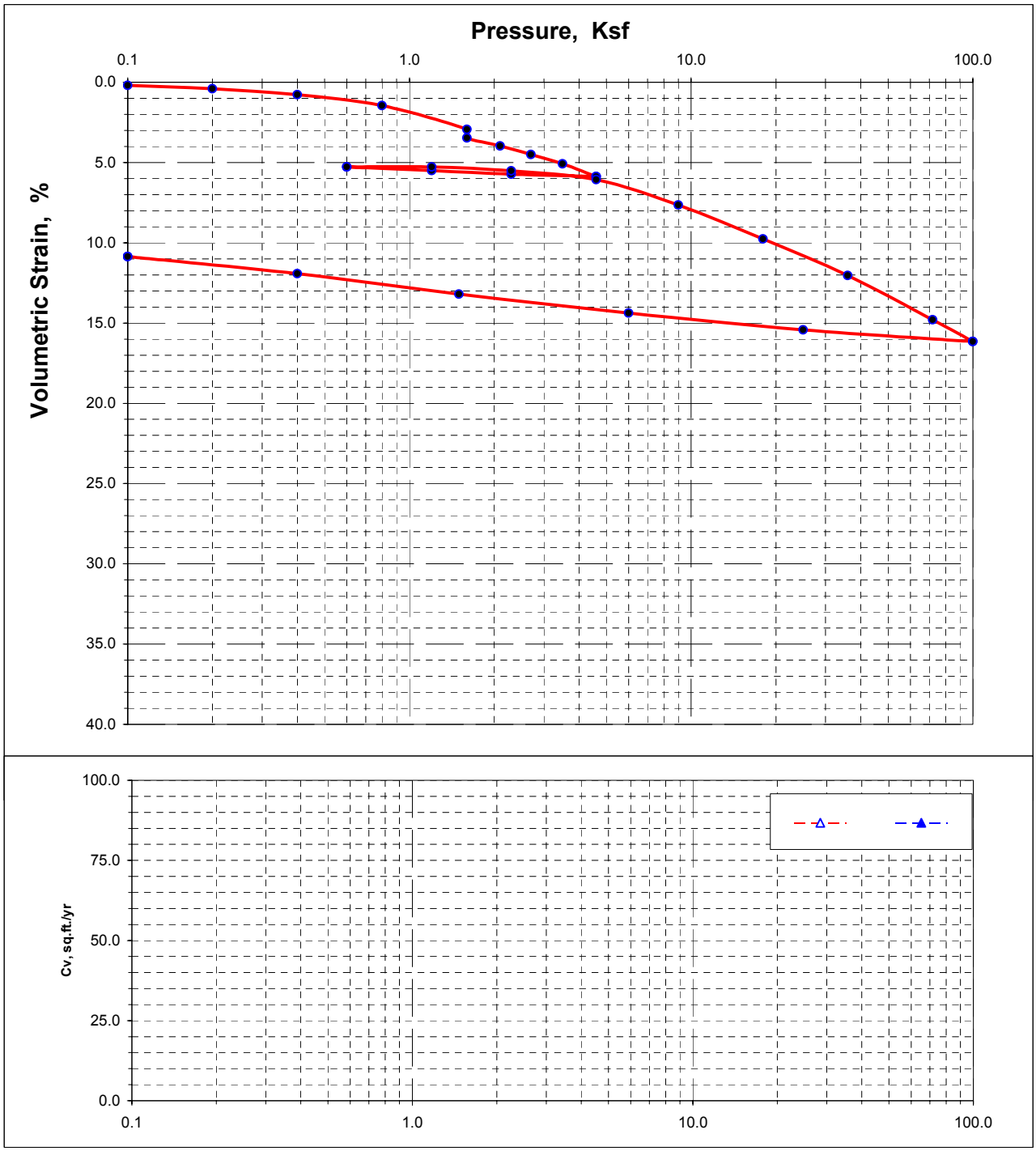


EA04-163701

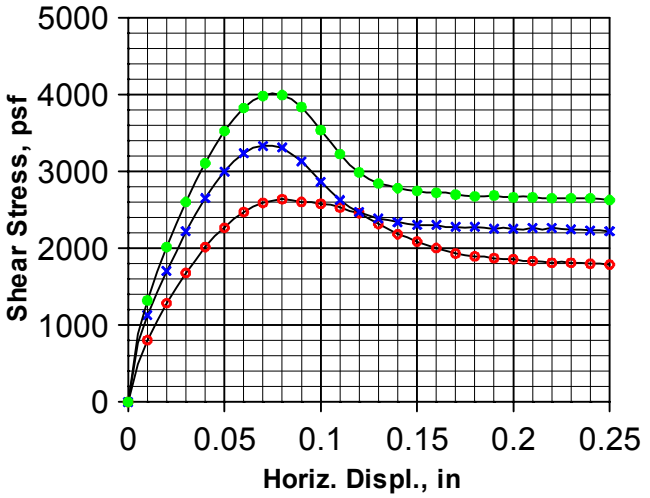
CONSOLIDATION TEST

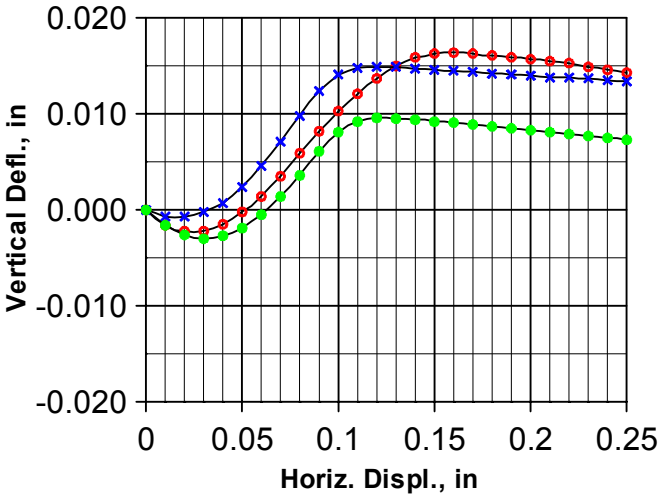
Boring Number	RW8-R1	Sample Number	16B	Depth (ft)	43.5-44	
Soil Description	Reddish brown clay with gravel					

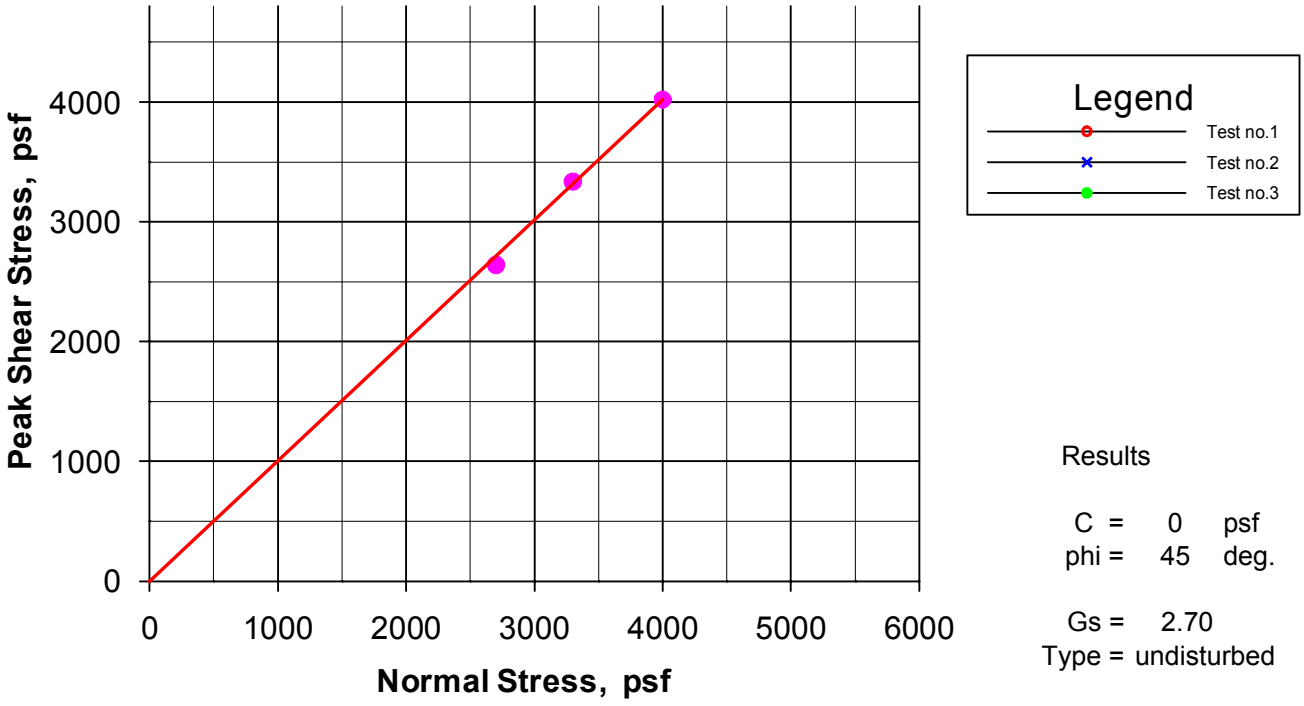
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	21.1	124.0	0.646	88.1	1.00	2.420	(assumed) 2.70	29	11
Final	17.0	135.4	0.457	100.2	0.885				



EA04-163701







Results

C = 0 psf
phi = 45 deg.

Gs = 2.70
Type = undisturbed

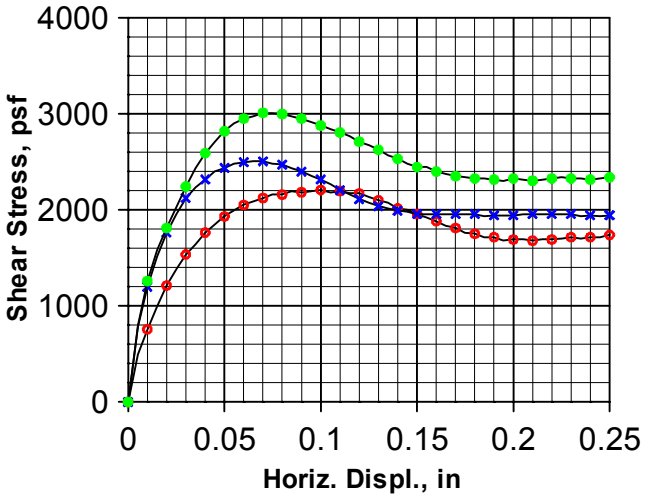
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2700	2640	0.080	0.18	19.5	110.4	100	0.527	1.00	2.416	19.1	104.9	85	0.607	1.052
2	3300	3336	0.070	0.18	19.4	108.0	94	0.561	1.00	2.416	19.3	103.8	84	0.624	1.041
3	4000	4020	0.075	0.18	18.8	107.6	90	0.567	1.00	2.416	18.9	103.4	81	0.630	1.040

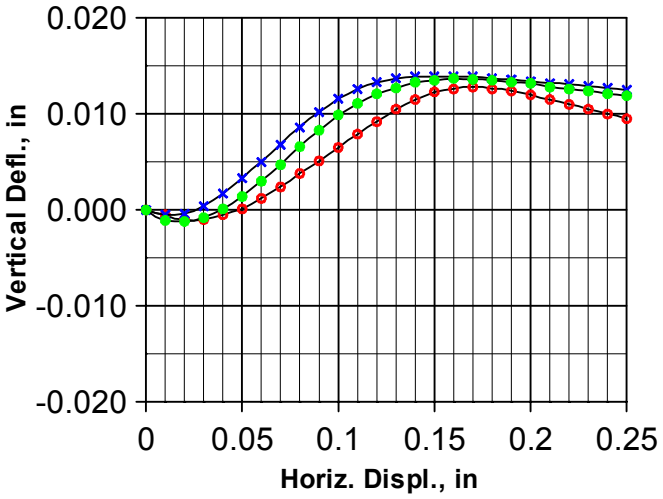
Client:	**Arup**	Boring #: **BTNB-R4**	Sample #: **9B**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **23.2-23.7**	
Project #:	**131558**	Soil: **Undisturbed brown silty sand**	

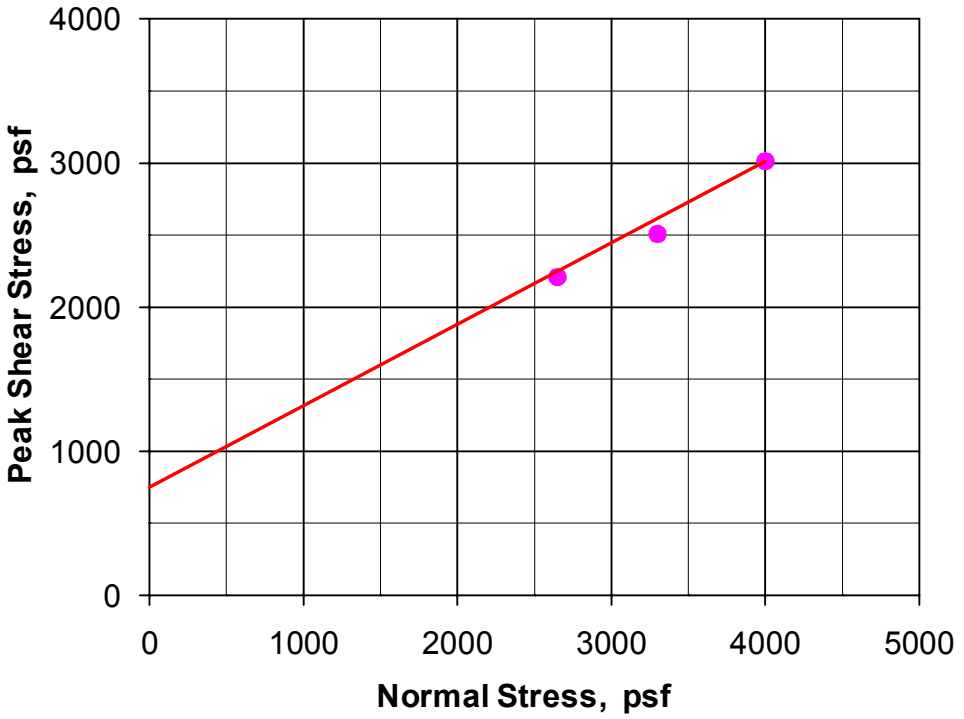
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

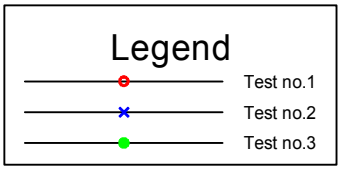
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 750 psf
phi = 29 deg.

Gs = 2.70
Type = undisturbed

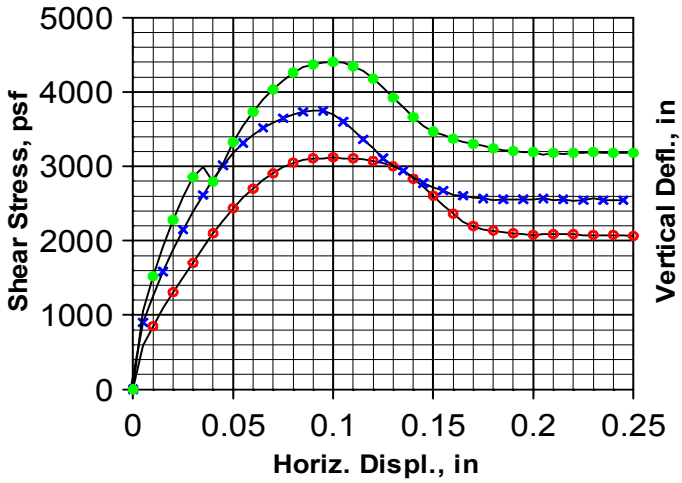
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2650	2208	0.100	0.18	26.4	100.5	105	0.676	1.00	2.416	23.3	97.5	86	0.729	1.032
2	3300	2508	0.065	0.18	25.3	100.7	101	0.674	1.00	2.416	24.2	97.7	90	0.725	1.031
3	4000	3012	0.070	0.18	30.8	95.9	110	0.758	1.00	2.416	25.7	92.5	84	0.822	1.036

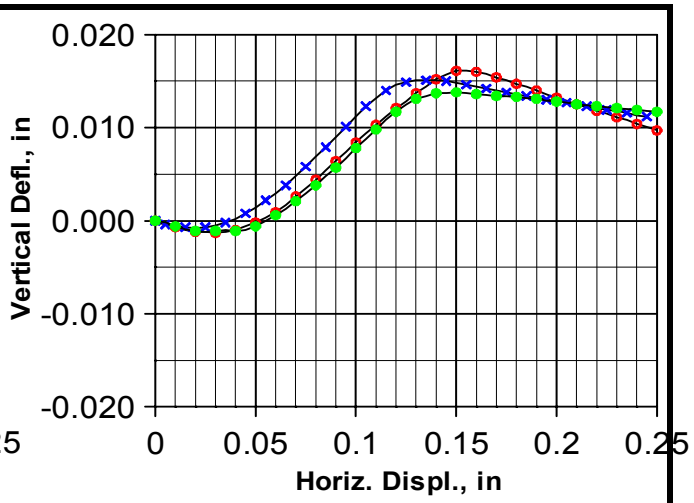
Client:	**Arup**	Boring #: **BTSB-R1**	Sample #: **9**
Project:	**Doyle Dr. Replacement Project**	Depth (ft): **22.5-23**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

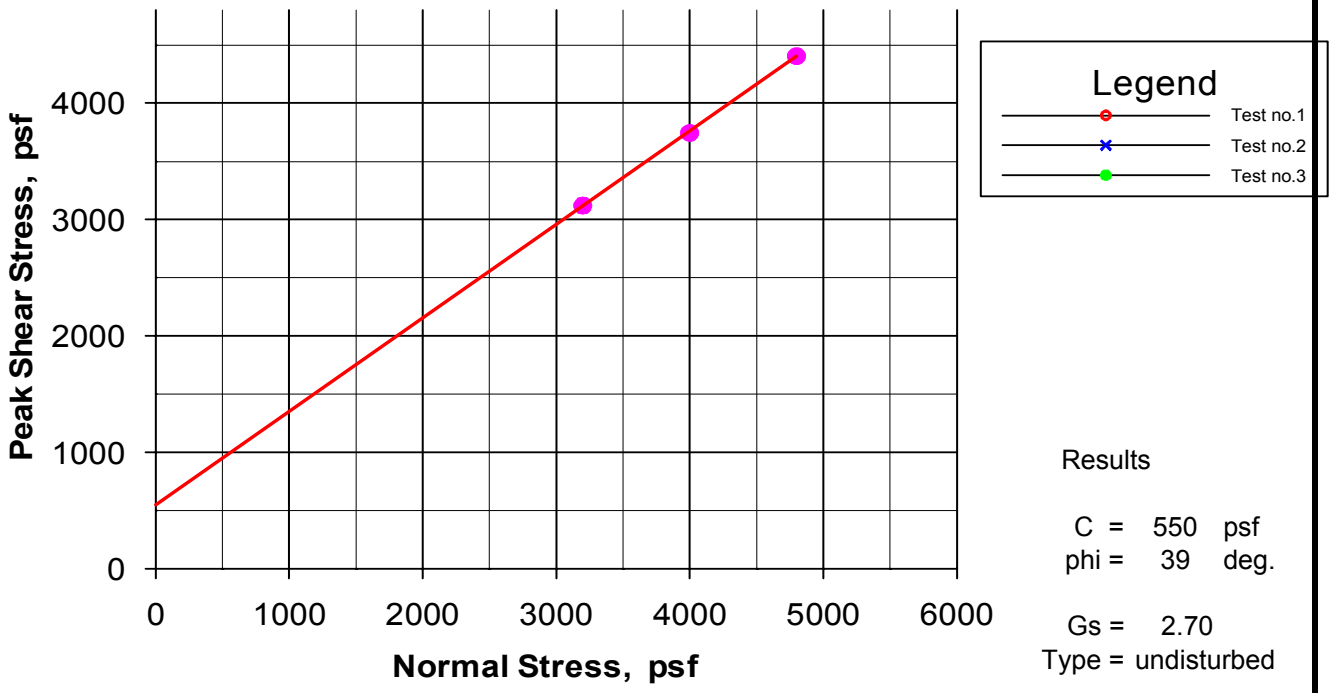
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____







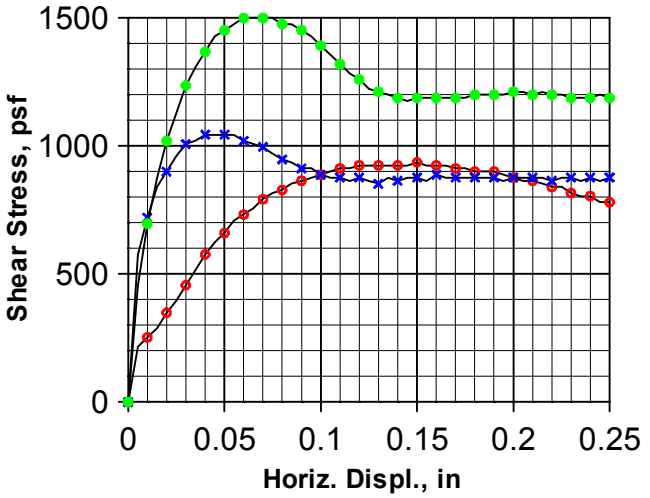
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	3200	3120	0.100	0.18	21.8	106.8	102	0.578	1.00	2.416	20.7	103.6	89	0.627	1.031
2	4000	3744	0.090	0.18	20.7	107.6	99	0.567	1.00	2.416	20.2	103.2	86	0.633	1.042
3	4800	4404	0.100	0.18	20.6	107.8	99	0.564	1.00	2.416	20.2	103.9	88	0.622	1.037

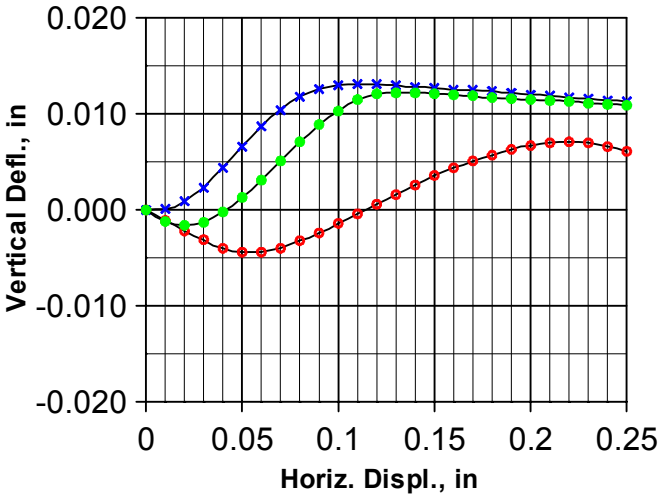
Client:	**ARUP**	Boring #: **BTSB-R2**	Sample #: **11B**
Project:	**Doyle Drive Replacement Project**	Depth (ft):	**28.1-28.4**
Project #:	**131558**	Soil:	**Undisturbed reddish brown poorly graded sand with silt**

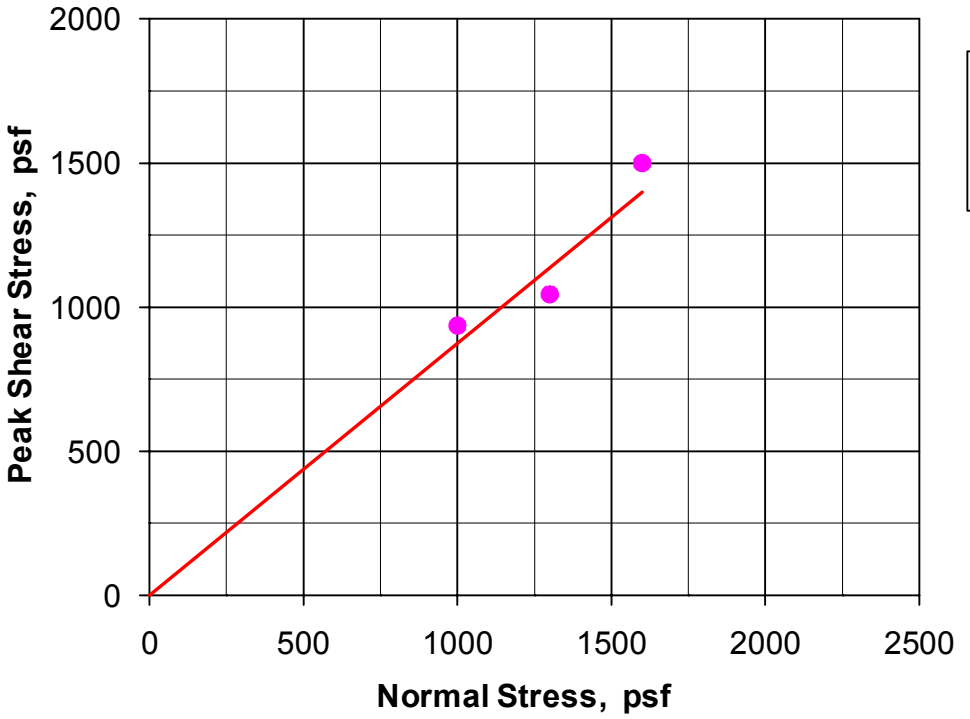
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

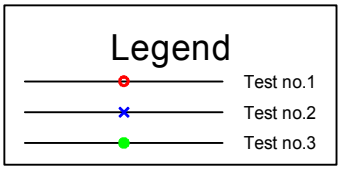
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 41 deg.

Gs = 2.70
Type = undisturbed

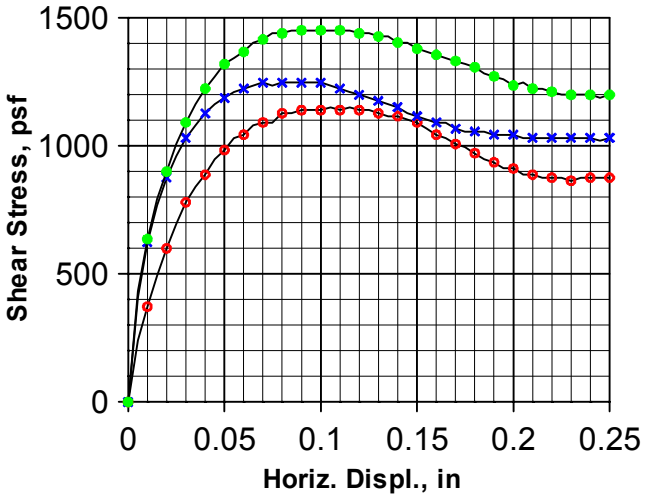
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	936	0.150	0.18	9.2	99.9	36	0.688	1.00	2.360	20.8	96.8	76	0.741	1.032
2	1300	1044	0.040	0.18	10.4	102.3	43	0.648	1.00	2.416	19.3	99.9	76	0.687	1.024
3	1600	1500	0.060	0.18	9.3	100.4	37	0.678	1.00	2.416	19.3	97.6	72	0.726	1.029

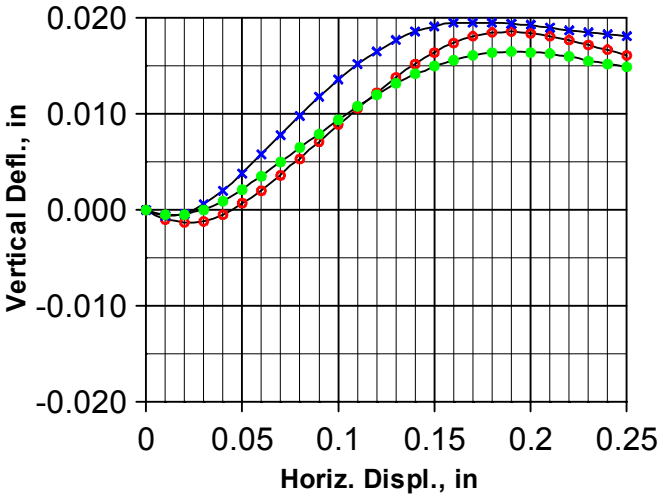
Client:	**ARUP**	Boring #: **BTSB-R3A**	Sample #: **7B**
Project:	**DOYLE DRIVE REPLACEMENT PROJECT**	Depth (ft): **9-9.5**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

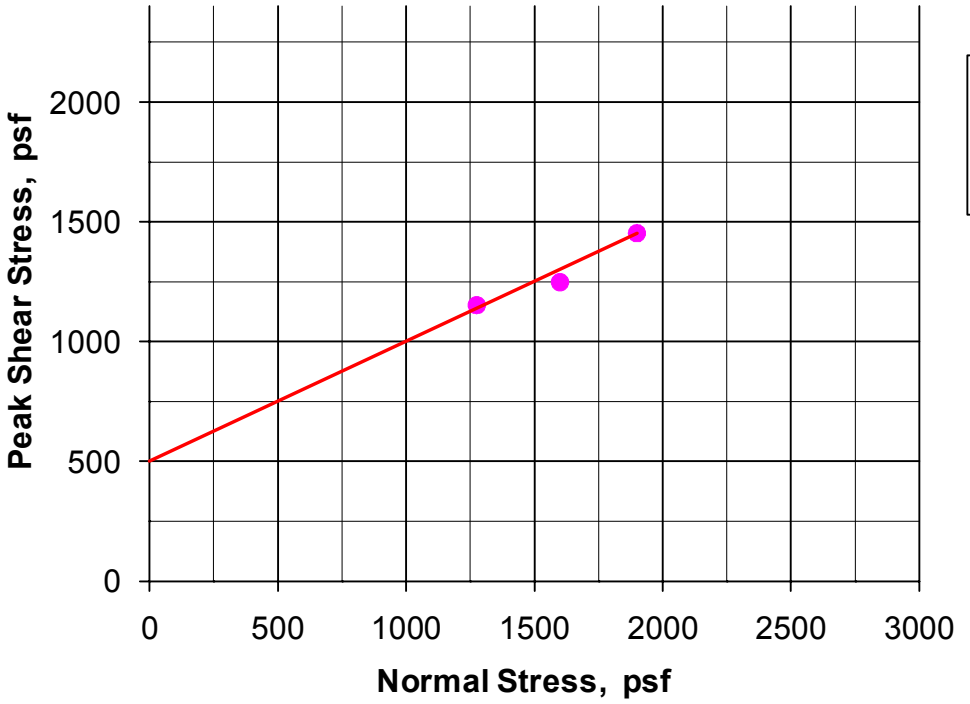
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

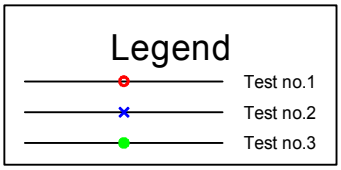
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 500 psf
phi = 27 deg.

Gs = 2.70
Type = undisturbed

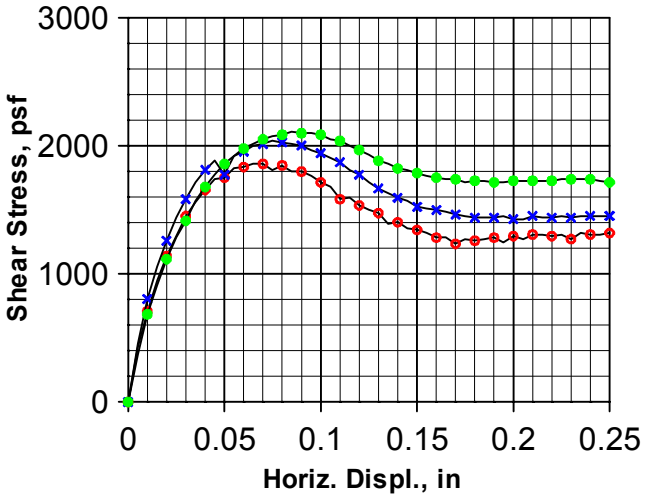
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1275	1152	0.105	0.18	28.3	94.6	98	0.782	1.00	2.416	27.9	91.8	90	0.836	1.031
2	1600	1248	0.070	0.18	26.5	97.3	98	0.732	1.00	2.416	26.3	94.0	89	0.793	1.036
3	1900	1452	0.085	0.18	27.2	97.9	102	0.721	1.00	2.416	25.0	94.9	87	0.777	1.033

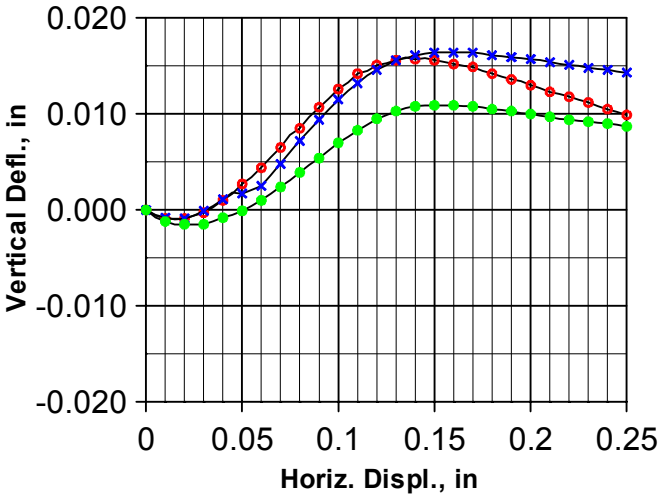
Client:	**Arup**	Boring #: **M-10**	Sample #: **5B**
Project:	**Doyle Dr. Replacement Project**	Depth (ft):	**10.5-11**
Project #:	**131558**	Soil:	**Undisturbed grayish brown poorly graded sand with organics**

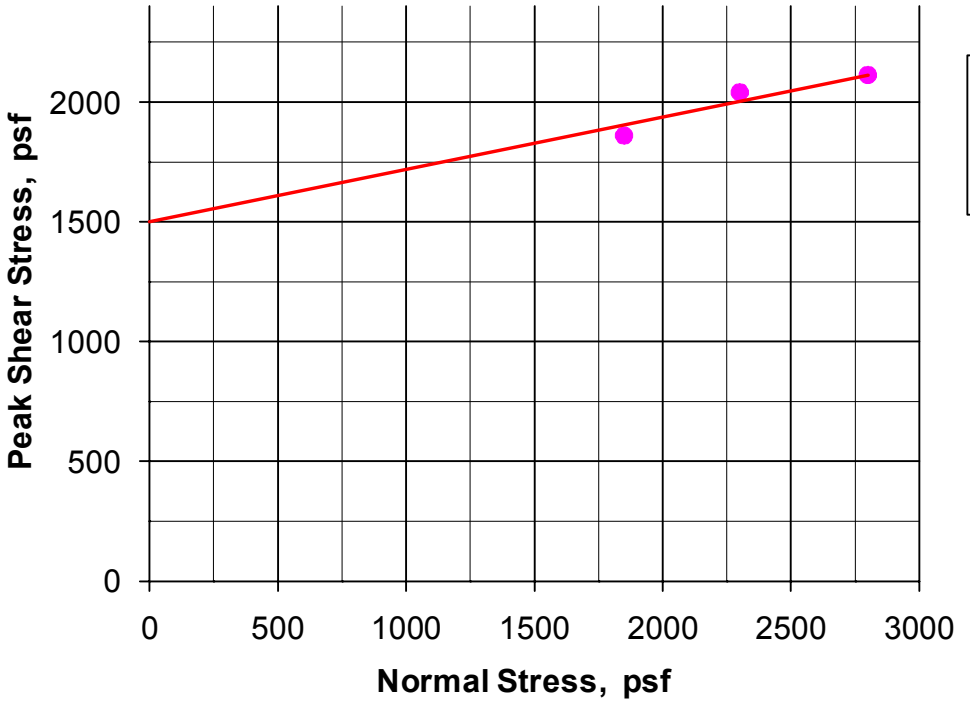
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

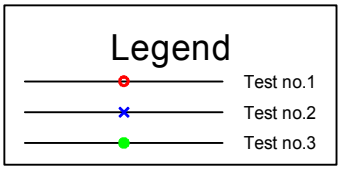
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 1500 psf
phi = 12 deg.

Gs = 2.70
Type = undisturbed

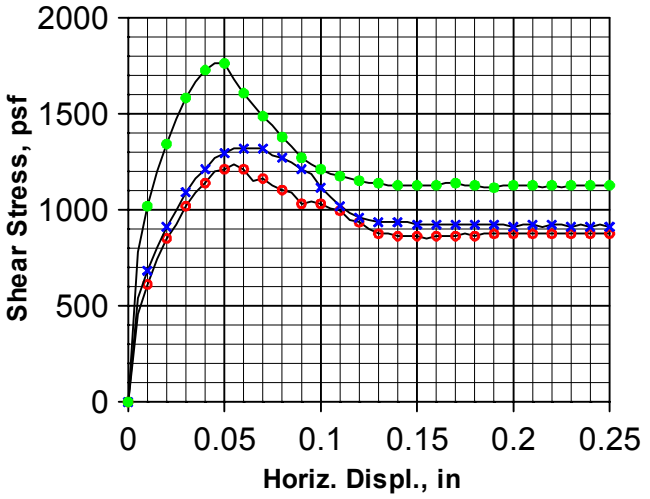
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1850	1860	0.065	0.18	23.9	104.4	105	0.614	1.00	2.416	22.2	101.7	91	0.657	1.027
2	2300	2040	0.075	0.18	26.6	102.9	112	0.639	1.00	2.416	24.6	99.1	95	0.701	1.038
3	2800	2112	0.085	0.18	24.9	102.4	104	0.645	1.00	2.416	23.5	99.8	92	0.689	1.026

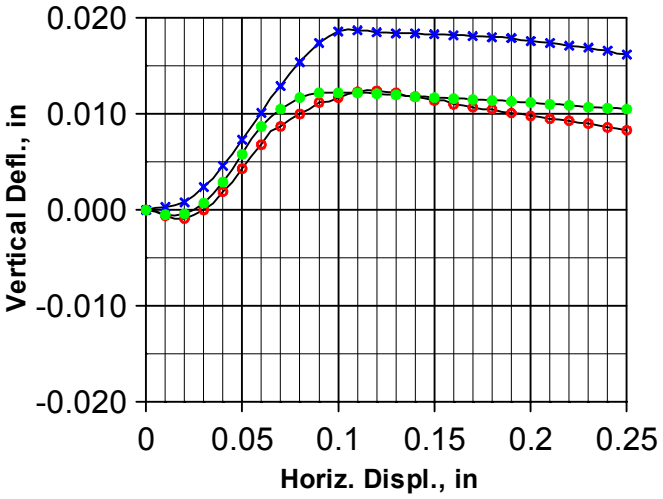
Client:	**Arup**	Boring #: **M-11**	Sample #: **5B**
Project:	**Doyle Dr. Replacement Project**	Depth (ft):	**15.8-16.3**
Project #:	**131558**	Soil:	**Undisturbed dark greenish gray poorly graded sand**

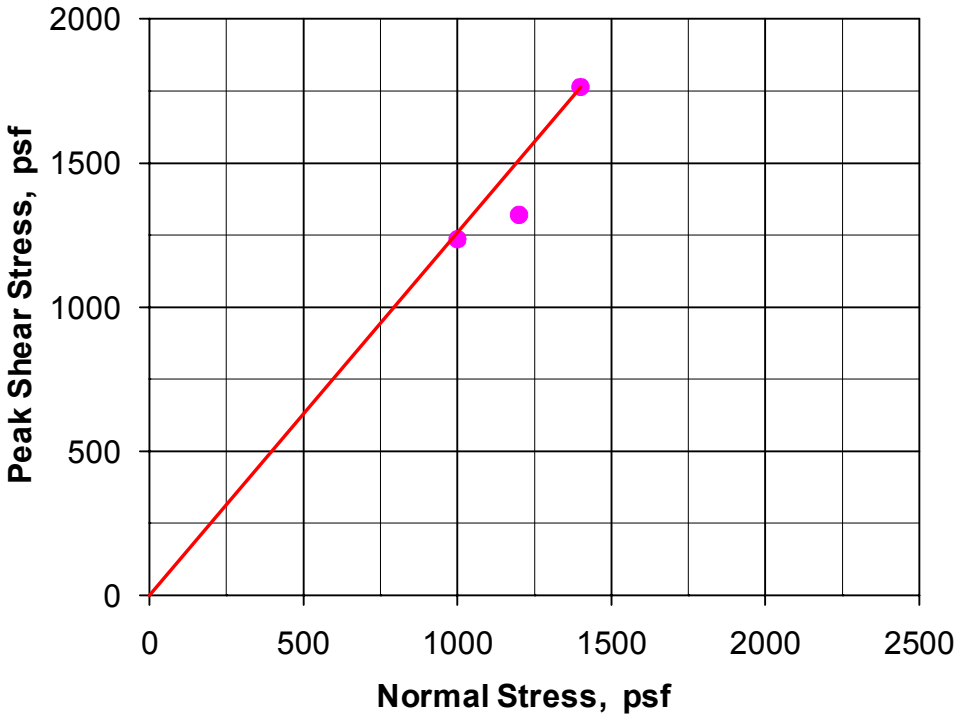
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

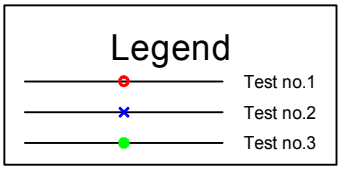
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 52 deg.

Gs = 2.70
Type = undisturbed

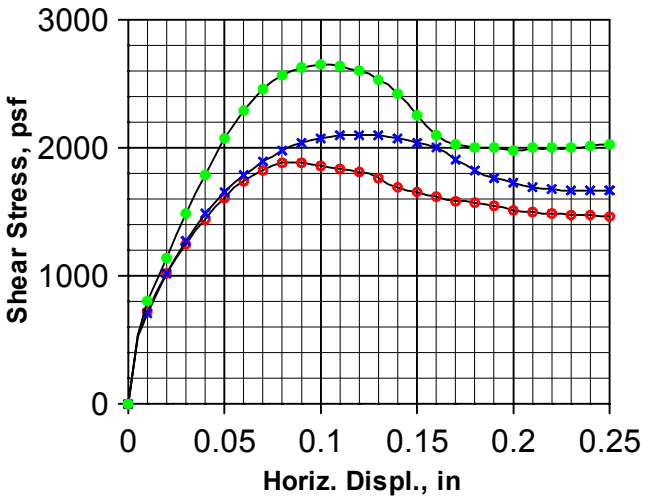
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	1236	0.055	0.18	16.6	110.4	85	0.527	1.00	2.416	19.7	106.3	91	0.586	1.038
2	1200	1320	0.055	0.18	16.8	108.9	83	0.548	1.00	2.416	20.0	103.9	87	0.622	1.048
3	1400	1764	0.045	0.18	16.3	111.0	85	0.519	1.00	2.416	19.4	106.1	89	0.589	1.046

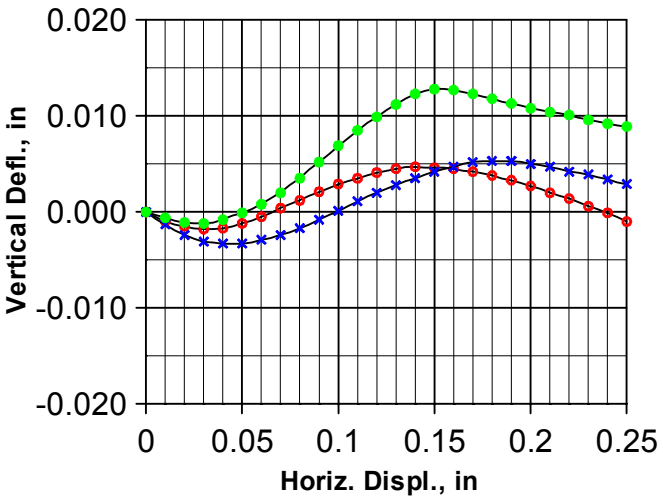
Client:	**Arup**	Boring #: **RW6-R1**	Sample #: **5B**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **12.6-13.1**	
Project #:	**131558**	Soil:	**Undisturbed reddish brown silty sand**

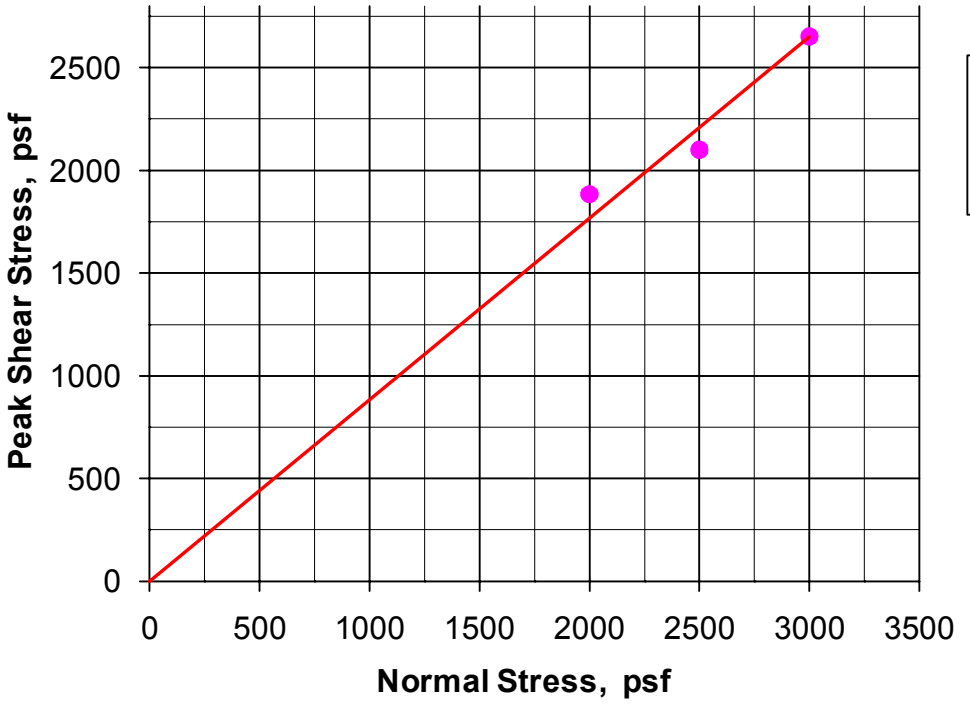
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

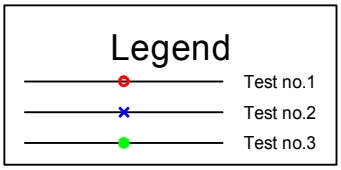
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 41 deg.

Gs = 2.70
Type = undisturbed

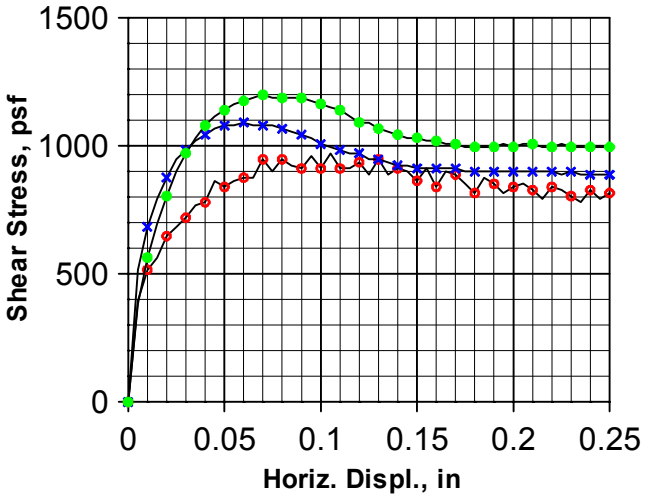
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2000	1884	0.080	0.09	21.2	108.2	103	0.557	1.00	2.416	20.7	105.8	94	0.594	1.023
2	2500	2100	0.110	0.09	22.1	107.3	104	0.571	1.00	2.416	19.4	103.4	83	0.630	1.037
3	3000	2652	0.100	0.09	18.7	113.0	103	0.491	1.00	2.416	18.6	109.0	92	0.547	1.037

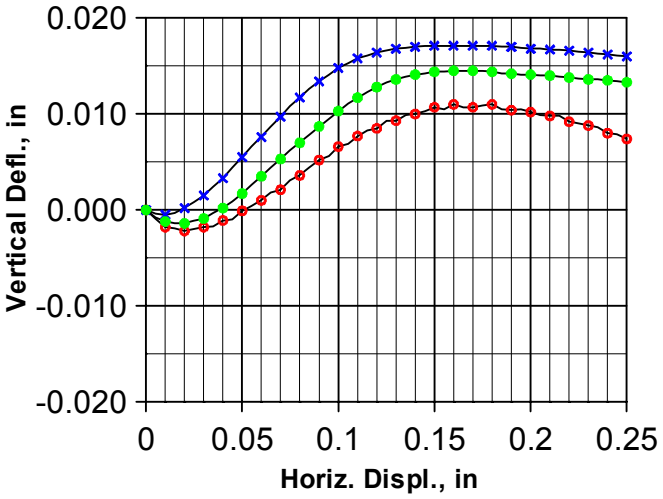
Client:	**Arup**	Boring #: **RW6-R1**	Sample #: **7A**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **17-17.5**	
Project #:	**131558**	Soil:	**Undisturbed dark yellowish brown clayey sand**

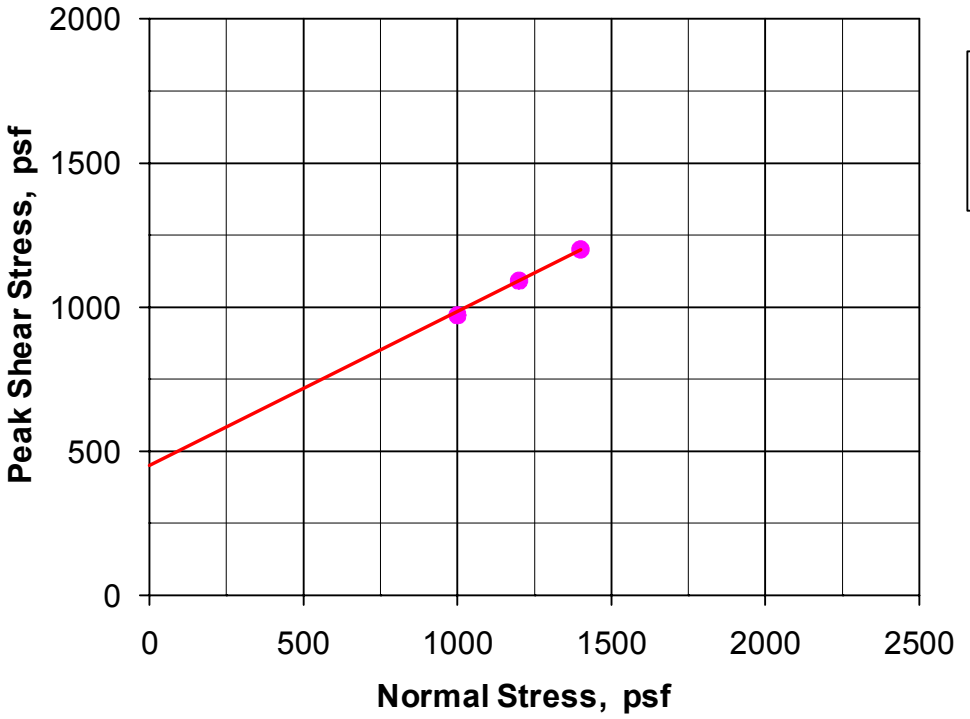
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

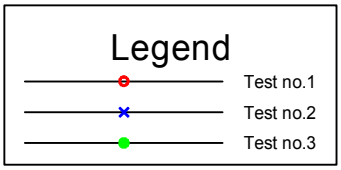
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 450 psf
phi = 28 deg.

Gs = 2.70
Type = undisturbed

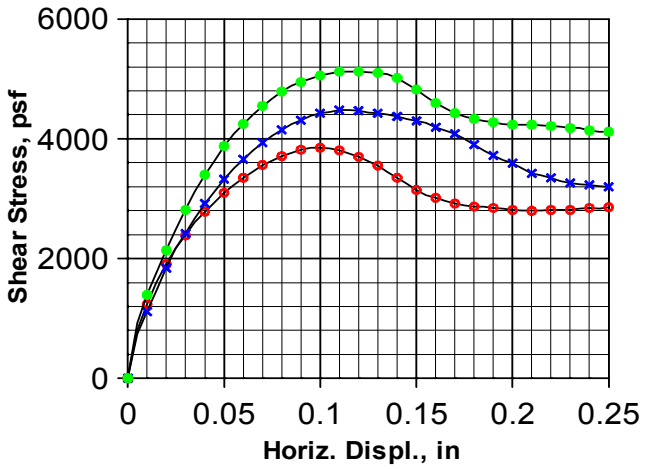
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	972	0.105	0.18	24.3	101.6	100	0.658	1.00	2.416	21.5	99.3	83	0.697	1.023
2	1200	1092	0.060	0.18	21.7	107.8	104	0.563	1.00	2.416	24.5	104.9	109	0.607	1.028
3	1400	1200	0.070	0.18	18.2	105.5	82	0.598	1.00	2.416	17.9	103.0	76	0.636	1.024

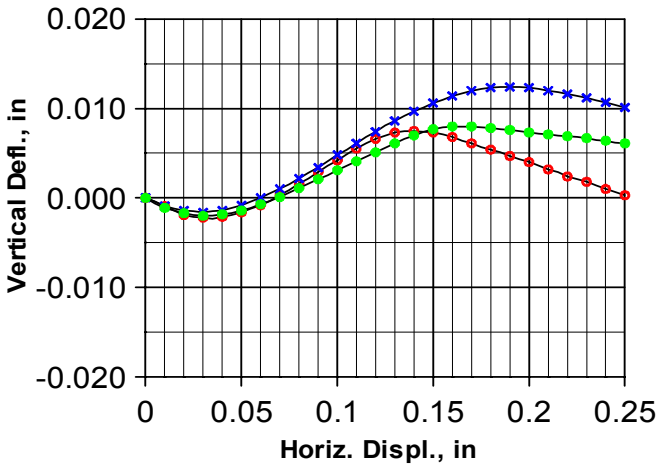
Client:	**Arup**	Boring #: **RW6-R2A**	Sample #: **3**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **7.8-8.3**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

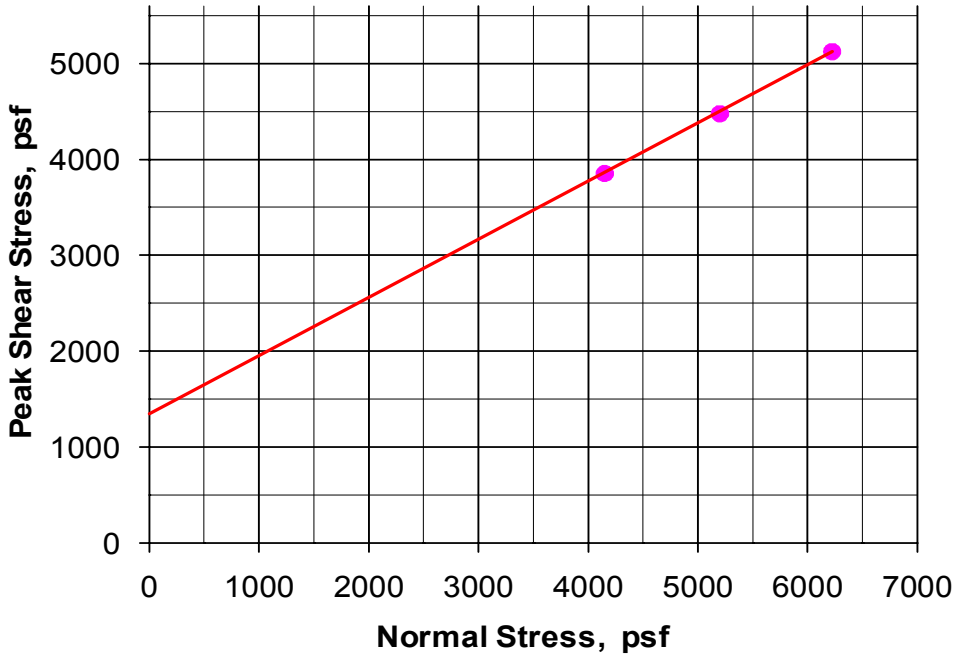
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

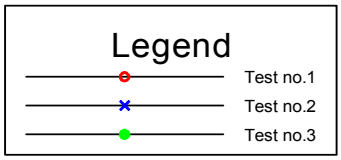
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 1350 psf
phi = 31 deg.

Gs = 2.70
Type = undisturbed

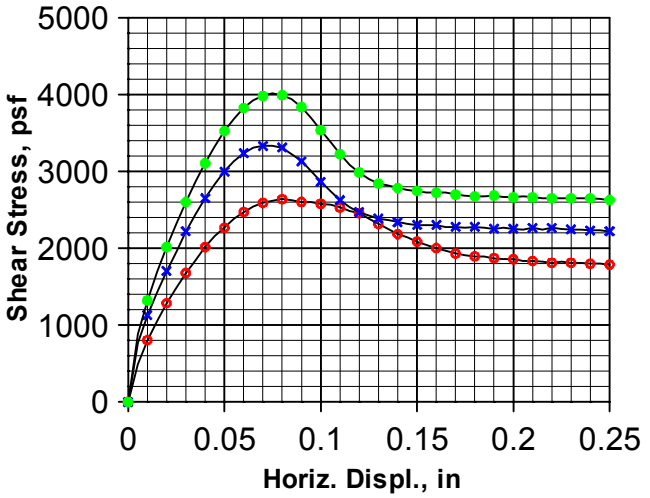
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	4150	3852	0.095	0.18	19.6	108.9	97	0.548	1.00	2.416	19.4	105.9	89	0.591	1.028
2	5200	4476	0.110	0.18	20.0	108.6	98	0.551	1.00	2.416	19.5	104.2	85	0.618	1.043
3	6225	5124	0.110	0.18	19.5	111.5	103	0.512	1.00	2.416	18.6	107.1	87	0.574	1.041

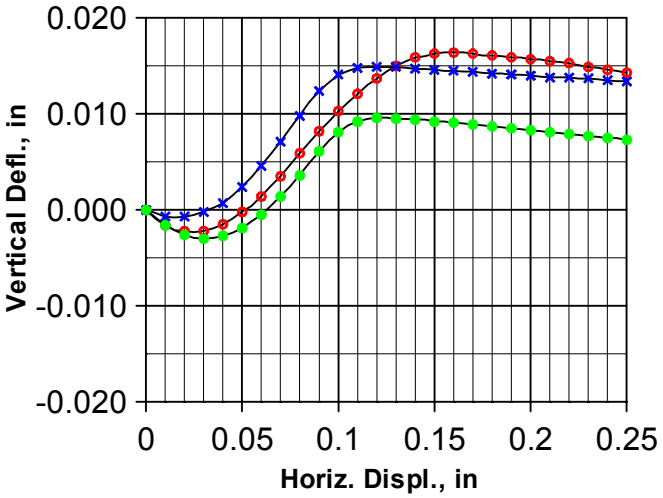
Client:	**Arup**	Boring #: **RW8-R1**	Sample #: **12A**
Project:	**Doyle Dr. Replacement Project**	Depth (ft): **33-33.5**	
Project #:	**EA04-163701**	Soil:	**Undisturbed brown clayey sand**

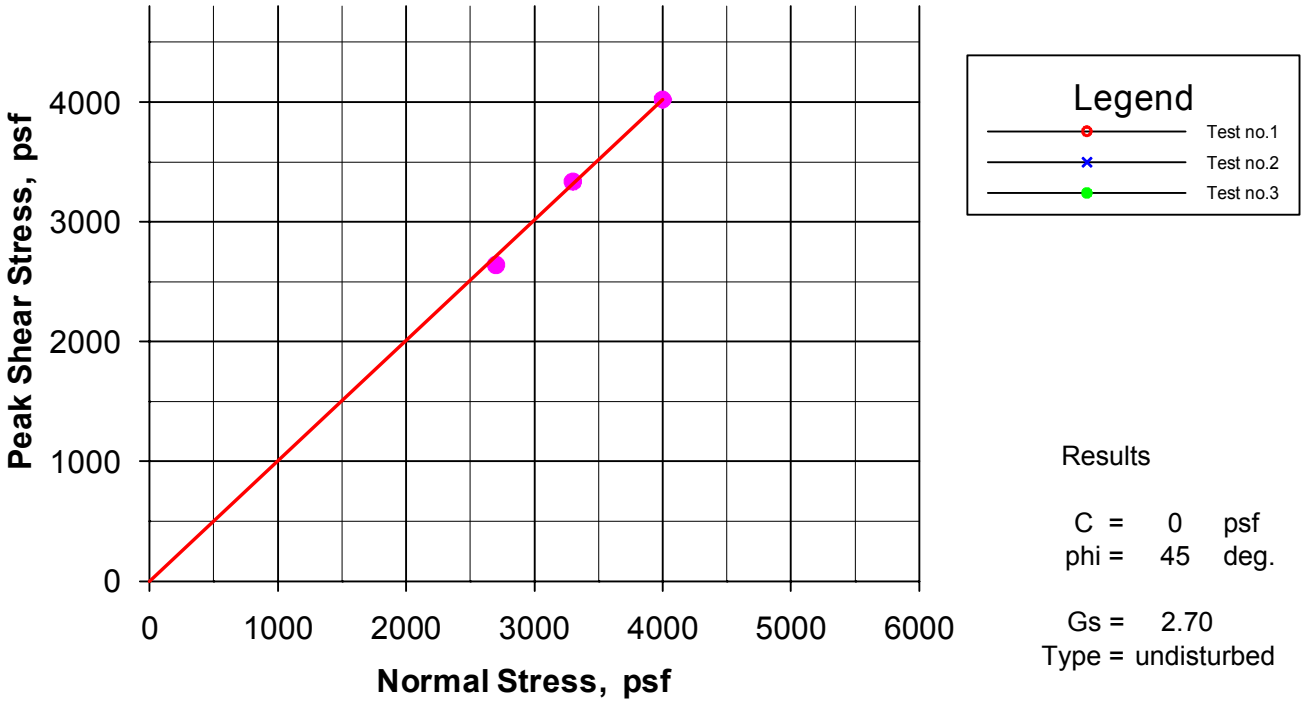
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____







Results

C = 0 psf
phi = 45 deg.

Gs = 2.70
Type = undisturbed

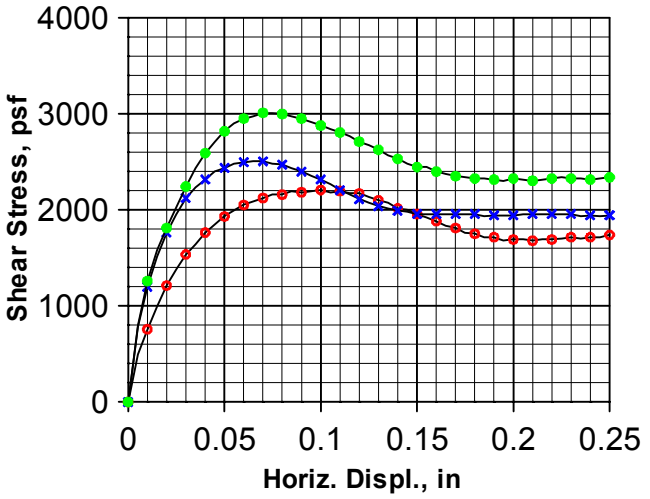
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2700	2640	0.080	0.18	19.5	110.4	100	0.527	1.00	2.416	19.1	104.9	85	0.607	1.052
2	3300	3336	0.070	0.18	19.4	108.0	94	0.561	1.00	2.416	19.3	103.8	84	0.624	1.041
3	4000	4020	0.075	0.18	18.8	107.6	90	0.567	1.00	2.416	18.9	103.4	81	0.630	1.040

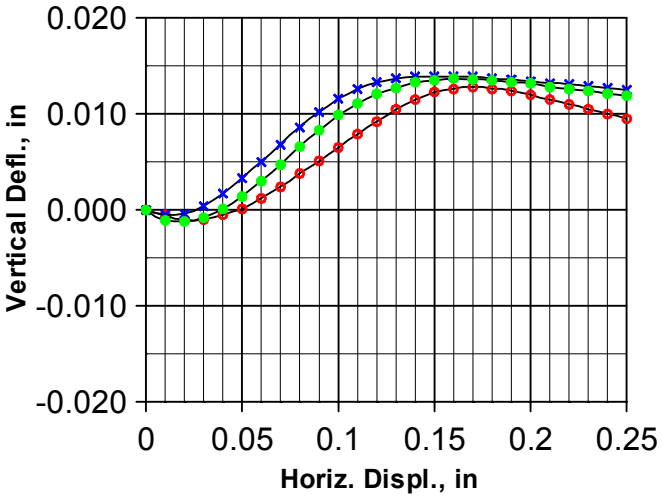
Client:	**Arup**	Boring #: **BTNB-R4**	Sample #: **9B**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **23.2-23.7**	
Project #:	**131558**	Soil: **Undisturbed brown silty sand**	

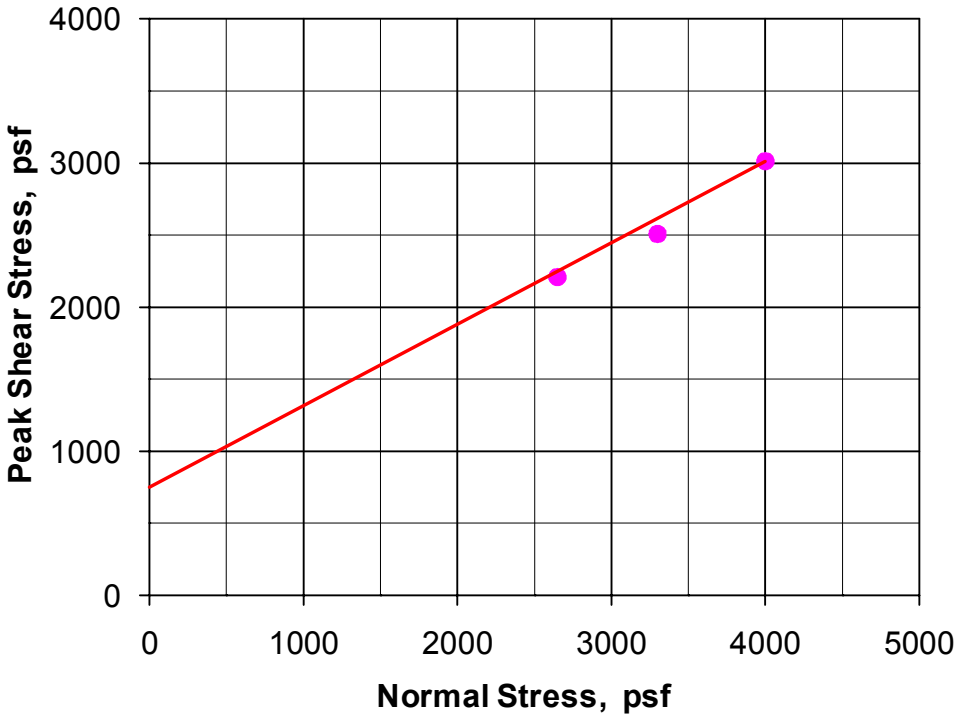
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

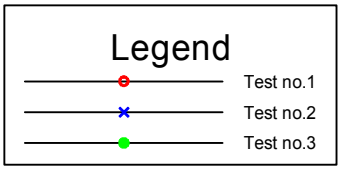
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 750 psf
phi = 29 deg.

Gs = 2.70
Type = undisturbed

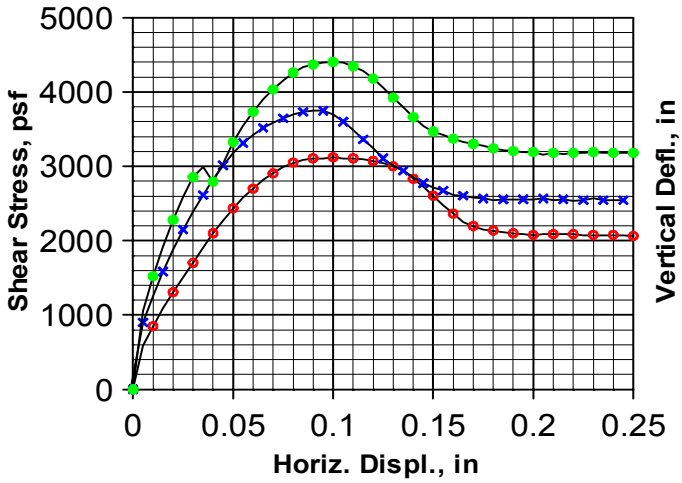
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2650	2208	0.100	0.18	26.4	100.5	105	0.676	1.00	2.416	23.3	97.5	86	0.729	1.032
2	3300	2508	0.065	0.18	25.3	100.7	101	0.674	1.00	2.416	24.2	97.7	90	0.725	1.031
3	4000	3012	0.070	0.18	30.8	95.9	110	0.758	1.00	2.416	25.7	92.5	84	0.822	1.036

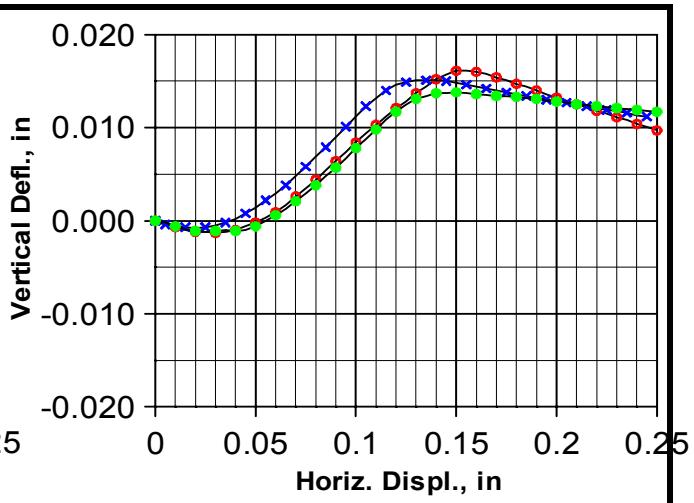
Client:	**Arup**	Boring #: **BTSB-R1**	Sample #: **9**
Project:	**Doyle Dr. Replacement Project**	Depth (ft): **22.5-23**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

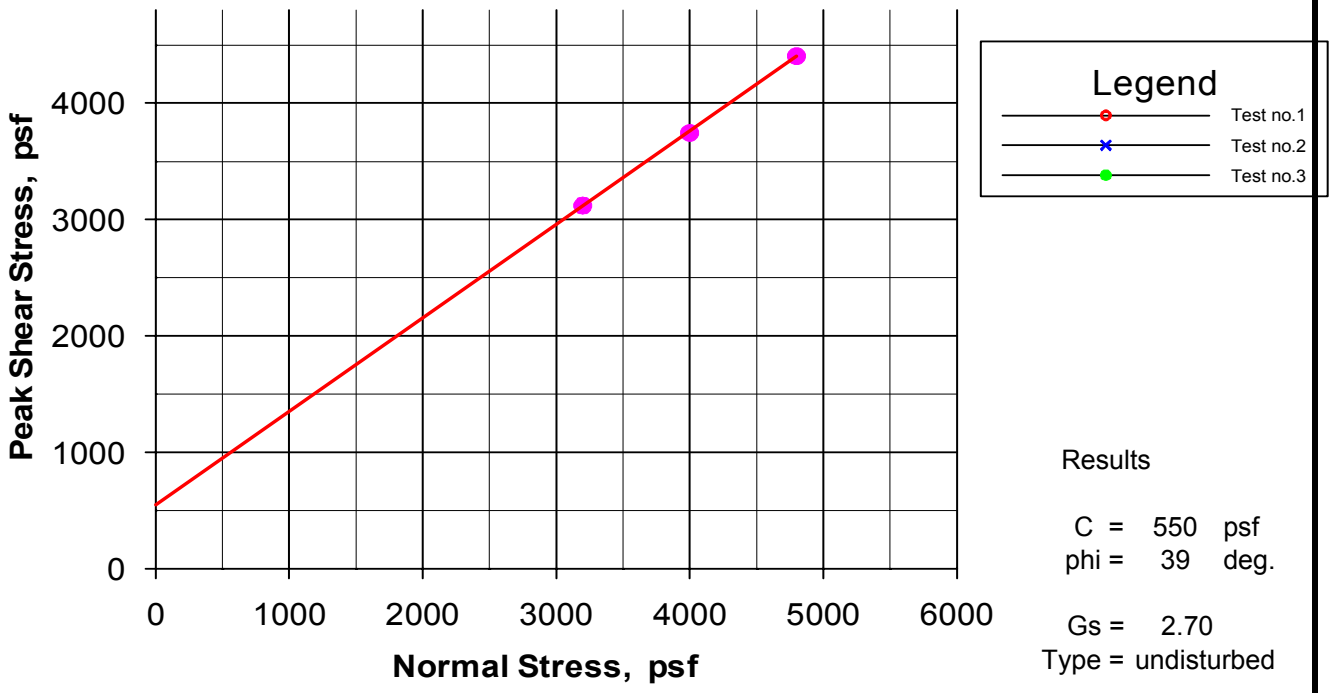
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____







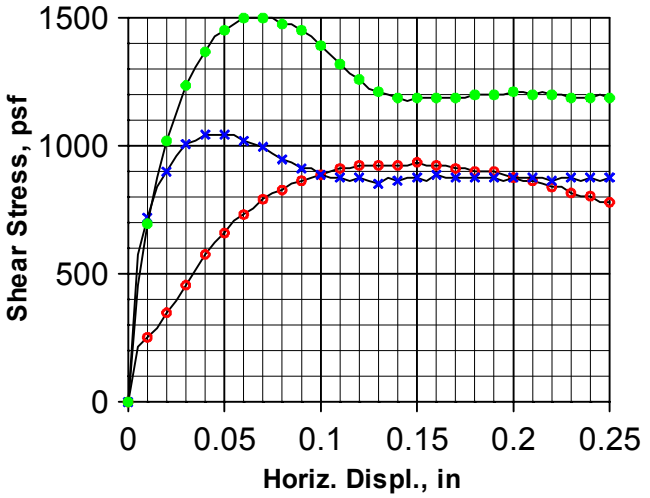
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	3200	3120	0.100	0.18	21.8	106.8	102	0.578	1.00	2.416	20.7	103.6	89	0.627	1.031
2	4000	3744	0.090	0.18	20.7	107.6	99	0.567	1.00	2.416	20.2	103.2	86	0.633	1.042
3	4800	4404	0.100	0.18	20.6	107.8	99	0.564	1.00	2.416	20.2	103.9	88	0.622	1.037

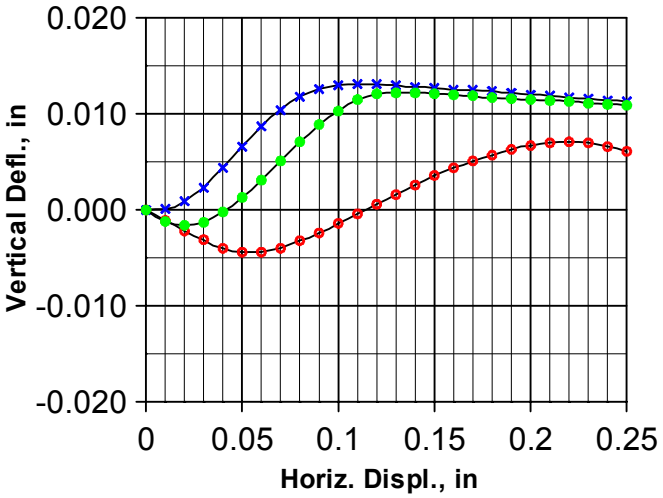
Client:	**ARUP**	Boring #: **BTSB-R2**	Sample #: **11B**
Project:	**Doyle Drive Replacement Project**	Depth (ft):	**28.1-28.4**
Project #:	**131558**	Soil:	**Undisturbed reddish brown poorly graded sand with silt**

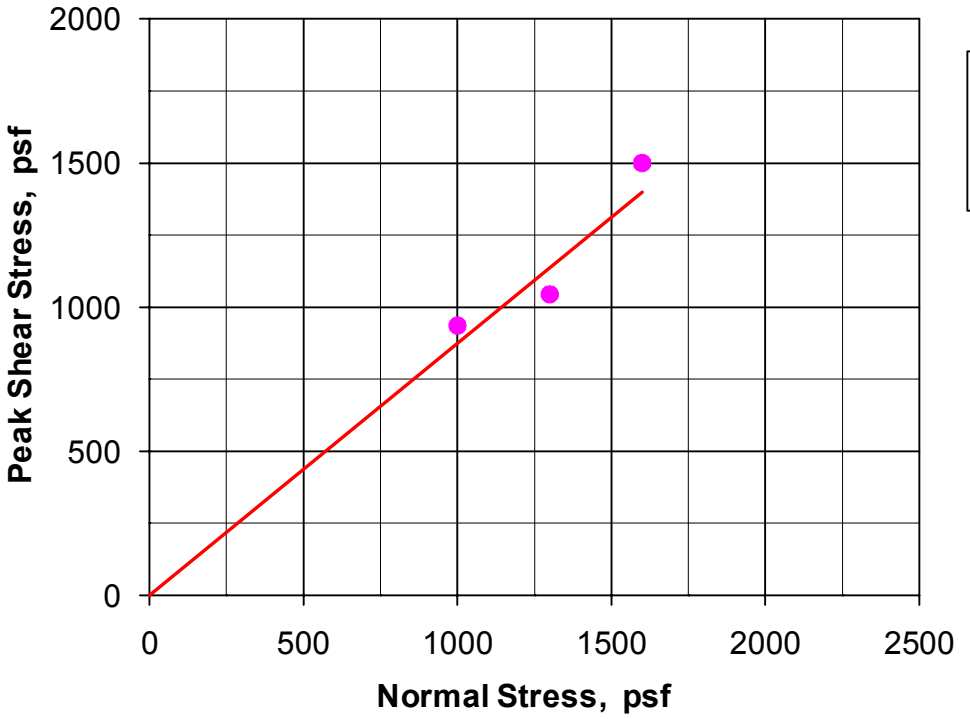
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

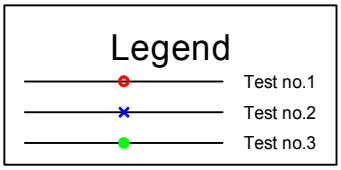
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 41 deg.

Gs = 2.70
Type = undisturbed

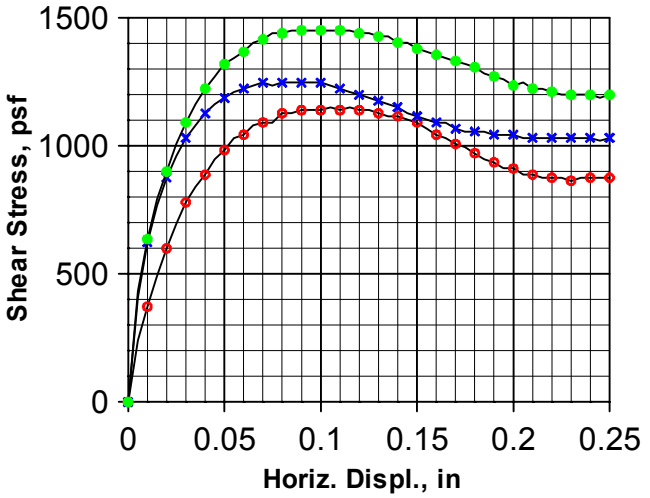
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	936	0.150	0.18	9.2	99.9	36	0.688	1.00	2.360	20.8	96.8	76	0.741	1.032
2	1300	1044	0.040	0.18	10.4	102.3	43	0.648	1.00	2.416	19.3	99.9	76	0.687	1.024
3	1600	1500	0.060	0.18	9.3	100.4	37	0.678	1.00	2.416	19.3	97.6	72	0.726	1.029

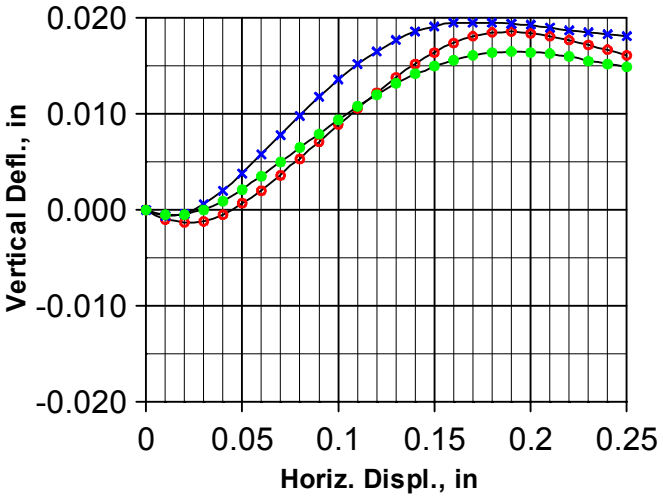
Client:	**ARUP**	Boring #: **BTSB-R3A**	Sample #: **7B**
Project:	**DOYLE DRIVE REPLACEMENT PROJECT**	Depth (ft): **9-9.5**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

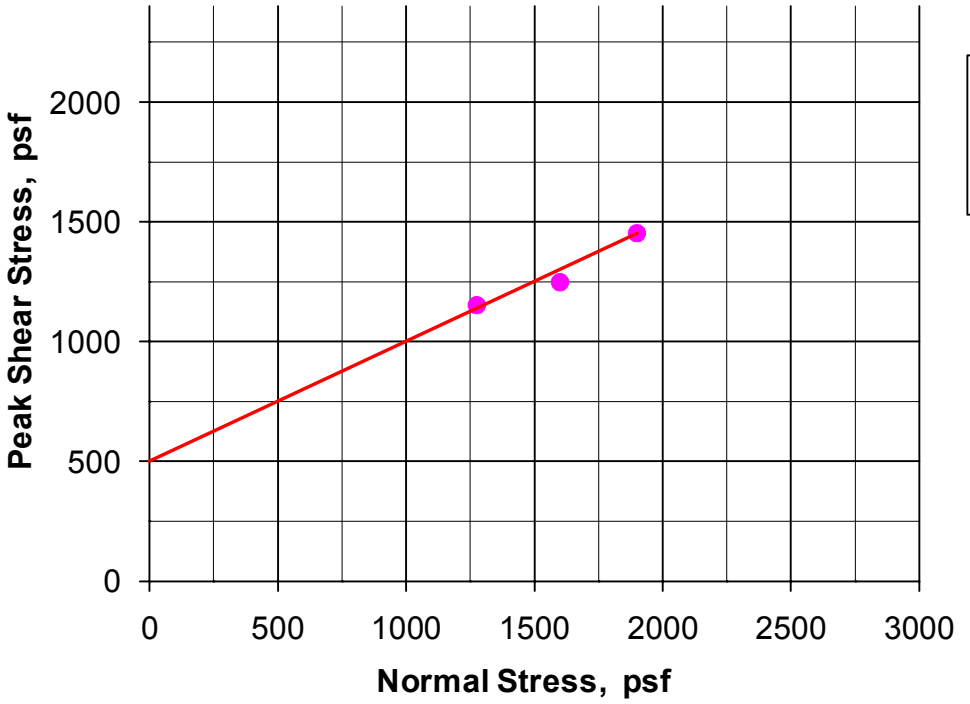
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

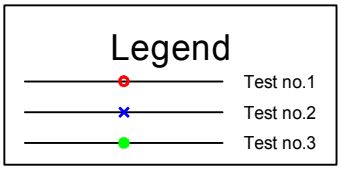
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 500 psf
phi = 27 deg.

Gs = 2.70
Type = undisturbed

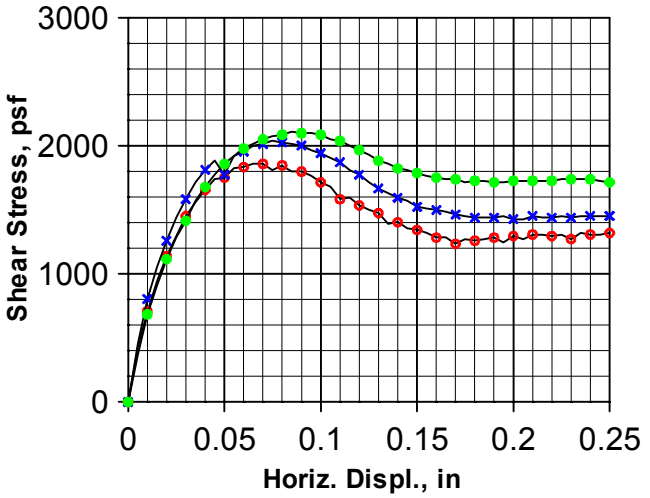
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1275	1152	0.105	0.18	28.3	94.6	98	0.782	1.00	2.416	27.9	91.8	90	0.836	1.031
2	1600	1248	0.070	0.18	26.5	97.3	98	0.732	1.00	2.416	26.3	94.0	89	0.793	1.036
3	1900	1452	0.085	0.18	27.2	97.9	102	0.721	1.00	2.416	25.0	94.9	87	0.777	1.033

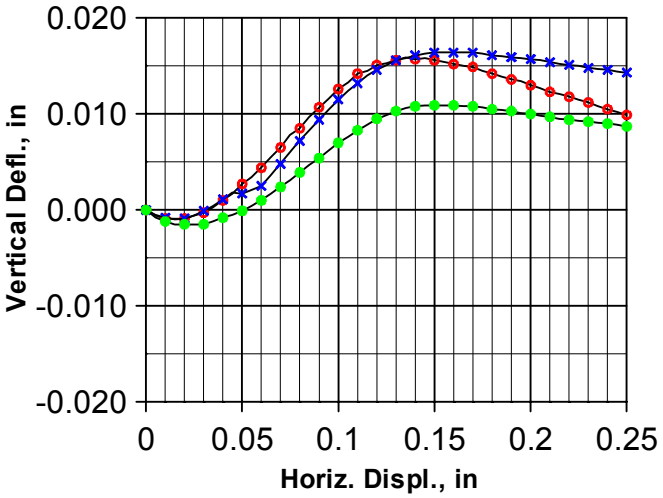
Client:	**Arup**	Boring #: **M-10**	Sample #: **5B**
Project:	**Doyle Dr. Replacement Project**	Depth (ft):	**10.5-11**
Project #:	**131558**	Soil:	**Undisturbed grayish brown poorly graded sand with organics**

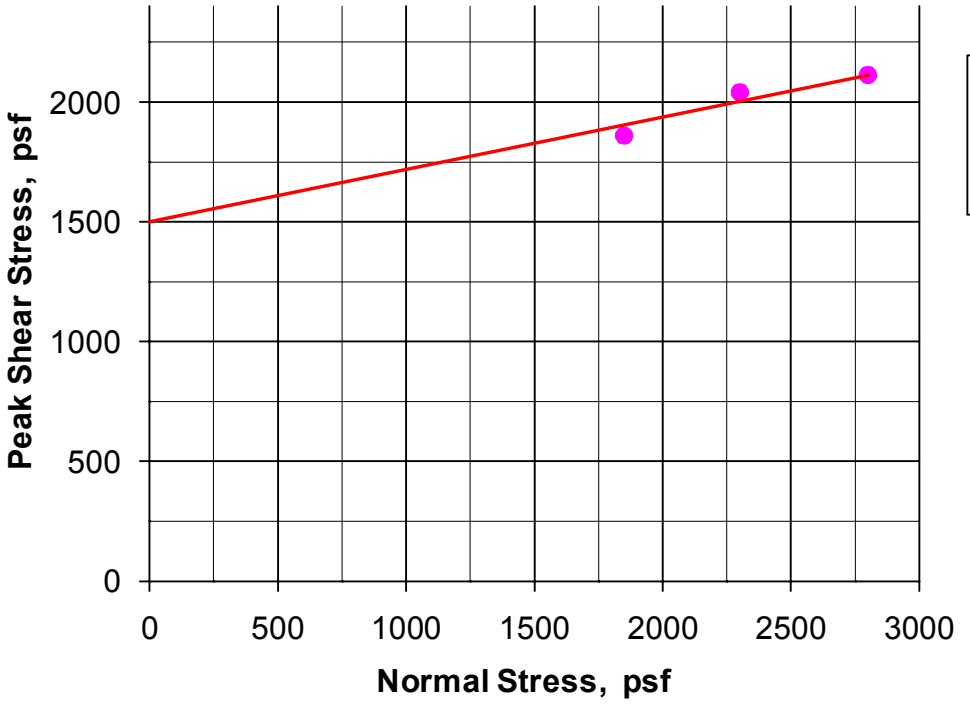
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

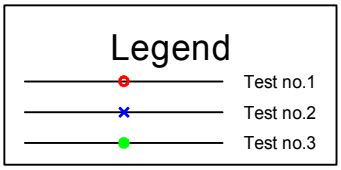
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 1500 psf
phi = 12 deg.

Gs = 2.70
Type = undisturbed

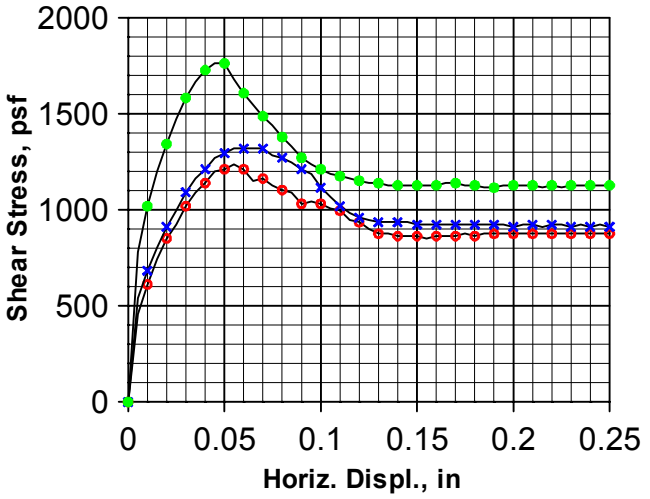
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1850	1860	0.065	0.18	23.9	104.4	105	0.614	1.00	2.416	22.2	101.7	91	0.657	1.027
2	2300	2040	0.075	0.18	26.6	102.9	112	0.639	1.00	2.416	24.6	99.1	95	0.701	1.038
3	2800	2112	0.085	0.18	24.9	102.4	104	0.645	1.00	2.416	23.5	99.8	92	0.689	1.026

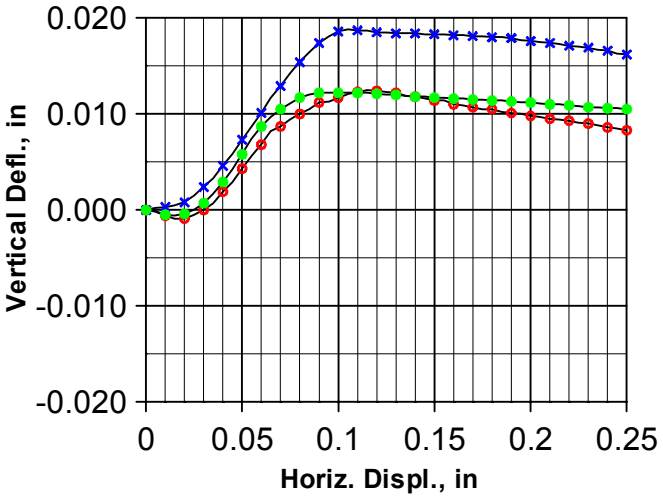
Client:	**Arup**	Boring #: **M-11**	Sample #: **5B**
Project:	**Doyle Dr. Replacement Project**	Depth (ft):	**15.8-16.3**
Project #:	**131558**	Soil:	**Undisturbed dark greenish gray poorly graded sand**

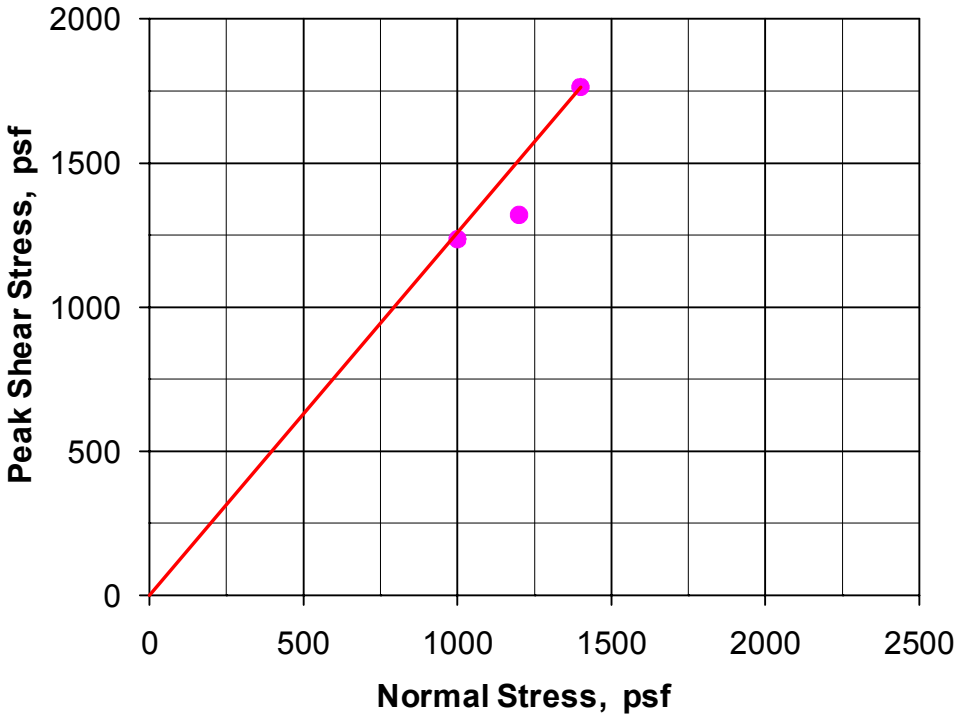
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

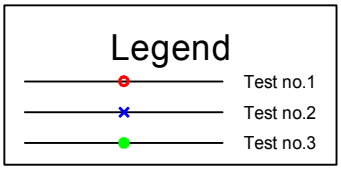
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 52 deg.

Gs = 2.70
Type = undisturbed

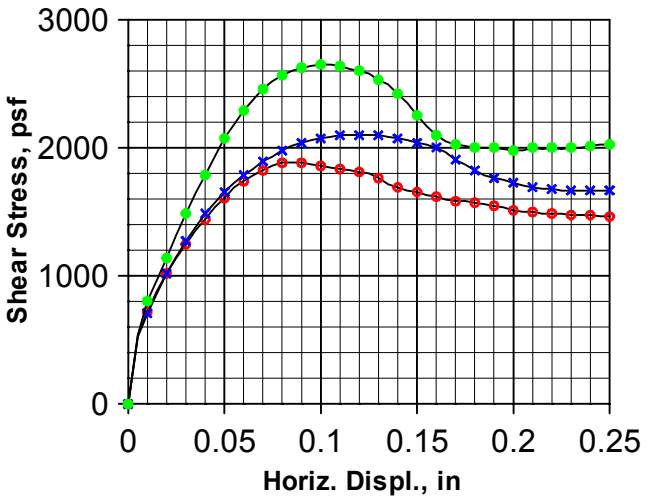
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	1236	0.055	0.18	16.6	110.4	85	0.527	1.00	2.416	19.7	106.3	91	0.586	1.038
2	1200	1320	0.055	0.18	16.8	108.9	83	0.548	1.00	2.416	20.0	103.9	87	0.622	1.048
3	1400	1764	0.045	0.18	16.3	111.0	85	0.519	1.00	2.416	19.4	106.1	89	0.589	1.046

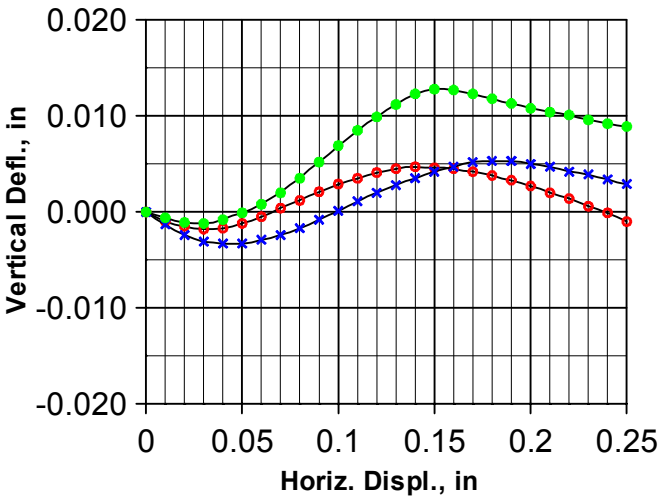
Client:	**Arup**	Boring #: **RW6-R1**	Sample #: **5B**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **12.6-13.1**	
Project #:	**131558**	Soil:	**Undisturbed reddish brown silty sand**

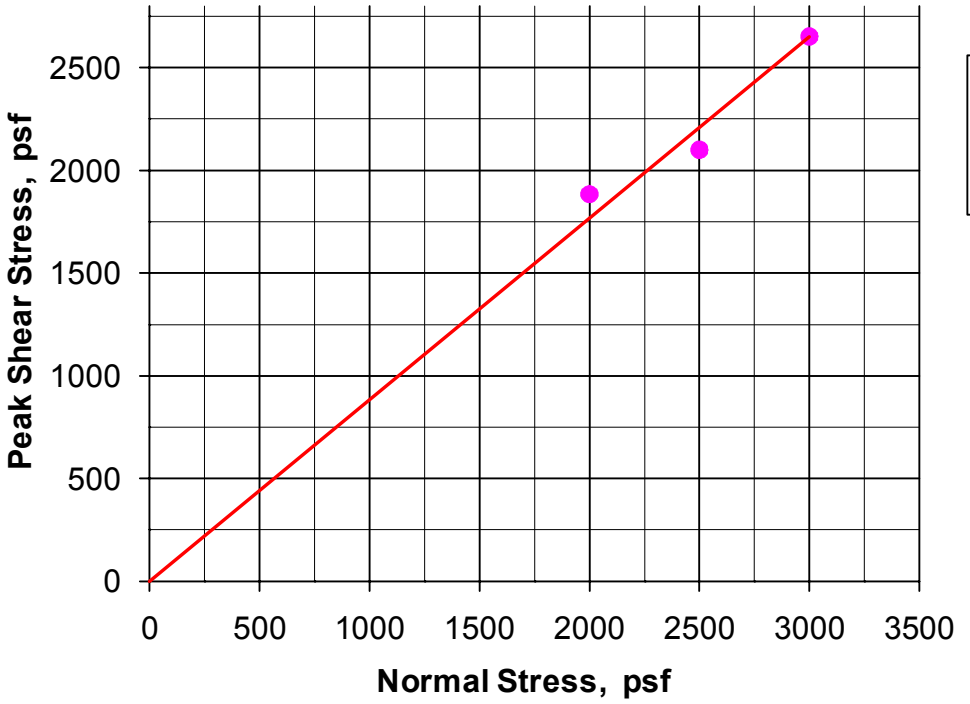
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

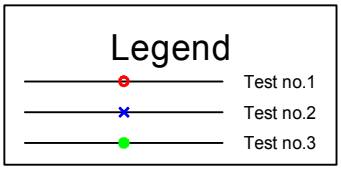
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 0 psf
phi = 41 deg.

Gs = 2.70
Type = undisturbed

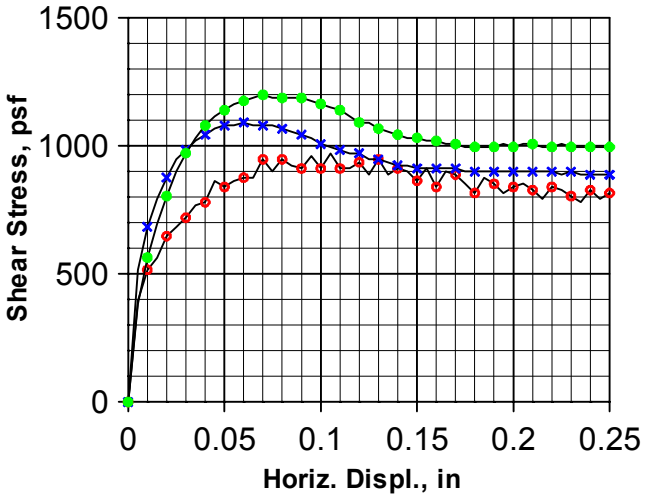
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	2000	1884	0.080	0.09	21.2	108.2	103	0.557	1.00	2.416	20.7	105.8	94	0.594	1.023
2	2500	2100	0.110	0.09	22.1	107.3	104	0.571	1.00	2.416	19.4	103.4	83	0.630	1.037
3	3000	2652	0.100	0.09	18.7	113.0	103	0.491	1.00	2.416	18.6	109.0	92	0.547	1.037

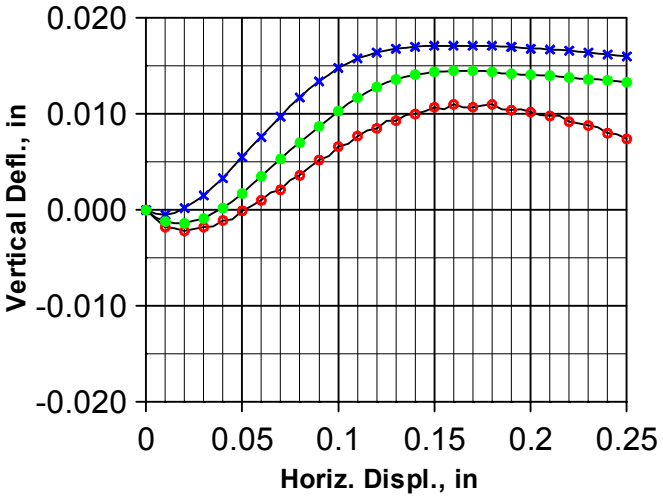
Client:	**Arup**	Boring #: **RW6-R1**	Sample #: **7A**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **17-17.5**	
Project #:	**131558**	Soil:	**Undisturbed dark yellowish brown clayey sand**

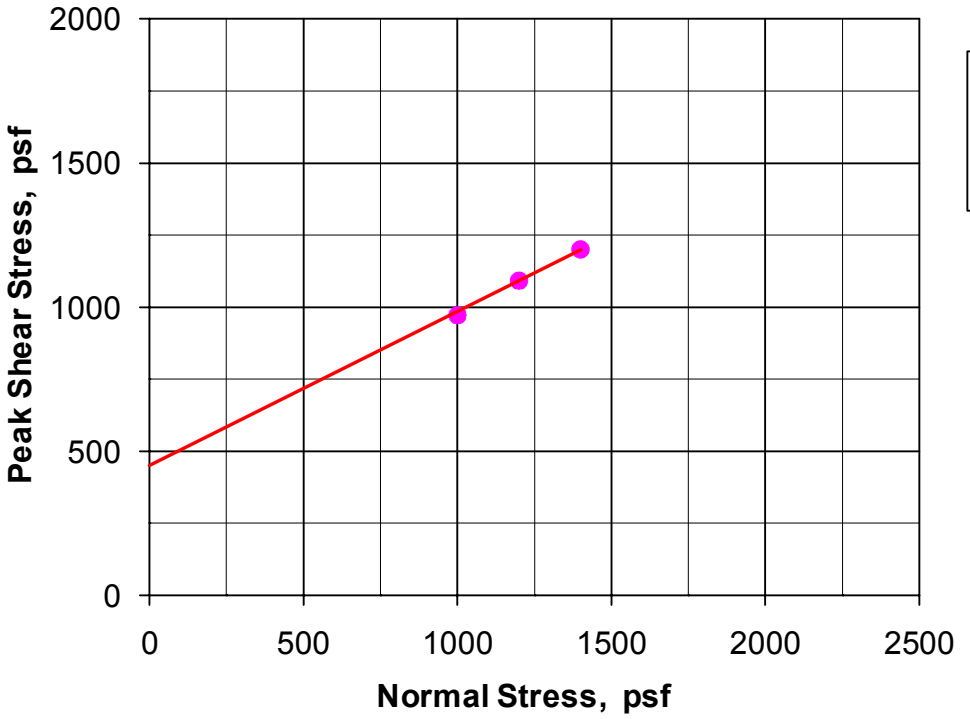
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

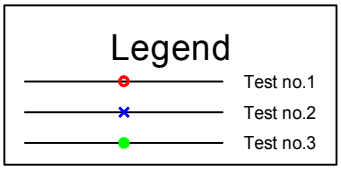
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 450 psf
phi = 28 deg.

Gs = 2.70
Type = undisturbed

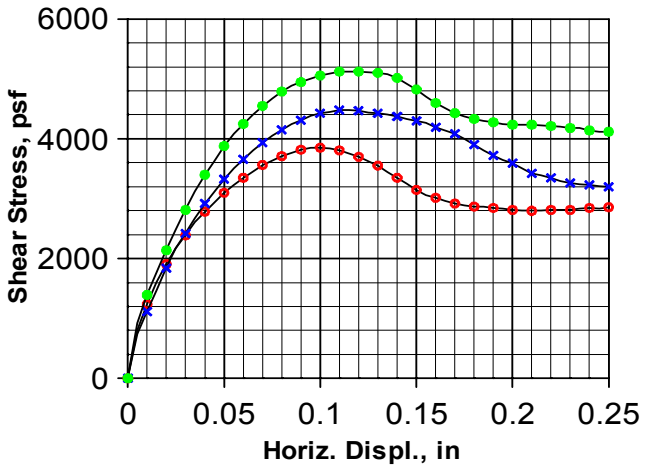
Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	1000	972	0.105	0.18	24.3	101.6	100	0.658	1.00	2.416	21.5	99.3	83	0.697	1.023
2	1200	1092	0.060	0.18	21.7	107.8	104	0.563	1.00	2.416	24.5	104.9	109	0.607	1.028
3	1400	1200	0.070	0.18	18.2	105.5	82	0.598	1.00	2.416	17.9	103.0	76	0.636	1.024

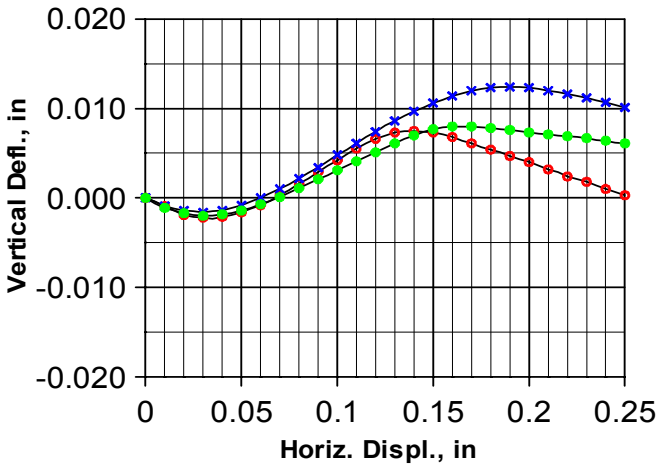
Client:	**Arup**	Boring #: **RW6-R2A**	Sample #: **3**
Project:	**Doyle Drive Replacement Project**	Depth (ft): **7.8-8.3**	
Project #:	**131558**	Soil:	**Undisturbed brown poorly graded sand**

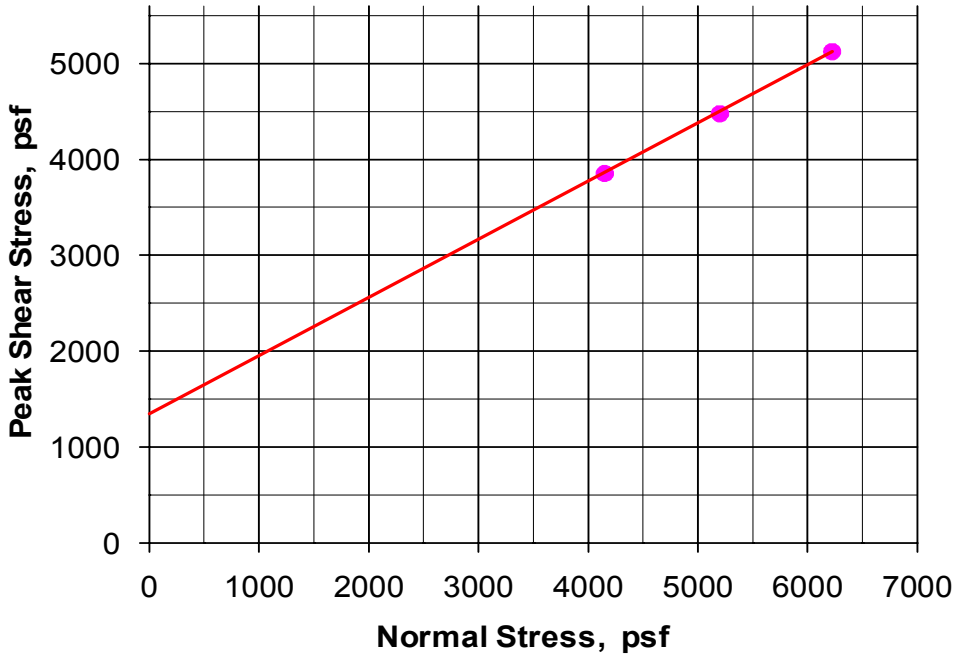
TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

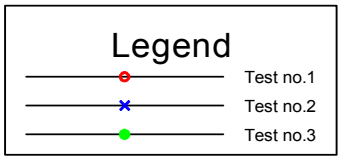
Signet Testing Labs, Inc.

Plate no: _____









Results

C = 1350 psf
phi = 31 deg.

Gs = 2.70
Type = undisturbed

Test no.	SigN psf	Peak Shear str., psf	Displ. in.	Strain Rate in./hr	Initial MC %	Initial DD pcf	Initial Sat. %	Initial Void Ratio	Initial Ht. in.	Initial Dia. in.	Final MC %	Final DD pcf	Final Sat. %	Final Void Ratio	Final Ht. in.
1	4150	3852	0.095	0.18	19.6	108.9	97	0.548	1.00	2.416	19.4	105.9	89	0.591	1.028
2	5200	4476	0.110	0.18	20.0	108.6	98	0.551	1.00	2.416	19.5	104.2	85	0.618	1.043
3	6225	5124	0.110	0.18	19.5	111.5	103	0.512	1.00	2.416	18.6	107.1	87	0.574	1.041

Client:	**Arup**	Boring #: **RW8-R1**	Sample #: **12A**
Project:	**Doyle Dr. Replacement Project**	Depth (ft): **33-33.5**	
Project #:	**EA04-163701**	Soil:	**Undisturbed brown clayey sand**

TEST REPORT: **Direct shear - inundated, consolidated, & drained test**

Signet Testing Labs, Inc.

Plate no: _____

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	BTSB-R1	BTSB-R2	BTSB-R3A	BTNB-R4	BTNB-R4	BTNB-R4	BTNB-R4	BTNB-R6	
	Sample #	5B	1B	3A	3A	5B	13A	19A	3B	
	Depth (ft.)	13-13.5	3-3.5	2.8-3.3	8-8.5	13.1-13.6	32.8-33.3	47.8-48.3	7.9-8.4	
	Soil type: (visual)	Brown poorly graded sand	Brown sand	Brown poorly graded sand	Brown lean clay with sand	Brown sandy silt	Brown poorly graded sand with clay	Brown sand	Reddish brown poorly graded sand with silt	
1.	Date tested:	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/21/08	05/22/08	05/22/08	1.
2.	Tested by:	CN	CN	CN	CN	CN	CN	KA	KA	2.
3.	Specimen height (in.)	5.81	6.00	6.00	4.93	5.88	5.85	5.80	6.00	3.
4.	Wt. of specimen + tare (gm)	1060.5	1074.3	1085.5	778.7	971.8	1152.9	933.0	901.0	4.
5.	Tare wt. (gm)	206.40	213.11	261.30	0.00	0.00	213.41	0.00	0.00	5.
6.	Diameter (in.)	2.42	2.42	2.40	2.42	2.42	2.42	2.41	2.42	6.
7.	Wet wt. of soil + dish wt. (gm)	1137.90	225.09	281.36	277.11	322.07	333.81	690.09	276.28	7.
8.	Dry wt. of soil + dish wt. (gm)	1026.90	216.59	266.41	248.89	287.17	286.65	622.49	246.32	8.
9.	Wt. of dish (gm)	284.85	54.75	42.33	43.19	40.42	51.73	303.12	42.87	9.
10.	Dish ID									10.
	Wet Density (pcf)	121.7	118.8	115.6	130.7	136.8	132.9	134.2	124.3	
	Dry Density (pcf)	105.8	112.9	108.4	114.9	119.8	110.7	110.8	108.3	
	Moisture Content (%)	15.0	5.3	6.7	13.7	14.1	20.1	21.2	14.7	
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.592	0.493	0.555	0.466	0.406	0.522	0.521	0.555	
	Saturation (%)	68.2	28.8	32.5	79.5	94.0	103.8	109.7	71.6	

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	BTNB-R6	BTNB-R6	BTNB-R7A	BTNB-R7A	BTNB-R7A	M9/RW7-A1A	M9/RW7-A1A	M9/RW7-A1A	
	Sample #	7A	9B	4	8	9A	3B	6	8	
	Depth (ft.)	18-18.5	23.3-23.8	9-10.5	19-20.5	22.8-23.3	6-6.5	12-13.5	16.5-18	
	Soil type: (visual)	Brown sandy clay	Strong brown silty sand	Dark brown clay	Reddish brown sandy clay	Dark brown silty sand	Black silty sand with organics	Brown silty sand	Gray clayey sand	
1.	Date tested:	05/22/08	05/22/08	05/21/08	05/21/08	05/22/08	05/22/08	05/21/08	05/21/08	1.
2.	Tested by:	KA	KA	CN	CN	KA	KA	CN	CN	2.
3.	Specimen height (in.)	6.00	6.00			6.05	5.90			3.
4.	Wt. of specimen + tare (gm)	963.3	988.4			968.9	802.5			4.
5.	Tare wt. (gm)	0.00	0.00			0.00	0.00			5.
6.	Diameter (in.)	2.41	2.42			2.41	2.41			6.
7.	Wet wt. of soil + dish wt. (gm)	653.22	257.52	123.78	128.29	262.87	639.27	1300.80	1199.80	7.
8.	Dry wt. of soil + dish wt. (gm)	597.08	228.37	112.69	113.97	225.98	505.42	1119.40	1018.10	8.
9.	Wt. of dish (gm)	285.83	42.53	58.39	53.19	40.39	167.87	296.54	285.06	9.
10.	Dish ID									10.
	Wet Density (pcf)	134.0	136.3			133.6	113.5			
	Dry Density (pcf)	113.5	117.8			111.5	81.3			
	Moisture Content (%)	18.0	15.7	20.4	23.6	19.9	39.7	22.0	24.8	
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.484	0.430			0.511	1.073			
	Saturation (%)	100.5	98.6			104.9	99.8			

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	M-10	M-10	M-10	M-10	M-11	RW6-R1	RW6-R1		
	Sample #	2	7	11A	18	7B	1A	3B		
	Depth (ft.)	4-5.5	14.3-14.8	24.3-24.8	40.5-42	20.9-21.4	2.8-3.3	7.6-8.1		
	Soil type: (visual)	Grayish brown poorly graded sand	Gray sand	Light brown poorly graded sand with silt	Brown silty sand	Gray poorly graded sand	Brown silty sand	Yellowish brown lean clay with sand		
1.	Date tested:	05/21/08	05/22/08	05/22/08	05/21/08	05/22/08	05/22/08	05/22/08		1.
2.	Tested by:	CN	KA	KA	CN	KA	KA	KA		2.
3.	Specimen height (in.)		5.60	5.85		5.40	5.75			3.
4.	Wt. of specimen + tare (gm)		1115.5	1128.7		1061.1	856.4			4.
5.	Tare wt. (gm)		217.18	213.43		212.37	0.00			5.
6.	Diameter (in.)		2.41	2.41		2.40	2.41			6.
7.	Wet wt. of soil + dish wt. (gm)	1020.60	333.53	652.31	1057.20	270.42	217.19	237.70		7.
8.	Dry wt. of soil + dish wt. (gm)	882.90	287.98	559.50	925.20	233.22	195.16	212.53		8.
9.	Wt. of dish (gm)	276.76	52.06	168.31	284.60	43.10	51.81	51.71		9.
10.	Dish ID									10.
	Wet Density (pcf)		133.9	130.6		132.2	124.3			
	Dry Density (pcf)		112.2	105.5		110.6	107.7			
	Moisture Content (%)	22.7	19.3	23.7	20.6	19.6	15.4	15.7		
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio		0.502	0.597		0.523	0.564			
	Saturation (%)		103.9	107.4		101.0	73.6			

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	RW6-R2A	RW6-R2A	BTNB-R5						
	Sample #	1B	7B							
	Depth (ft.)	3.5-4	18.3-18.8	54-55						
	Soil type: (visual)	Dark brown poorly graded sand	Reddish brown silty sand	Dark gray clayey gravel						
1.	Date tested:	06/10/08	06/10/08	07/01/08						1.
2.	Tested by:	KA	KA	JH						2.
3.	Specimen height (in.)	5.90	6.00	5.58						3.
4.	Wt. of specimen + tare (gm)	742.9	1185.7	804.9						4.
5.	Tare wt. (gm)	0.00	253.58	0.00						5.
6.	Diameter (in.)	2.42	2.41	2.10						6.
7.	Wet wt. of soil + dish wt. (gm)	233.70	244.31	1028.00						7.
8.	Dry wt. of soil + dish wt. (gm)	225.52	220.68	959.30						8.
9.	Wt. of dish (gm)	42.46	41.91	223.54						9.
10.	Dish ID									10.
	Wet Density (pcf)	104.2	129.6	158.6						
	Dry Density (pcf)	99.7	114.5	145.1						
	Moisture Content (%)	4.5	13.2	9.3						
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
	Void Ratio	0.689	0.471	0.161						
	Saturation (%)	17.5	75.7	156.4						

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Drive Replacement Project Retaining Wall Job no : EA04-163701

	Boring #	RW8-R1	RW8-R1	RW8-R1	RW8-R5	RW8-R5	RW8-R5	RW8-R5	
	Sample #	3B	5A	7B	3A	5B	17	24	
	Depth (ft.)	8.5-9	13-13.5	18.5-19	8-8.5	13.5-14	43-43.5	67.5-69	
	Soil type: (visual)	Very dark brown silty sand	Very dark brown silty clay with sand	Yellowish brown clay	Dark yellowish brown clayey sand	Olive brown poorly graded sand with silt	Olive brown poorly graded sand with silt	Olive brown silty sand	
1.	Date tested:	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	01/22/09	1.
2.	Tested by:	KA	KA	KA	KA	KA	KA	KA	2.
3.	Specimen height (in.)	5.98	5.51	5.84	5.76	5.96	6.00		3.
4.	Wt. of specimen + tare (gm)	787.7	847.3	926.5	896.0	935.7	972.3		4.
5.	Tare wt. (gm)	0.00	0.00	0.00	0.00	0.00	0.00		5.
6.	Diameter (in.)	2.42	2.42	2.42	2.42	2.42	2.42		6.
7.	Wet wt. of soil + dish wt. (gm)	246.59	663.67	224.63	275.43	290.62	202.36	616.50	7.
8.	Dry wt. of soil + dish wt. (gm)	228.70	597.74	195.25	239.90	259.43	175.95	516.91	8.
9.	Wt. of dish (gm)	42.09	303.28	40.26	51.36	52.18	43.17	165.58	9.
10.	Dish ID								10.
	Wet Density (pcf)	109.0	127.3	131.3	128.7	129.9	134.1		
	Dry Density (pcf)	99.5	104.0	110.4	108.3	112.9	111.9		
	Moisture Content (%)	9.6	22.4	19.0	18.8	15.0	19.9	28.3	
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
	Void Ratio	0.694	0.620	0.527	0.555	0.492	0.506		
	Saturation (%)	37.3	97.4	97.2	91.6	82.6	106.1		

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

MOISTURE & DENSITY TEST

Client : Arup Project : Doyle Dr. Replacement Project Job no : 131558

	Boring #	BTNB-R3	BTNB-R3	BTNB-R3	RW5-R1				
	Sample #	5A	8	13A	1A				
	Depth (ft.)	11.3-11.8	17.5-19	31.4-31.9	3-3.5				
	Soil type: (visual)	Yellowish brown clay	Brown clayey sand	Yellowish brown clayey sand	Yellowish brown silty sand				
1.	Date tested:	08/16/08	08/16/08	08/16/08	08/16/08				1.
2.	Tested by:	JH	JH	JH	JH				2.
3.	Specimen height (in.)	5.97		5.98	5.84				3.
4.	Wt. of specimen + tare (gm)	945.8		915.4	945.4				4.
5.	Tare wt. (gm)	0.00		0.00	0.00				5.
6.	Diameter (in.)	2.43		2.43	2.42				6.
7.	Wet wt. of soil + dish wt. (gm)	289.85	863.90	1080.70	1111.70				7.
8.	Dry wt. of soil + dish wt. (gm)	251.98	775.01	909.30	996.70				8.
9.	Wt. of dish (gm)	51.60	285.87	166.04	166.33				9.
10.	Dish ID								10.
	Wet Density (pcf)	130.0		125.6	134.0				
	Dry Density (pcf)	109.4		102.1	117.7				
	Moisture Content (%)	18.9	18.2	23.1	13.8				
	Gs (Assumed)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
	Void Ratio	0.541		0.650	0.432				
	Saturation (%)	94.4		95.8	86.6				

Additional data:

Wt. of dry soil + dish before washing (gm)								
Wt. of dry soil + dish after washing (gm)								
% Passing # 200 sieve								
USCS symbol								

Organic Content
ASTM D-2974 Method C

Client: Arup
Project Name: Doyle Drive Replacement Project
Project Number: EA 04-163701
Date 1/22/2009

Boring	RW8-R1		
Sample	5A		
Depth	13-13.5		
Wet Soil + Tare	663.67		
Dry Soil + Tare	597.74		
Tare	303.28		
Moisture Content (%)	**22.39**		
Weight Before 440°C + Tare	299.81		
Weight After 440°C + Tare	294.47		
Tare	147.97		
Weight of Ash (After 440°C)	146.5		
Weight of Oven-Dried Soil	151.84		
Ash Content (%)	96.48		
Organic Matter (%)	**3.52**		

Reviewed For Adequacy (RFA)

RECD JUL 10 2008

By: TC

Date: 7/10/2008

ADVANCED TERRA TESTING, Inc.

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w_miles@hotmail.com

June 20, 2008

Hamid Nazeri, Ph.D.
Advanced Terra Testing Inc.
833 Parfet Street, Unit A
Lakewood, CO 80215
Tel: 303-232-8308
hnazeri@terratesting.com

Re: Doyle Drive Replacement Project
Thin Section Petrography of 4 Rock Cores

Dear Hamid:

On June 10, 2008, Advanced Terra Testing delivered four rock cores for thin section petrographic evaluation. The lithographic name, mineralogy, grain size, primary and secondary textures, structures and alteration features were requested. The rock drill cores are labeled borehole TSB-R3 44.10-44.20', BTNB-R4 96.35-96.36', BTNB-R6 84.00-84.20', and RW6-R1 4-8 27.20-27.30'. The microscope photographs and results of these analyses are included in this report.

Thin Section Petrography:

In order to prepare a thin section, each cylindrical drill boring was cut in order to form a smooth rock surface, followed by gluing the rock surface to a glass slide. A rock section was cut from the rock and then the rock section was ground to form a smooth thin section for analysis. The resulting thin sections are labeled to the nearest depth in 0.01-foot increments.

The thin sections were then examined by petrographic microscopy with crossed nicols. The thin sections were examined at 40-power or 100-power microscope enlargement, and further enlarged by a factor of 4.5 for the enclosed pictures. Representative microscope photographs are enclosed to illustrate stone structures. The label for each microscope photograph gives a scale for micrometers as um. The mineral compositions of these rock cores are listed in Table 1. Comments and descriptions for each thin section are found in Table 2. If there is regional terminology that the customer may prefer for the following thin section mineral descriptions, they will be adapted in include such terminology for this report.

Table 1

Mineral Composition of Rock Cores by Thin Section Microscopy

Sample Depth, ft.	BTSB-R3 44.10-44.20'	BTNB-R4 96.35-96.36'	BTNB-R6 84.00-84.20'	RW6-R1 27.20-27.30'
Quartz	63%	0%	0%	63%
Feldspar (albite)	21%	0%	0%	30%
Chlorite	5%	0%	0%	5%
Muscovite	4%	0%	0%	2%
Kaolinite	7%	0%	0%	0%
Clinochrysotile	0%	56%	87%	0%
Lizardite	0%	0%	13%	0%
Hydrotalcite	0%	44%	0%	0%

Table 2

Microscopy of the Thin Sections of Rock Cores

Boring BTSB-R3 44.10-44.20'

This is a gray metamorphic sandstone with quartz, feldspar, kaolinite and chlorite present. The major mineral components are listed in Table 1.

Grain Size: Large quartz and feldspar grains whose sizes range from about 200 to 900 micrometers, with a background of other finer grains of kaolinite and chlorite of less than 25 micrometers.

Primary and Secondary Features: Metamorphic sandstone containing large grains of quartz and albite feldspar with finer grains of kaolinite and chlorite.

Textures and Structures: Large randomly shaped grains whose sizes range from about 200 to 900 micrometers as a result of metamorphism.

Microscope Description: At 40x, microscope photo #1 shows the large grains of quartz and albite feldspar with the finer interstitial grains of kaolinite and chlorite. At 100x, microscope photo #2 also shows the large grains of quartz and albite with finer grains of kaolinite and chlorite.

Boring BTNB-R4 96.35-96.36' This is a green serpentine with clinochrysotile and hydrotalcite, but no quartz or feldspar present. The major mineral components are listed in Table 1.

Grain Size: Elongate Grain sizes range from about 50 to 100 micrometers.
Primary and Secondary Features: Serpentine containing clinochrysotile and hydrotalcite.
Textures and Structures: Grain sizes range from about 50 to 100 micrometers as a result of metamorphism.
Microscope Description: At 40x, microscope photo #1 shows the predominant crystallites of clinochrysotile and hydrotalcite. Clinochrysotile crystallites exhibit elongated growth habit while the hydrotalcite crystallites are more equidimensional. At 100x, microscope photo #2 also shows the elongate growth habit of the clinochrysotile.

Boring BTNB-R6 84.00-84.20'
This is a dark green gabbro with clinochrysotile and lizardite. The major mineral components are listed in Table 1.

Grain Size: Quartz grain sizes range from about 50 to exceed 1,000 micrometers,
Primary and Secondary Features: Gabbro rock containing clinochrysotile and lizardite.
Textures and Structures: The clinochrysotile shows elongate growth with widths of about 40 to 50 micrometers. Lizardite occurs between the clinochrysotile structures.
Microscope Description: Microscope photo #1 shows clinochrysotile and lizardite structures ranging from 50 to over 1,000 micrometers in length. At 100x, microscope photo #2 shows the crystallite structure of clinochrysotile in more detail.

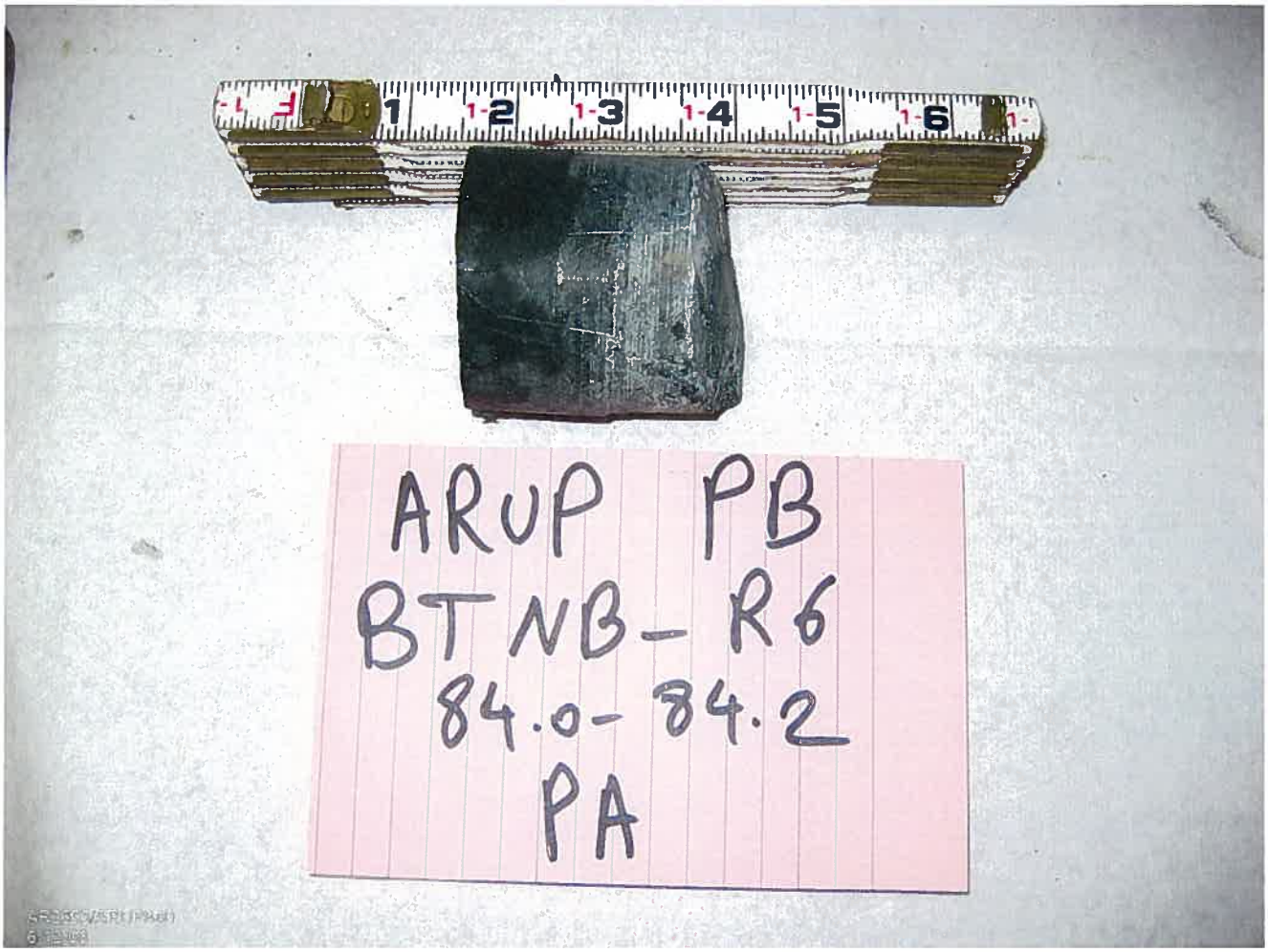
Boring RW6-R1 27.20-27.30'
This is a reddish brown metamorphosed sandstone with quartz, albite, chlorite and muscovite present. The major mineral components are listed in Table 1.

Grain Size: Quartz and albite grains range from about 25 to 200 micrometers with smaller chlorite and muscovite grains.
Primary and Secondary Features: Sandstone containing quartz, albite, chlorite and muscovite mica.
Textures and Structures: Large randomly shaped grains whose sizes range from about 25 to 200 micrometers.
Microscope Description: Microscope photo #1 shows relatively large quartz and feldspar grain growth with smaller chlorite and muscovite grains. At 100x, microscope photo #2 shows the grain sizes in greater detail.

William Miles, Ph.D.

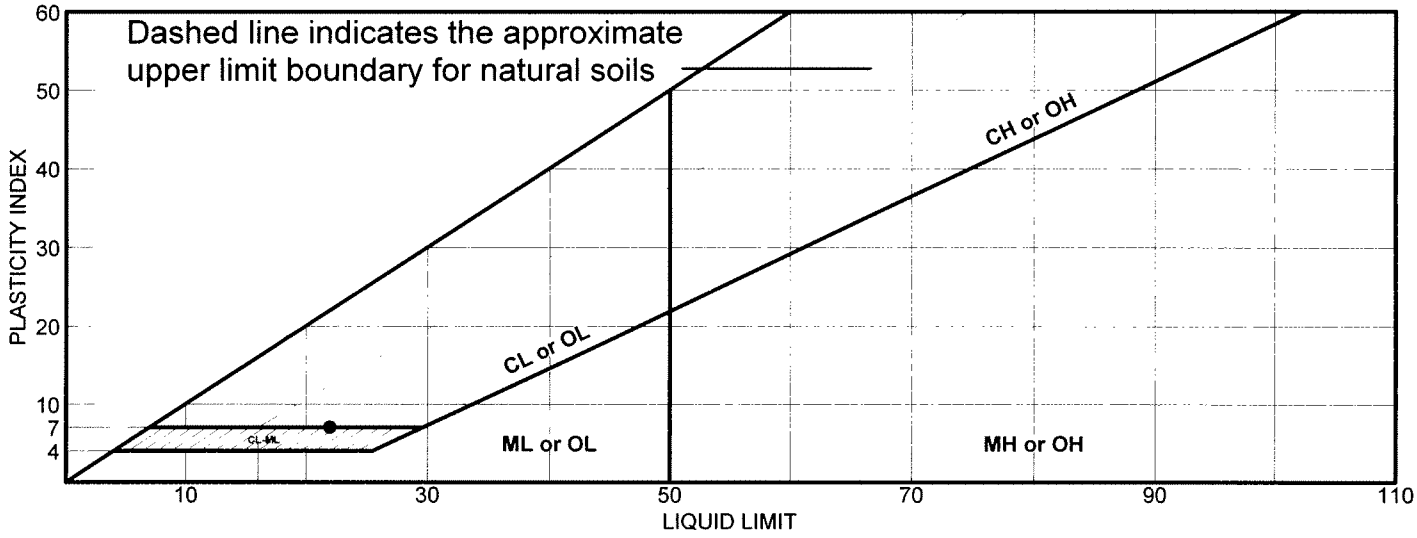
5.5
5.6
5.7
5.8
5.9
ARUP PB
BTNB - R4
96.35 - 96.36
PA
AR2653 ARDP9635
6-12-08

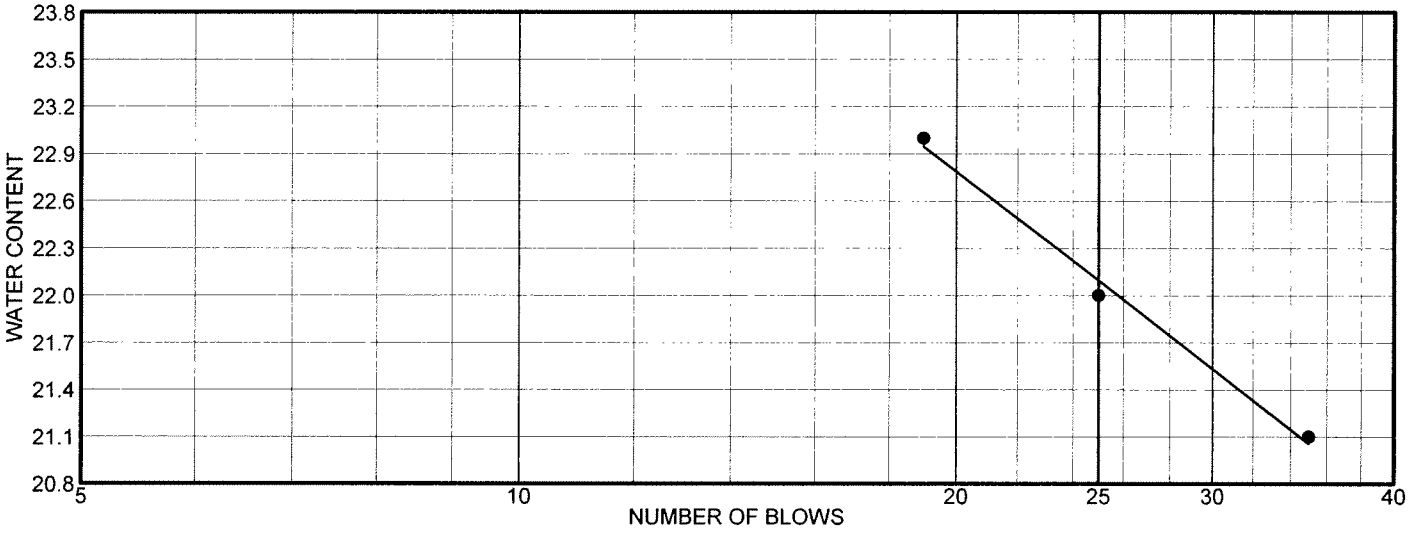
ARUP PB
RW6— R1
27.20-27.30
PA


ARUP PB
BTNB-R6
84.0-84.2
PA

5.5
5.6
5.7
5.8
5.9
ARUP PB
BT NB - R4
96.35 - 96.36
PA
AR2653/ARDP9635

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Very dark gray silty clayey gravel	22	15	7			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R1 **Elev./Depth:** 51.5-52.3

Remarks:

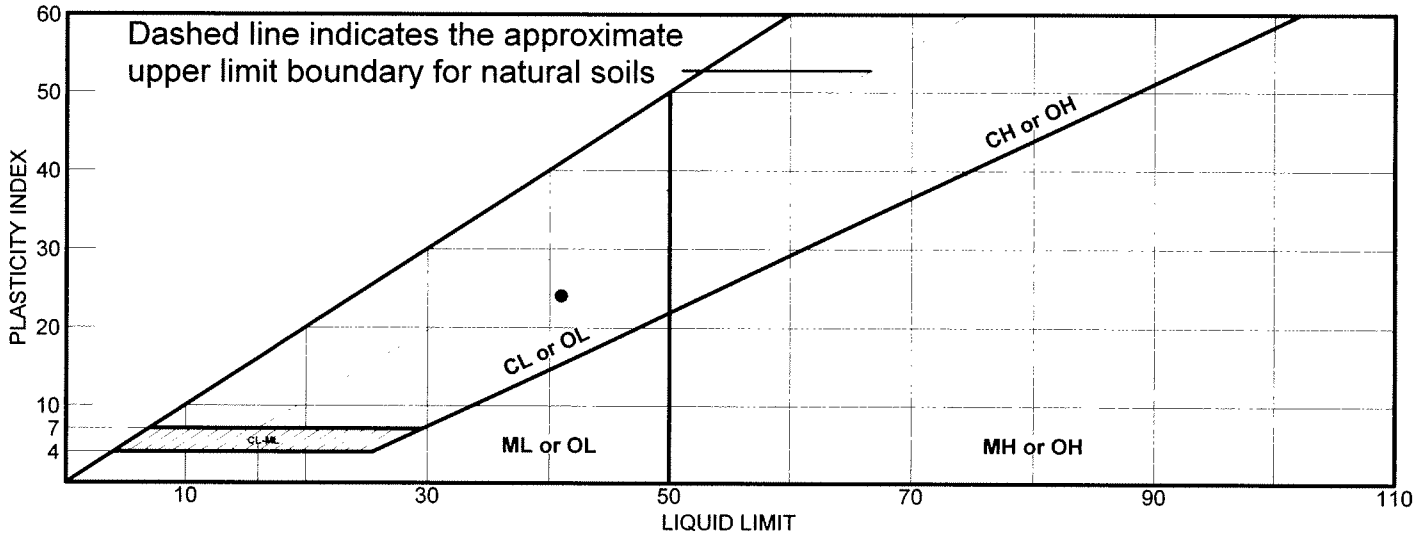
●

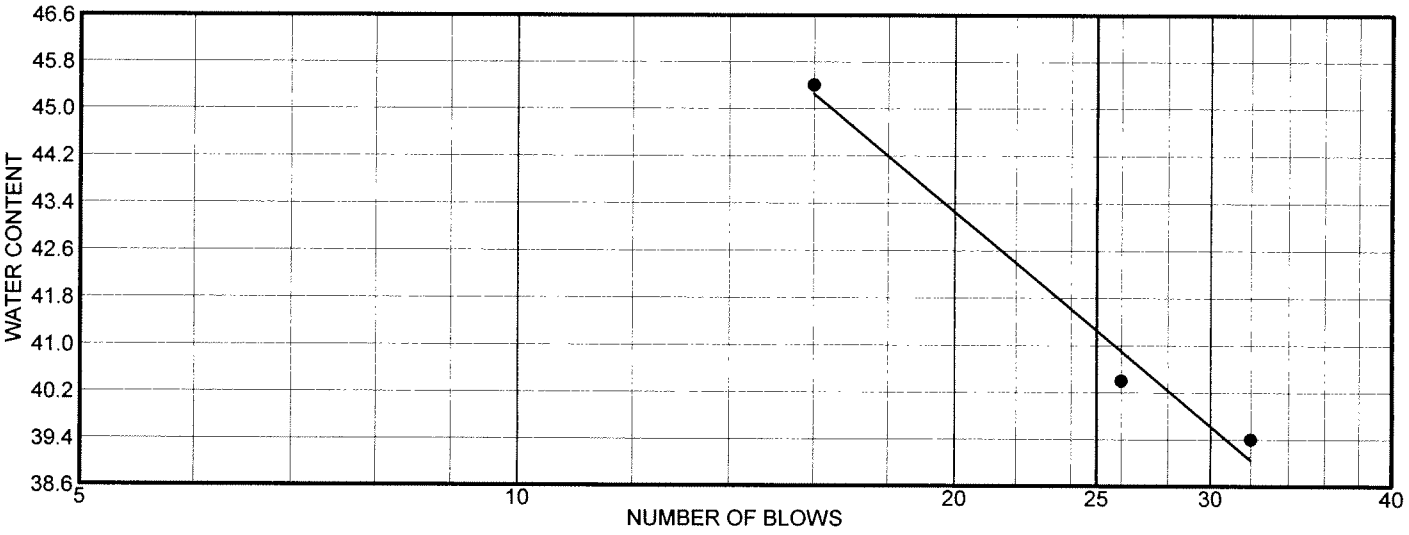
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	41	17	24			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R3 **Sample No.:** 5A **Elev./Depth:** 11.3-11.8

Remarks:

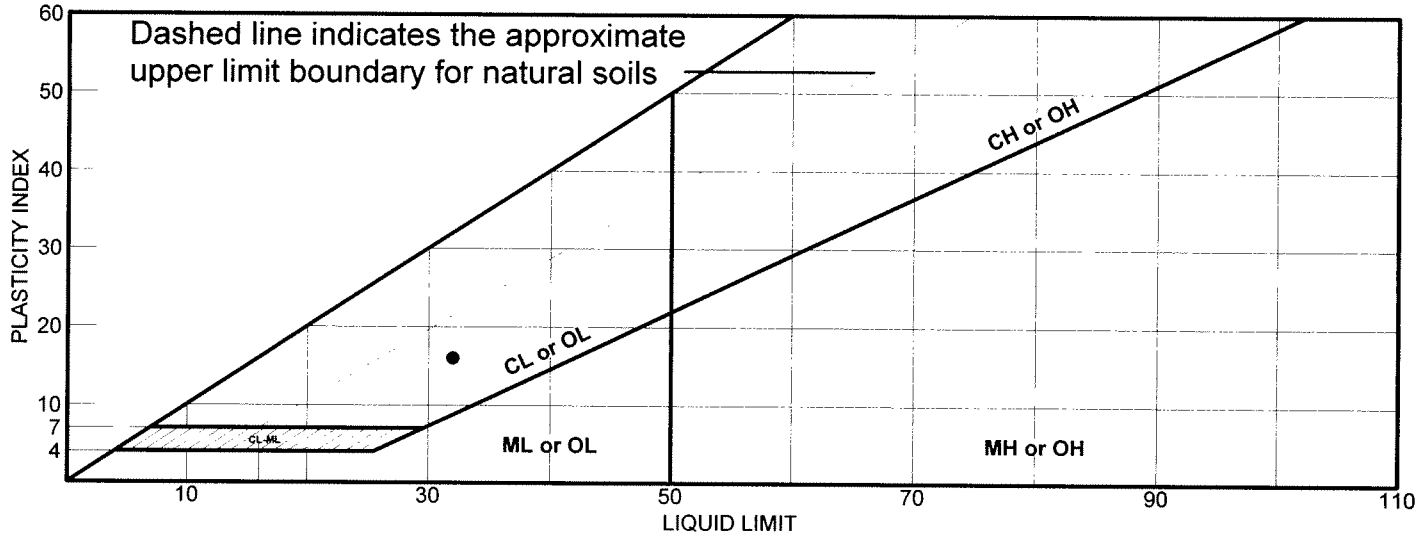
●

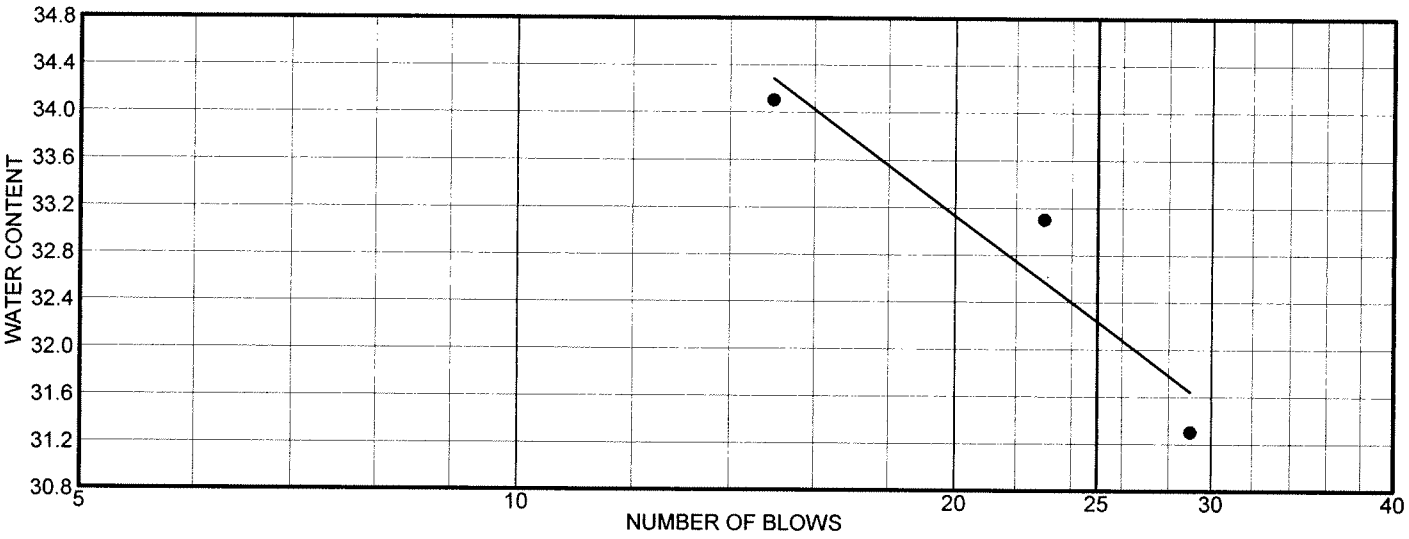
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown Lean clay with sand	32	16	16	97.4	81.1	CL

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R4 **Sample No.:** 3A **Elev./Depth:** 8-8.5

Remarks:

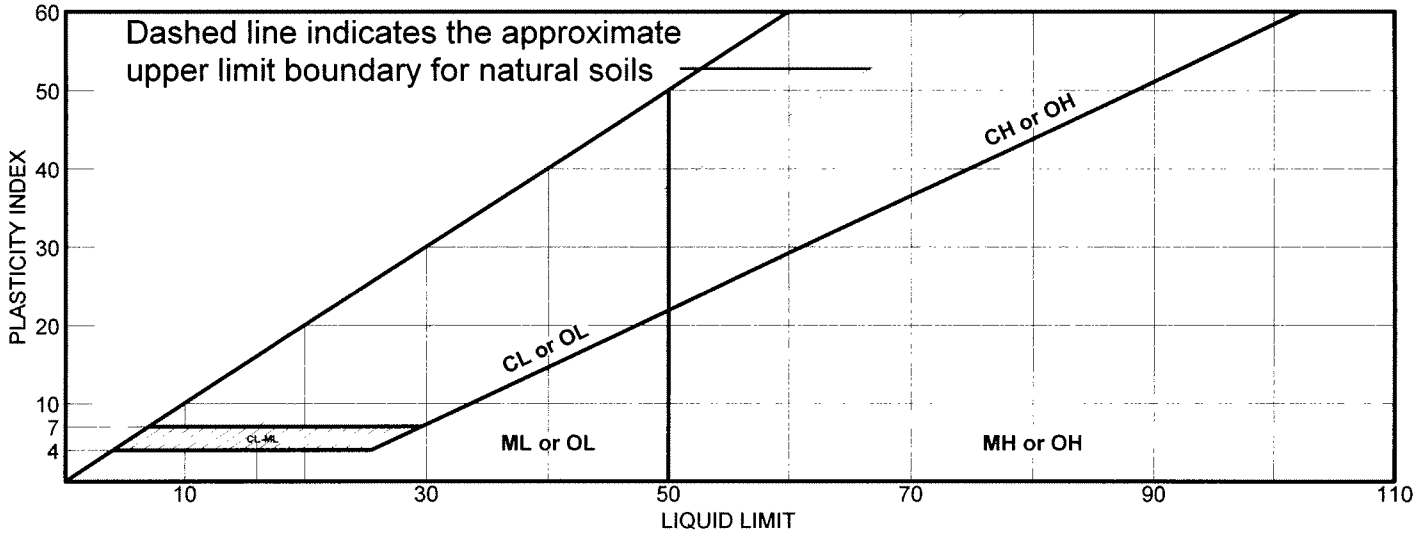
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bluish gray clayey sand		NP	NP			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R4 **Elev./Depth:** 59.9-60.75

Remarks:

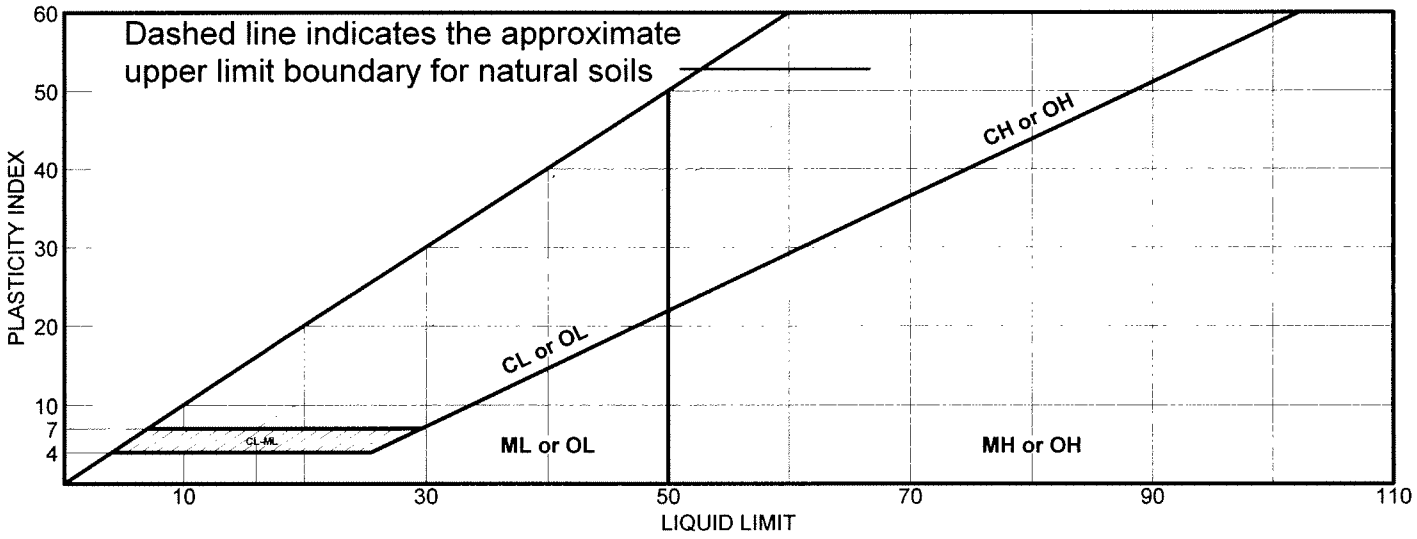
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bluish gray clayey sand		NP	NP			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R4 **Elev./Depth:** 87.1-88.1

Remarks:

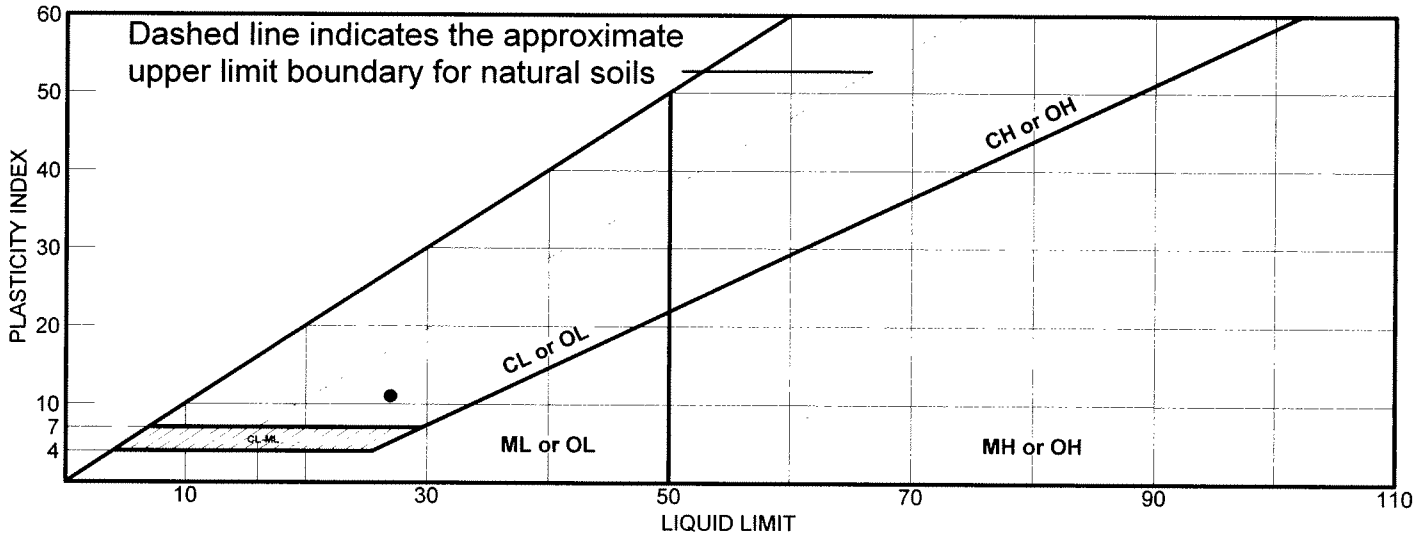
●

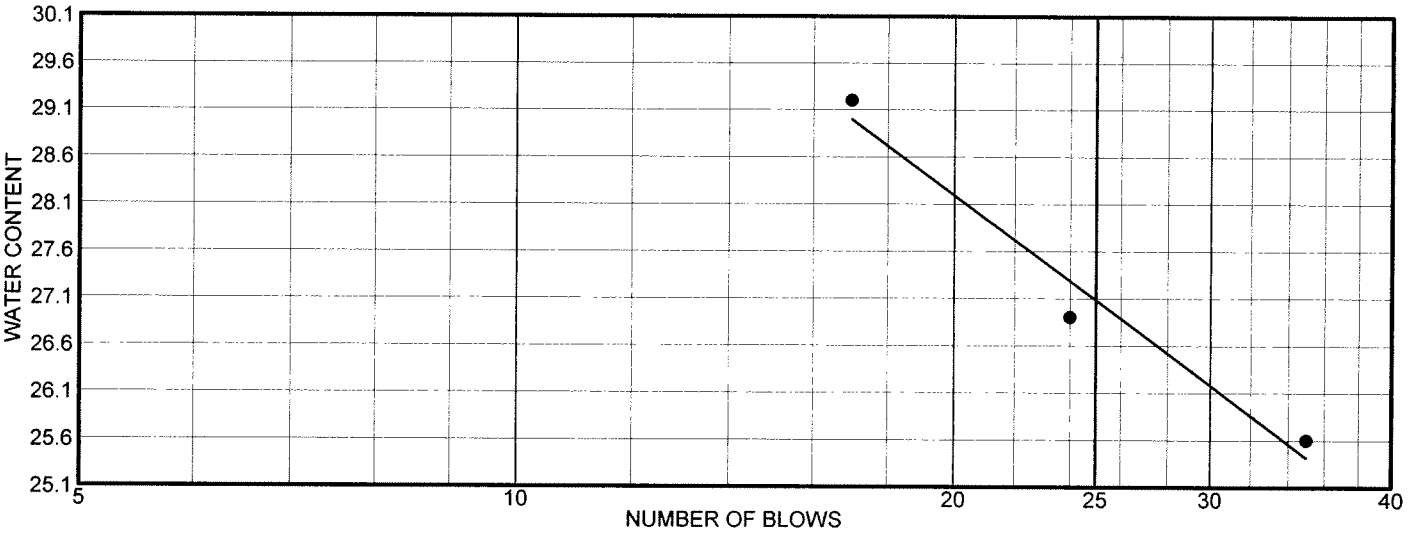
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark gray clayey gravel	27	16	11			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R5 **Elev./Depth:** 54-55

Remarks:

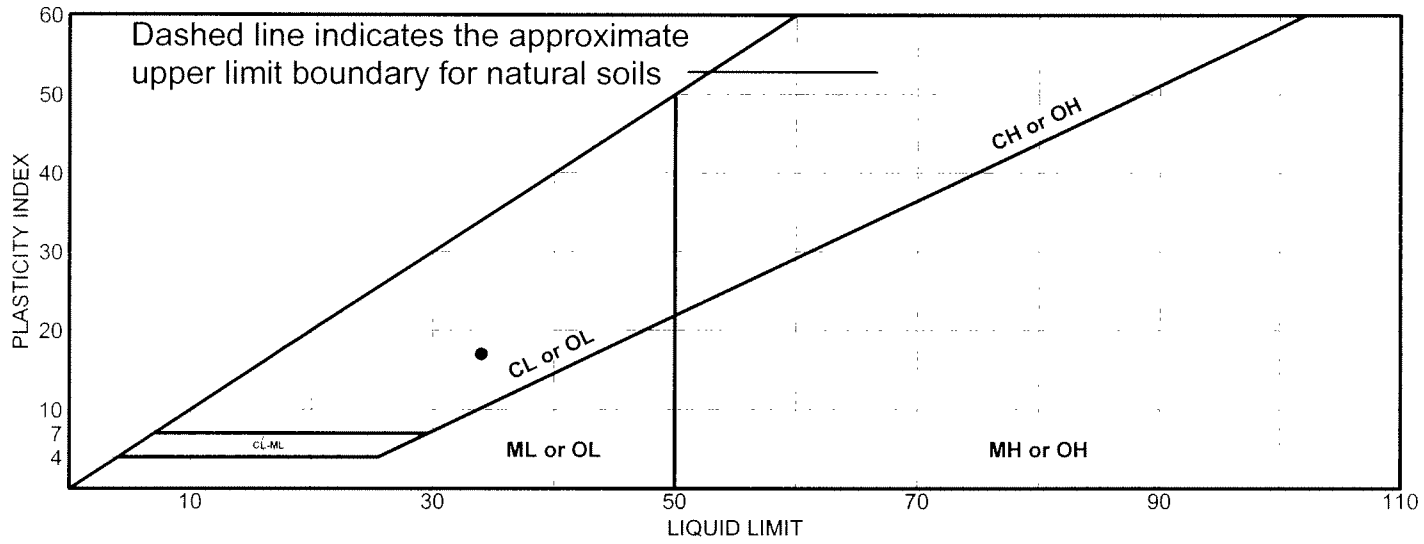
●

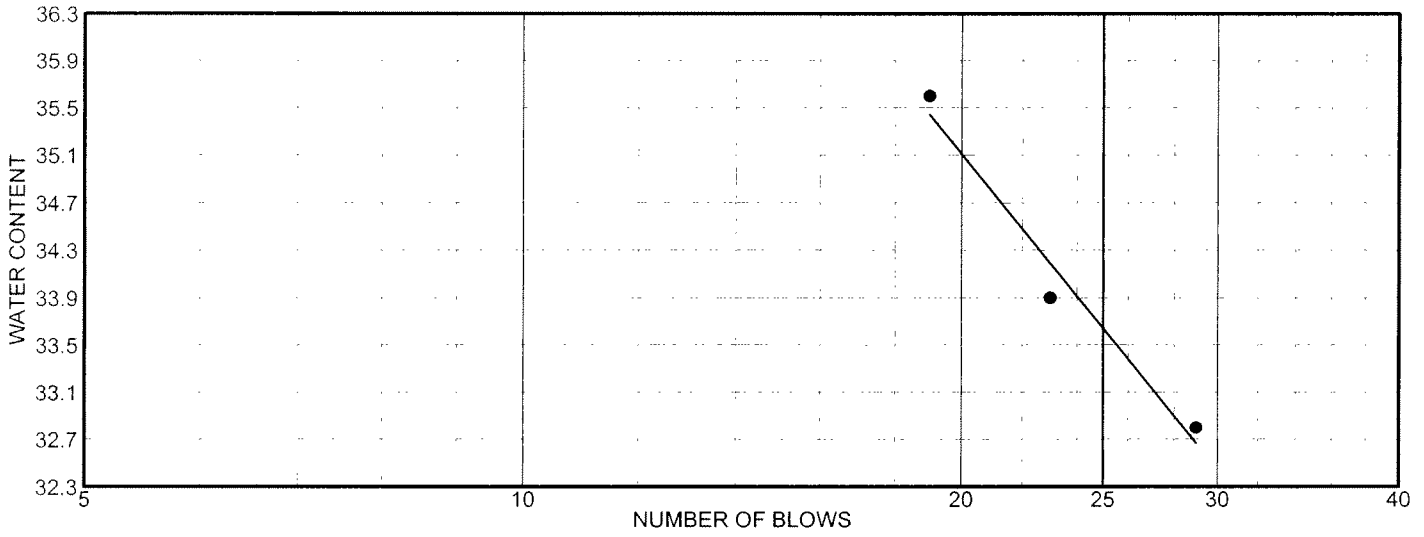
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	34	17	17			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R6 **Sample No.:** 5 **Elev./Depth:** 13-13.5

Remarks:

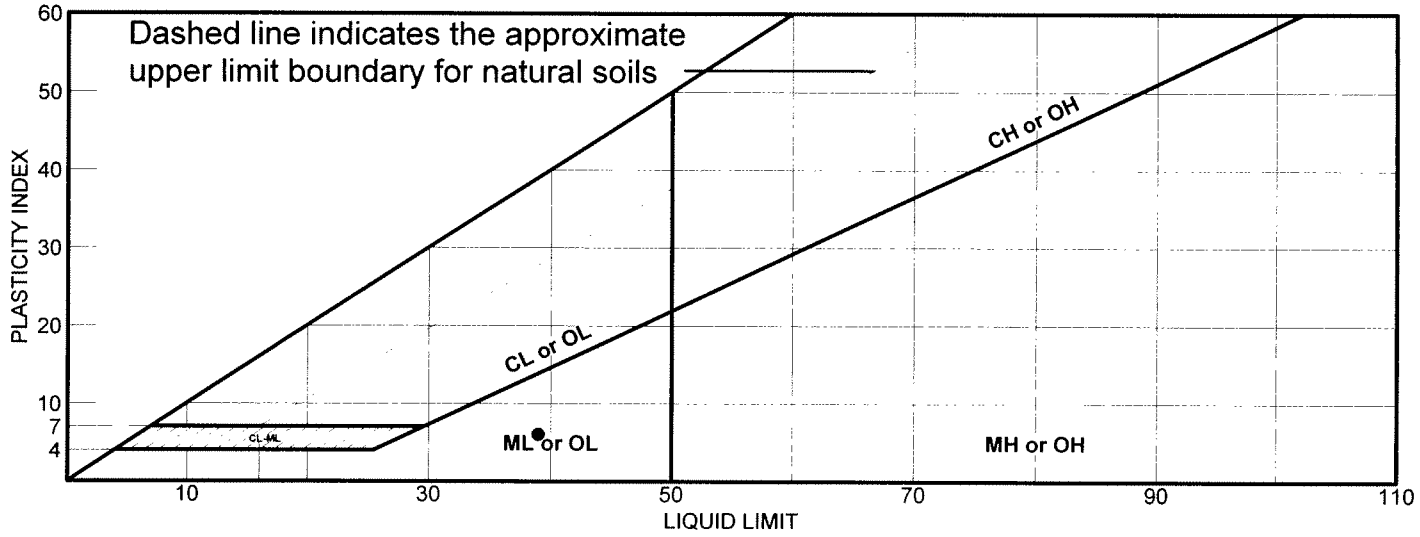
●

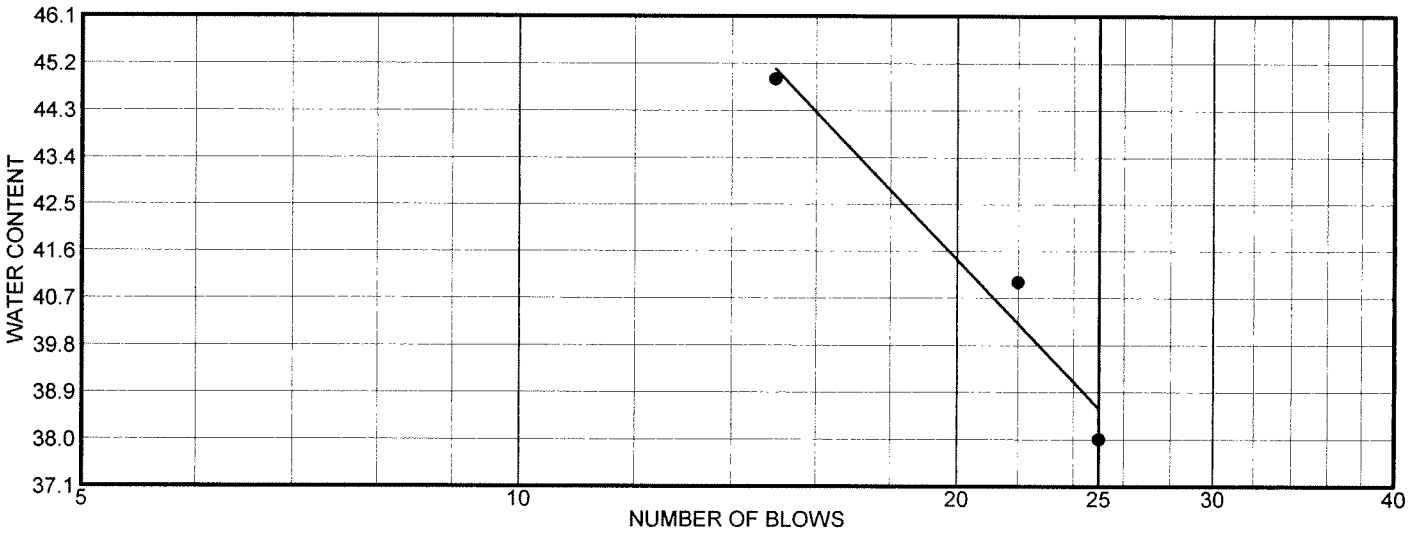
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark bluish gray silt	39	33	6			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R6 **Elev./Depth:** 90.4-91

Remarks:

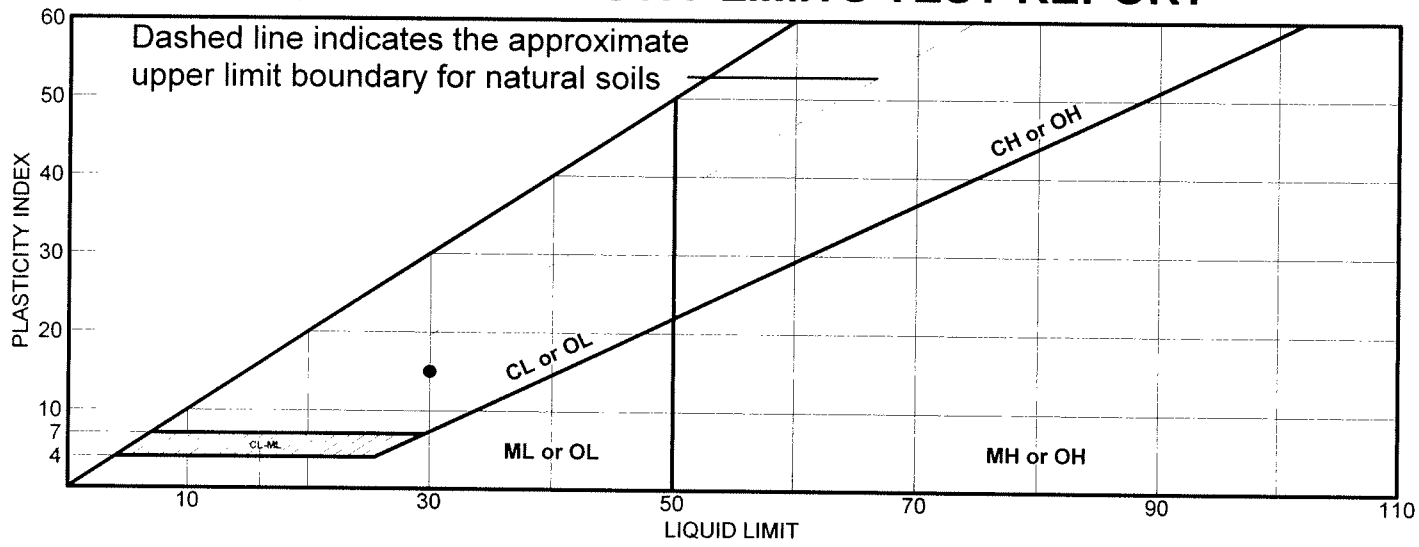
●

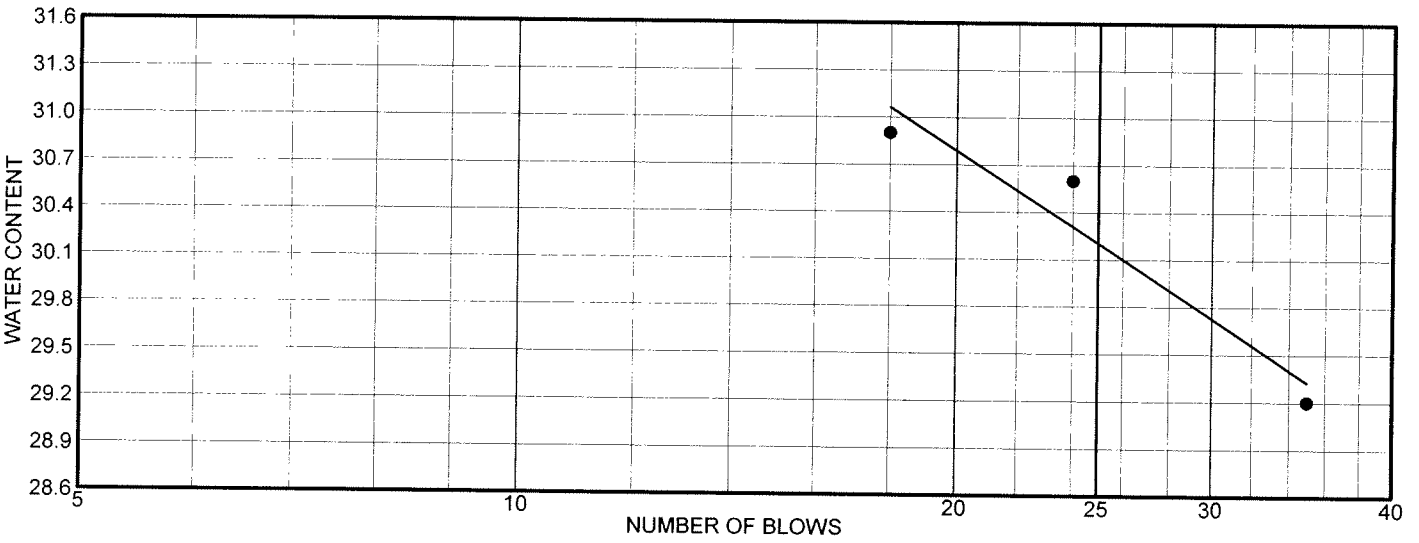
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown clay	30	15	15			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R7A **Sample No.:** 4 **Elev./Depth:** 9-10.5

Remarks:

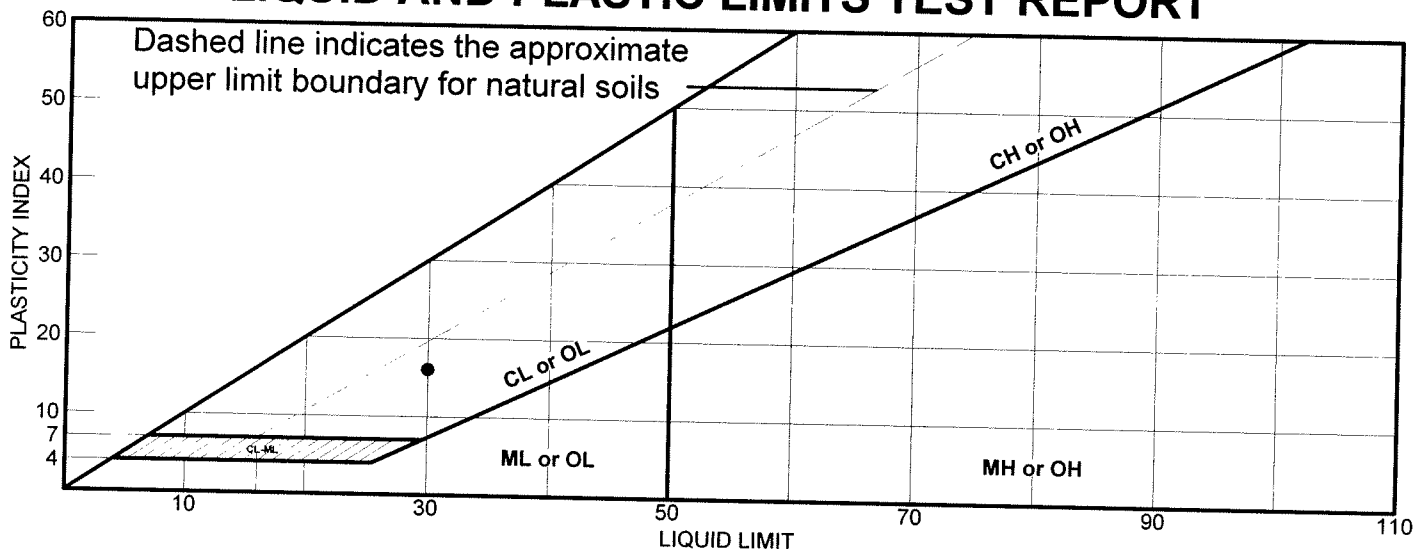
●

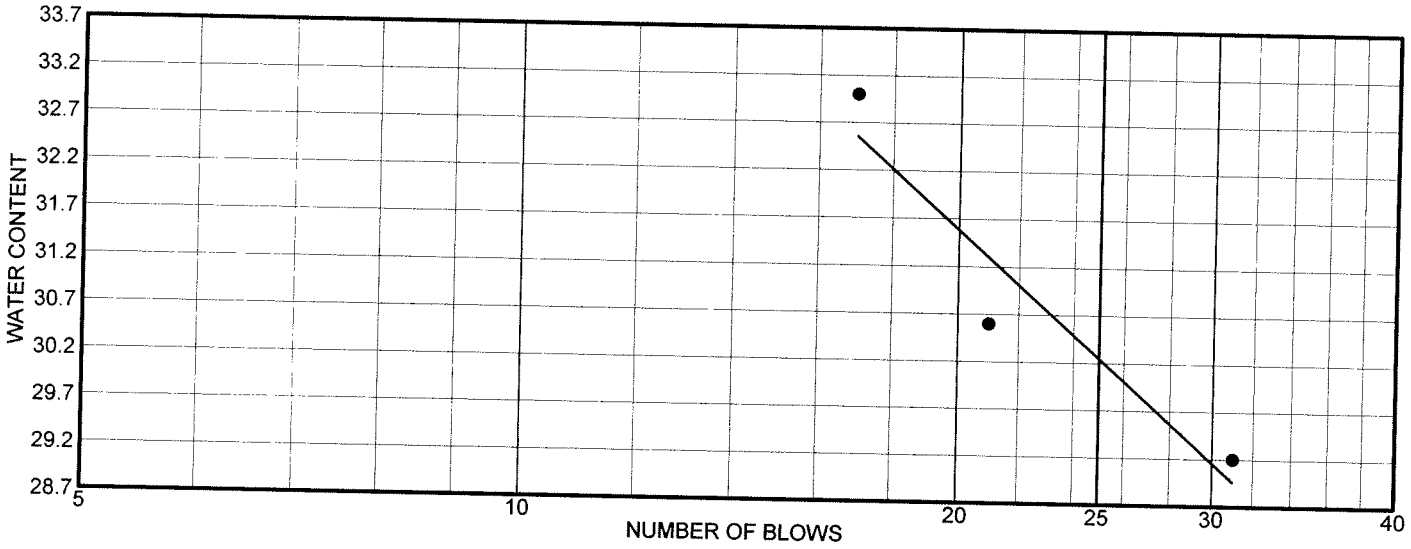
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown sandy clay	30	14	16			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R7A **Sample No.:** 8 **Elev./Depth:** 19-20.5

Remarks:

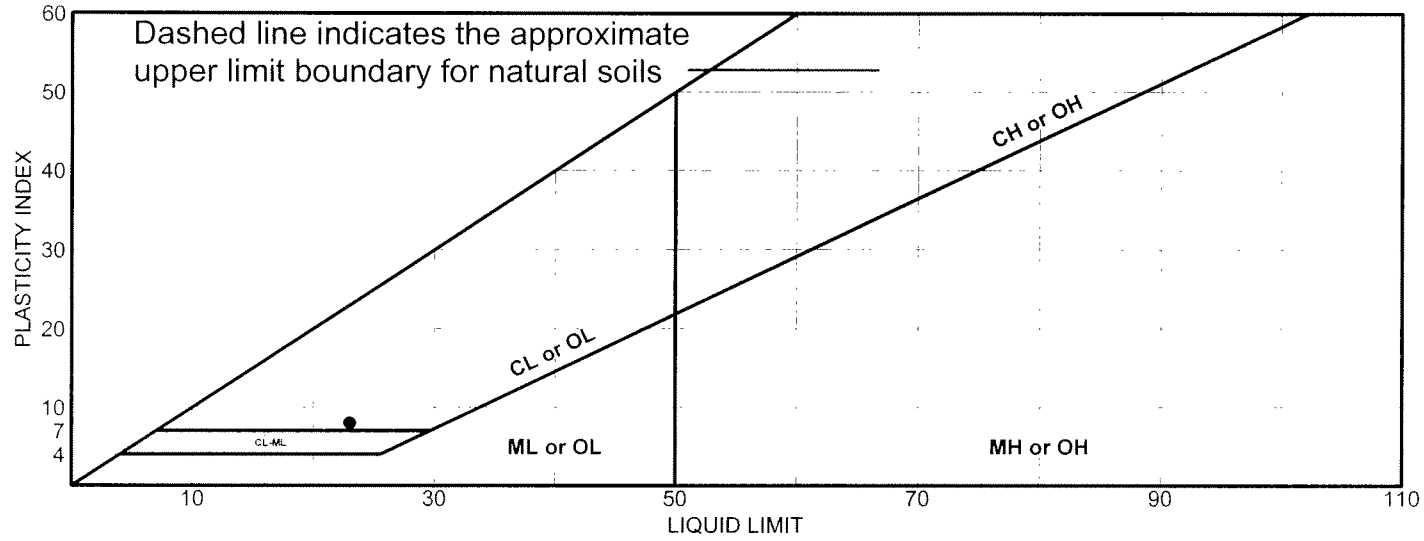
●

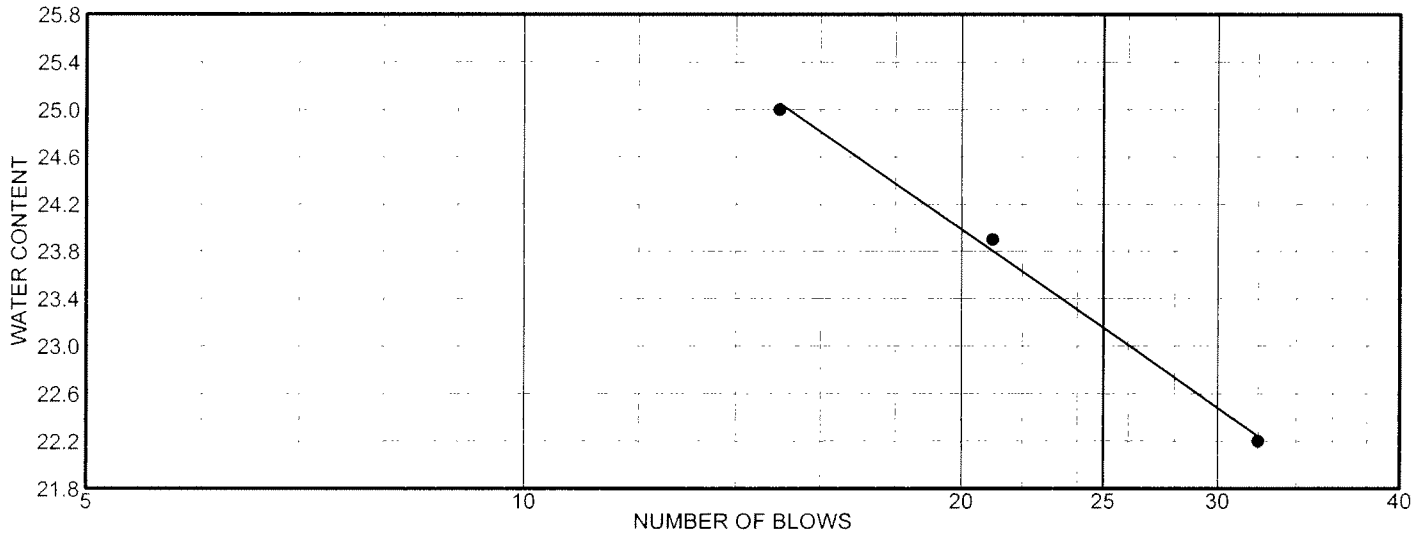
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy clay	23	15	8			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R7 **Sample No.:** 3B **Elev./Depth:** 13.3-13.8

Remarks:

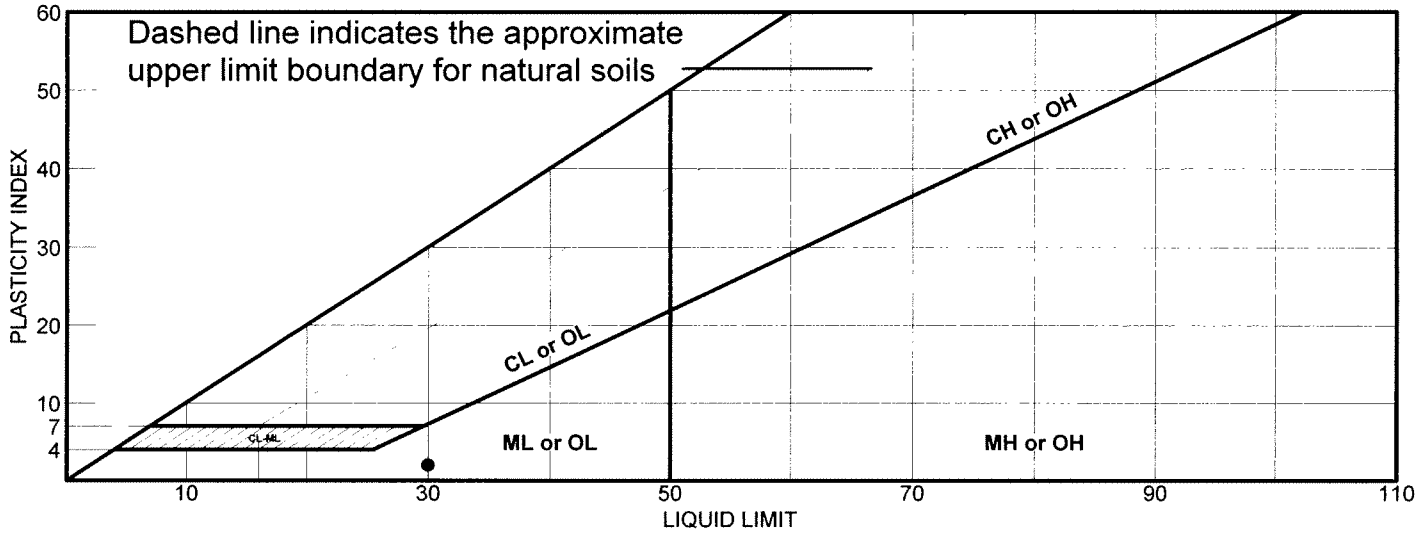
●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bluish gray gravelly silt	30	28	2			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTNB-R7 **Elev./Depth:** 86.1-86.7

Remarks:

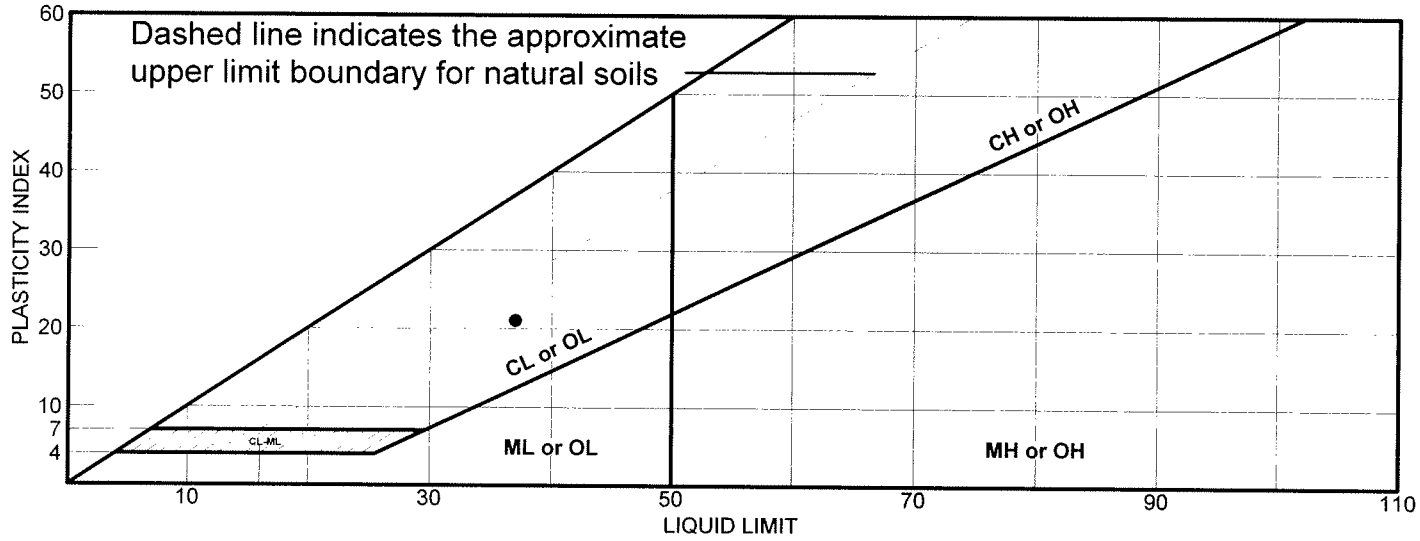
●

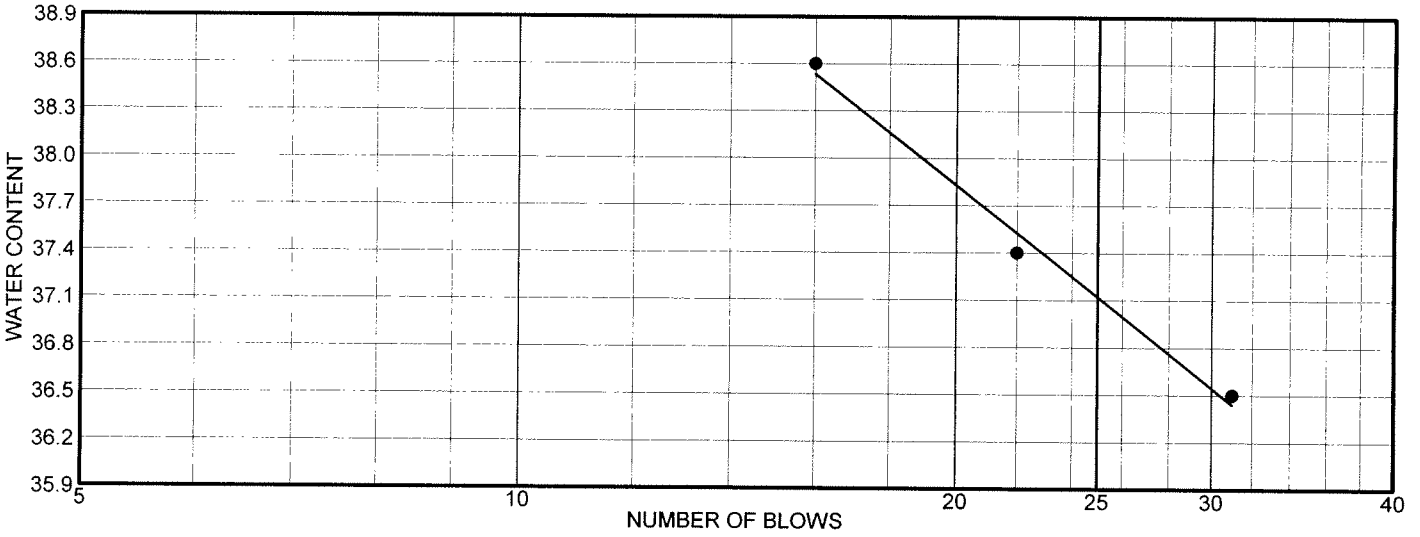
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay	37	16	21			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R1 **Sample No.:** 11 TOP **Elev./Depth:** 27.5-30

Remarks:

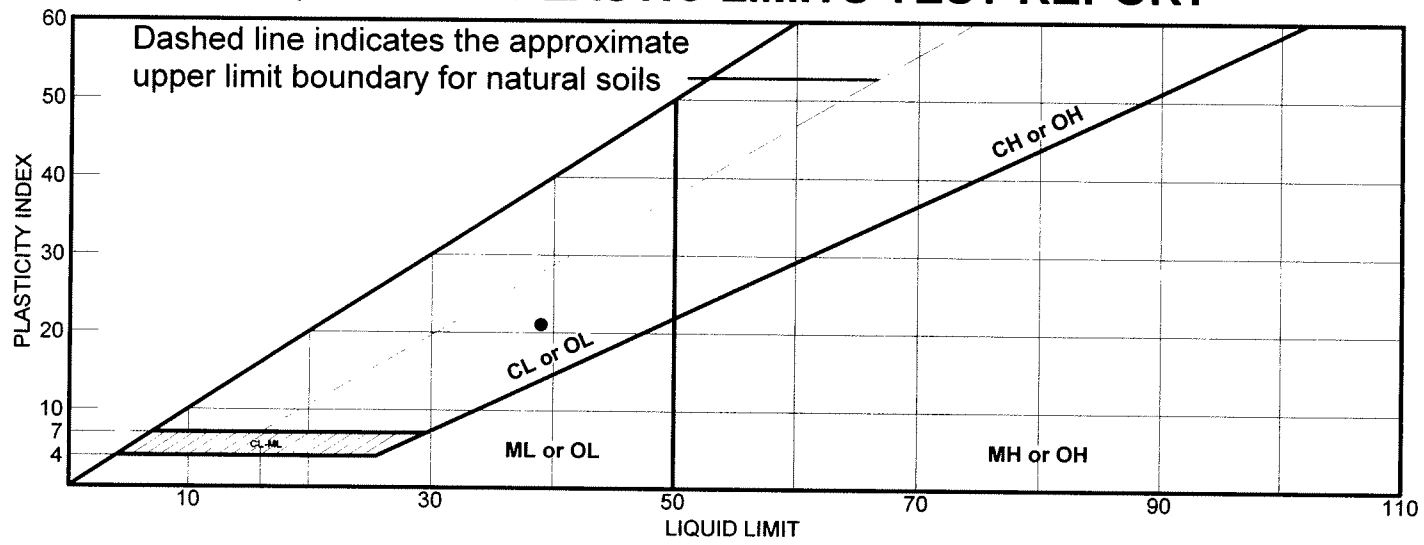
●

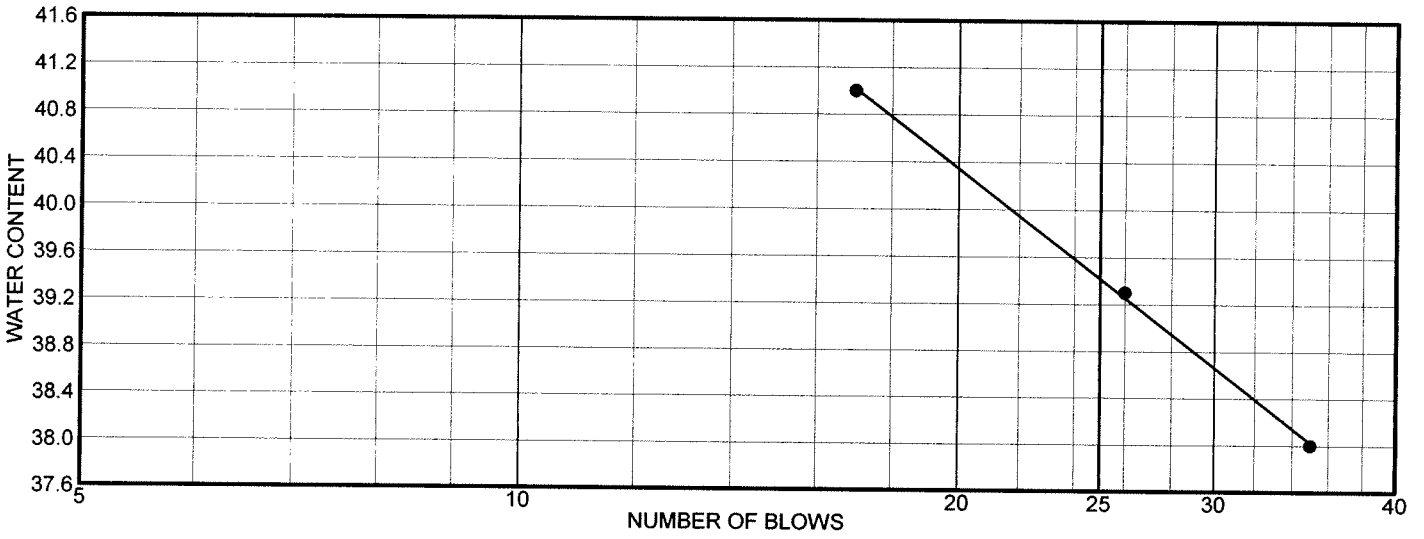
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive brown clay with sand	39	18	21			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R1 **Sample No.:** 11 Bottom **Elev./Depth:** 27.5-30

Remarks:

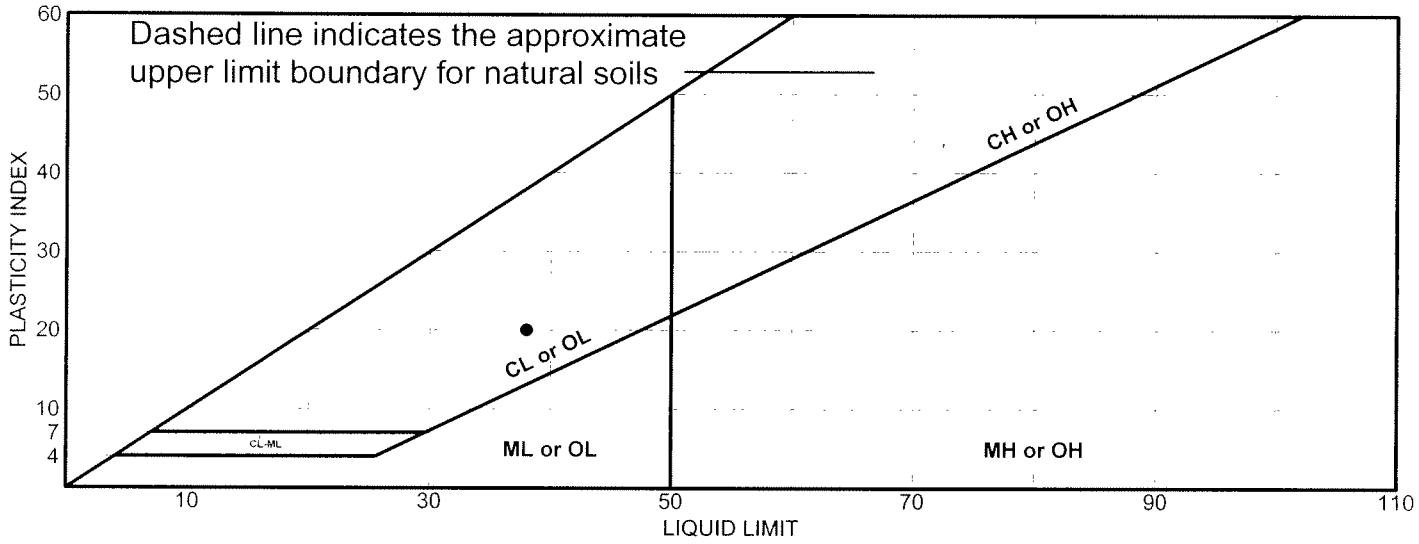
●

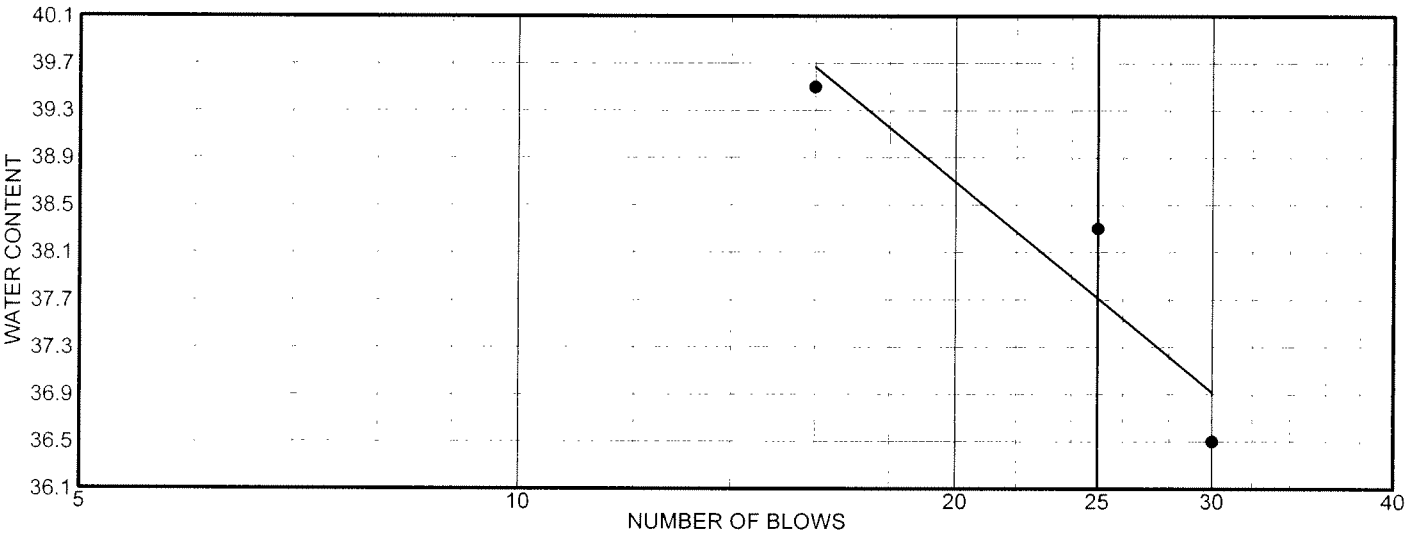
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay	38	18	20			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 5A **Elev./Depth:** 12.8-13.3

Remarks:

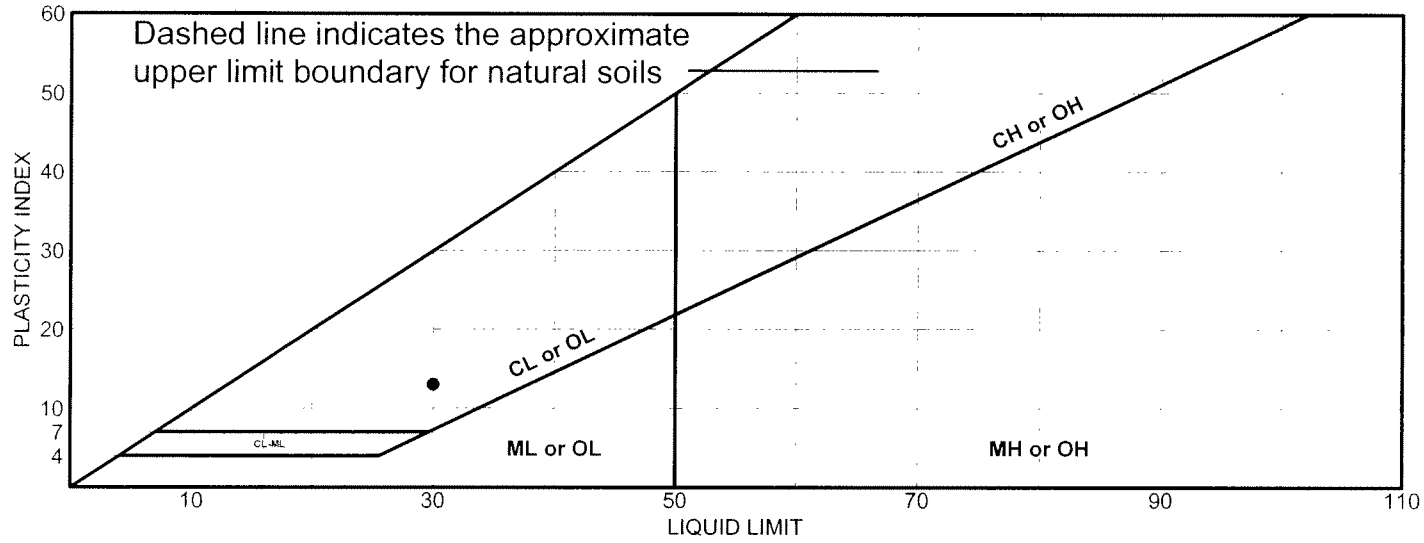
●

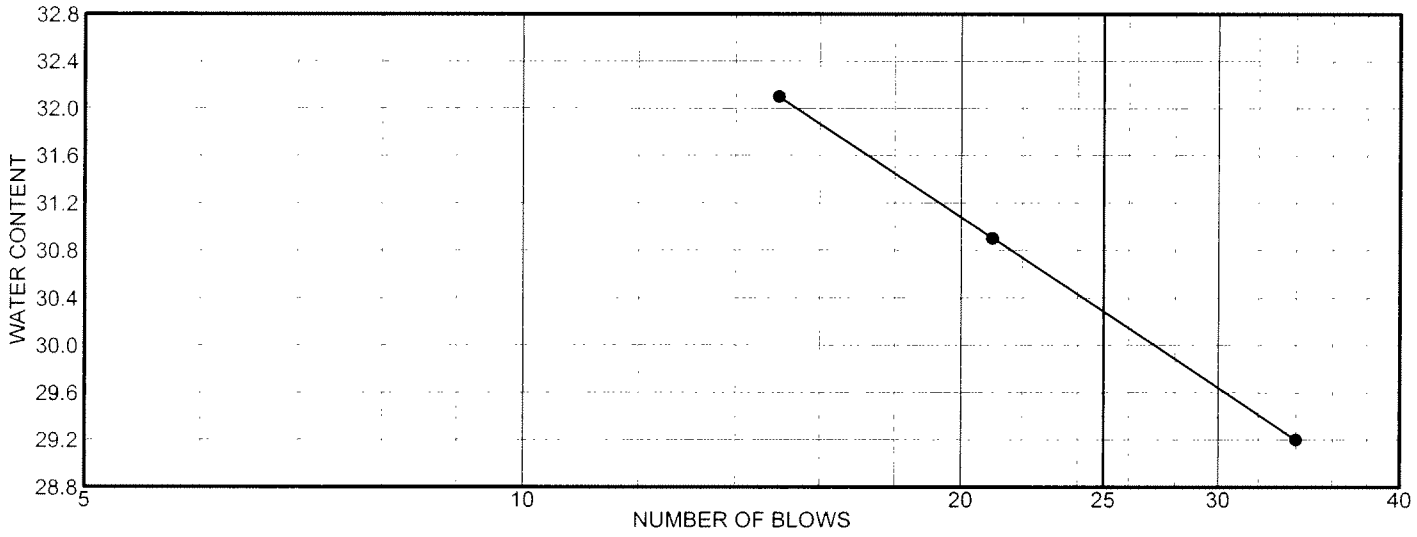
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay	30	17	13			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 15A **Elev./Depth:** 37.8-38.3

Remarks:

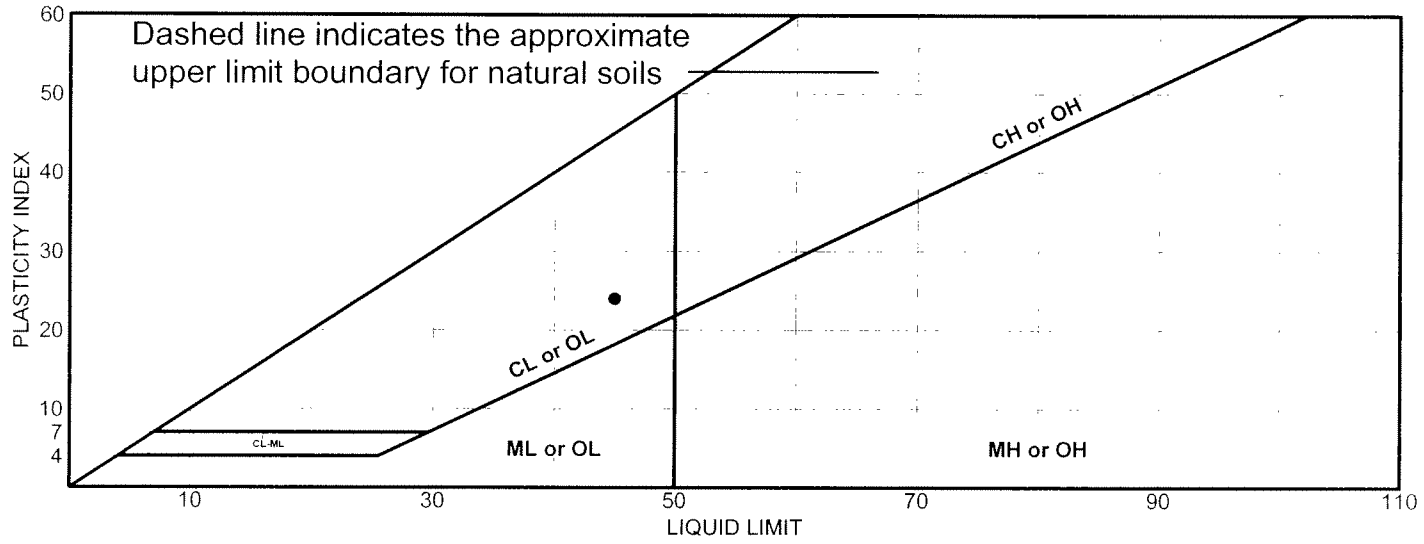
●

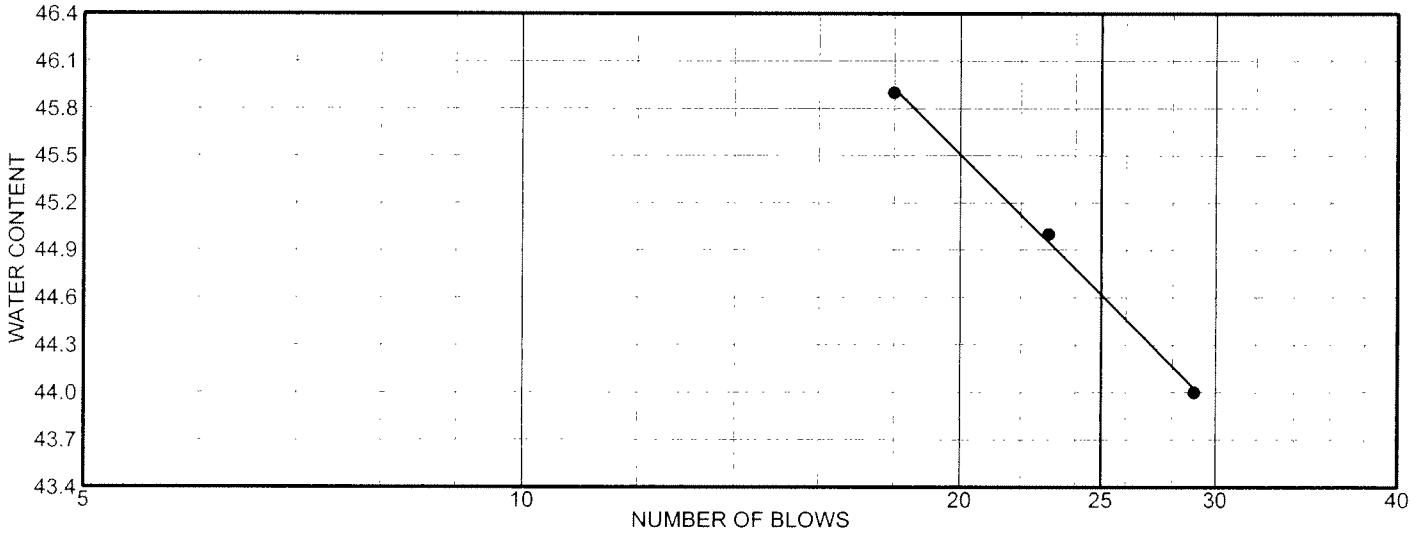
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	45	21	24			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 15B **Elev./Depth:** 38.3-38.8

Remarks:

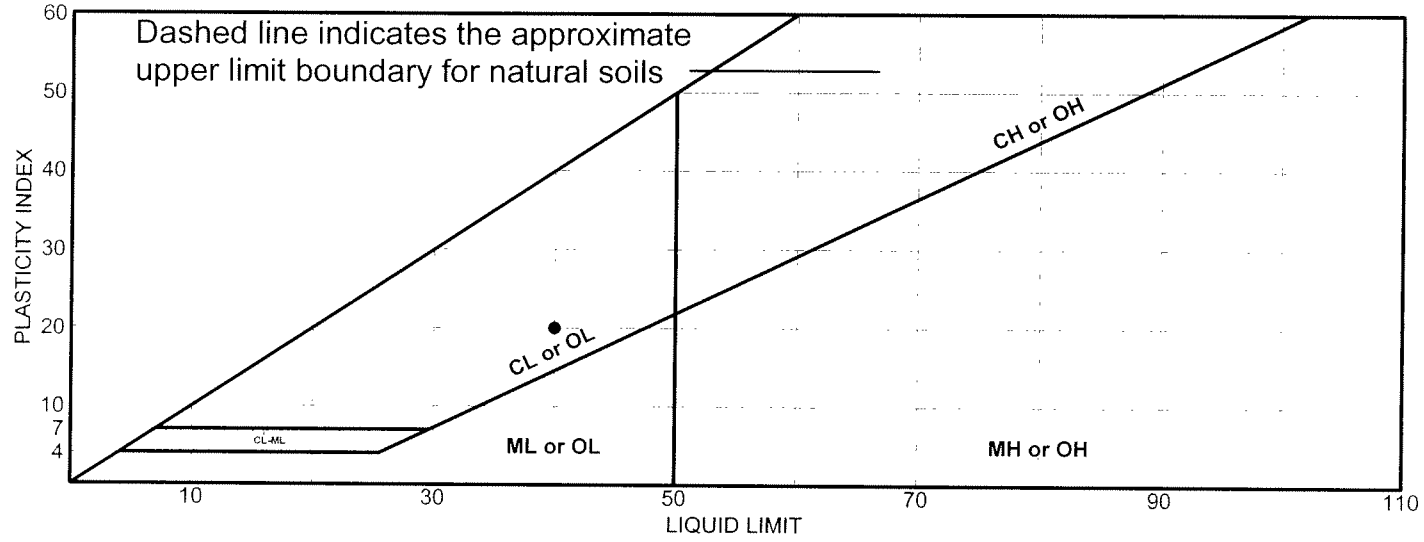
●

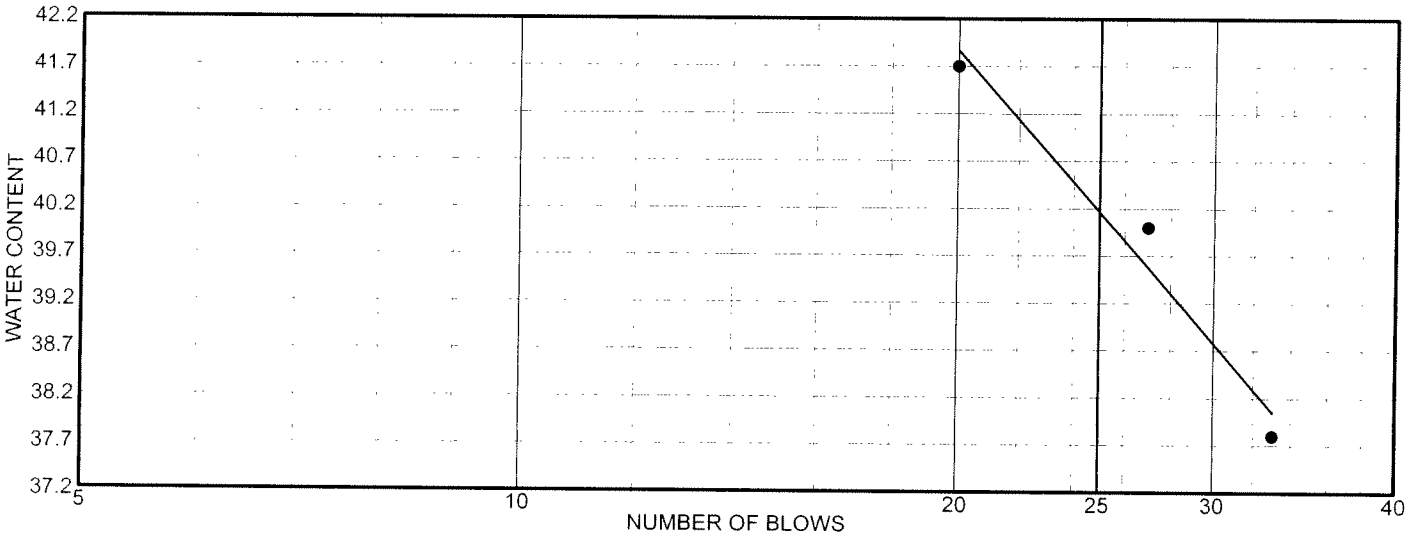
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	40	20	20			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R2 **Sample No.:** 17 **Elev./Depth:** 42.8-43.3

Remarks:

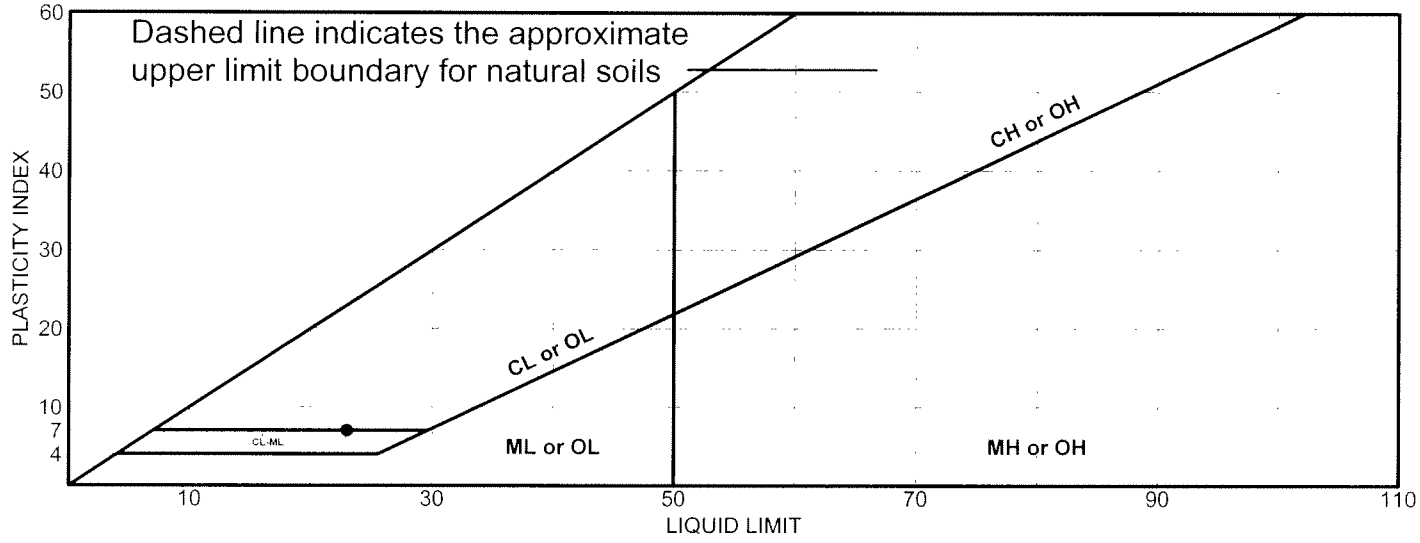
●

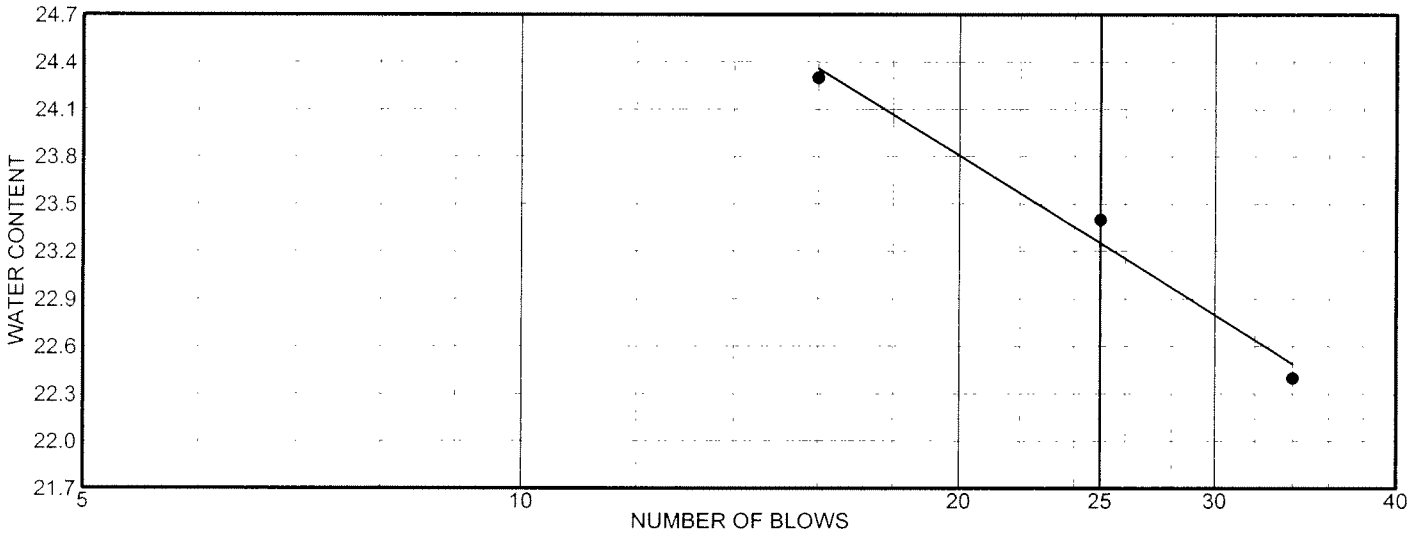
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown sandy clay	23	16	7			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** BTSB-R3A **Sample No.:** 9A **Elev./Depth:** 12.8-13.3

Remarks:

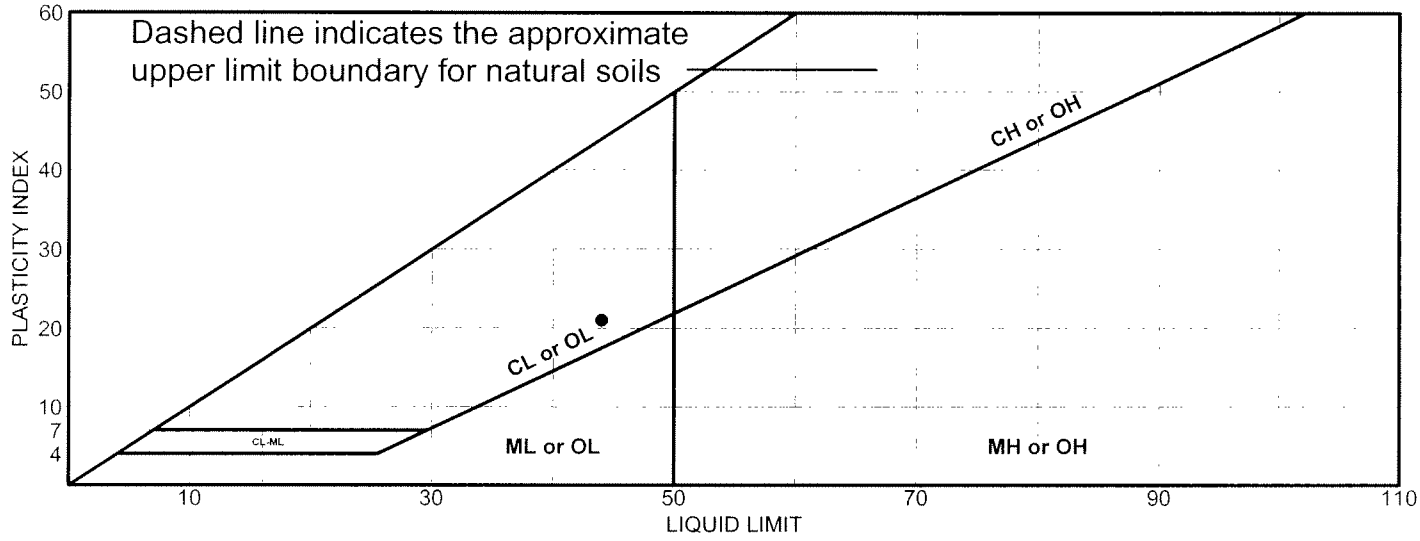
●

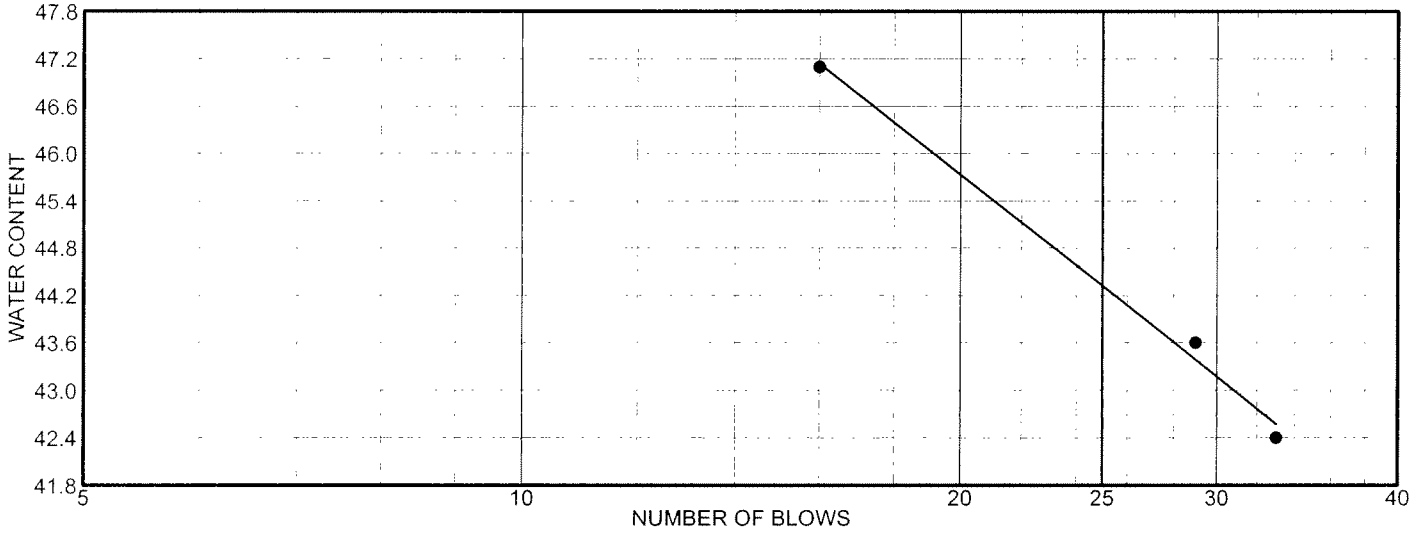
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive gray clay with gravel	44	23	21			

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** M9/RW7-A1A **Sample No.:** 17 **Elev./Depth:** 40.8-41.3

Remarks:

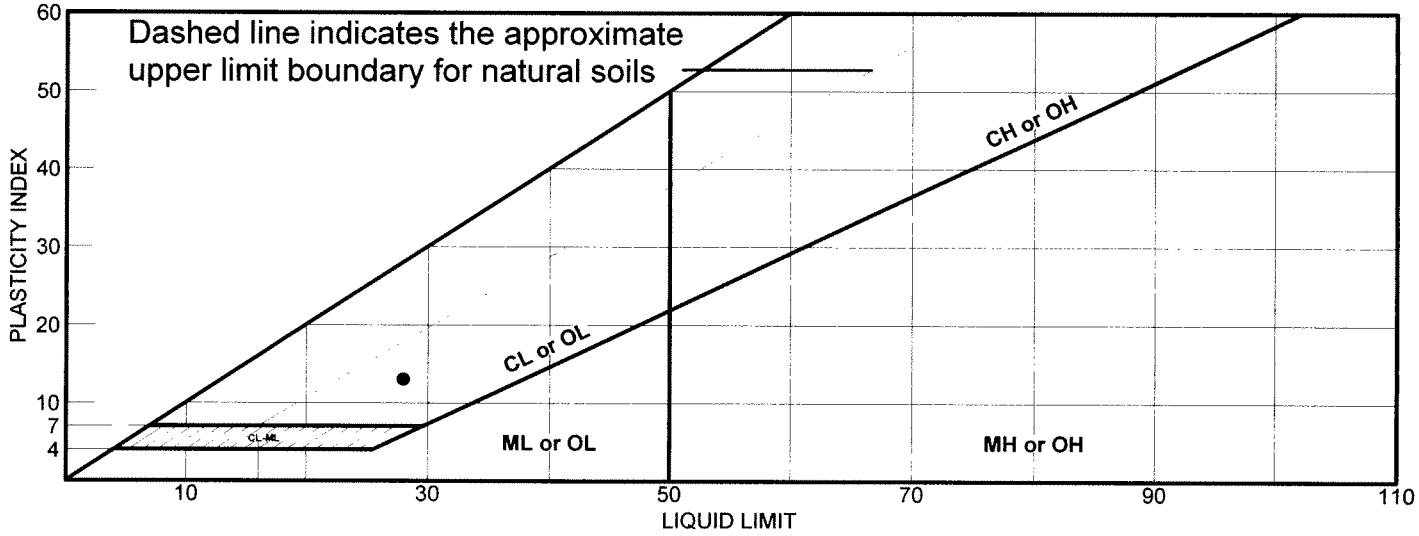
●

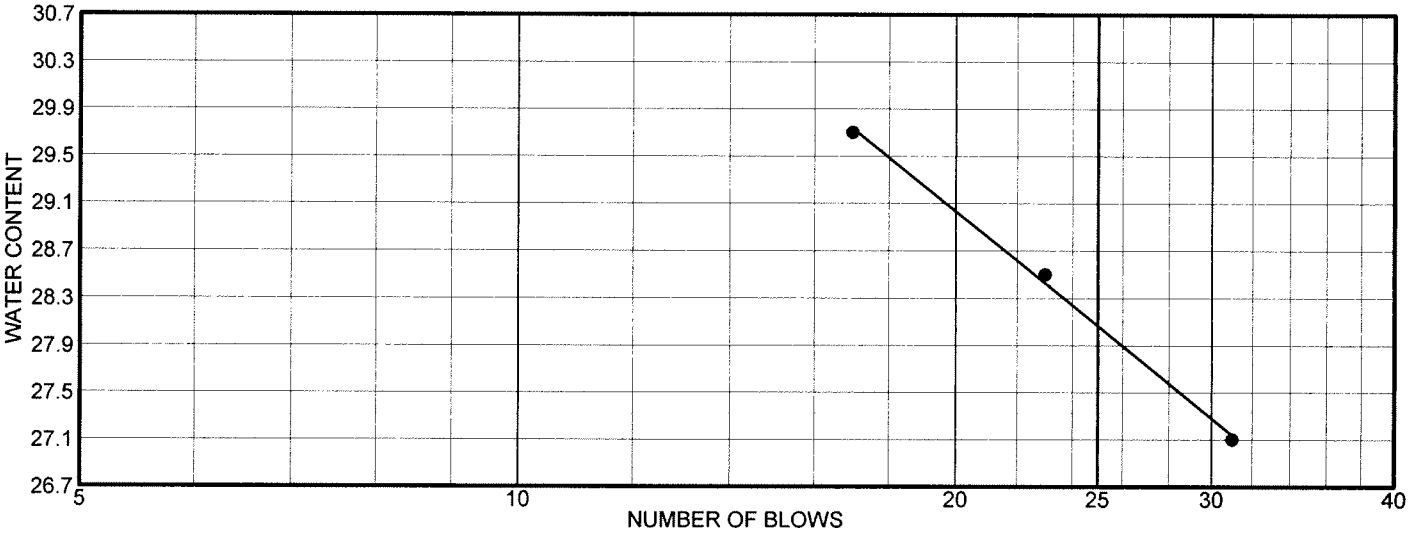
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown Lean clay with sand	28	15	13	97.3	75.6	CL

Project No. 131558 **Client:** Arup

Project: Doyle Dr. Replacement Project

● **Source:** RW6-R1 **Sample No.:** 3B **Elev./Depth:** 7.6-8.1

Remarks:

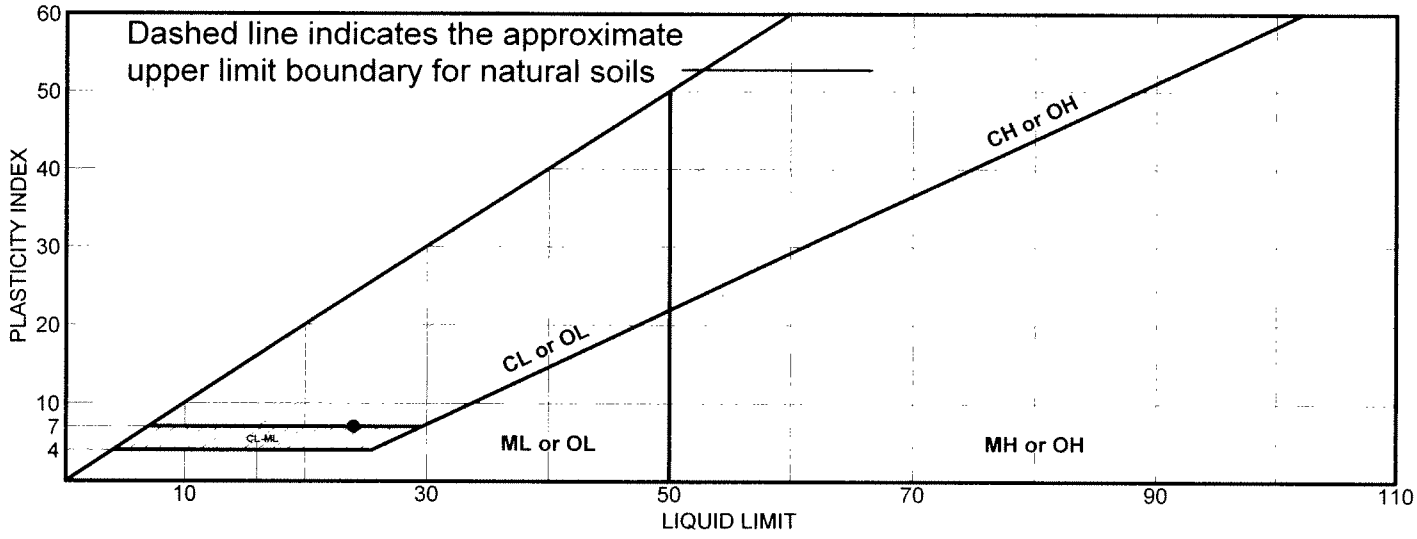
●

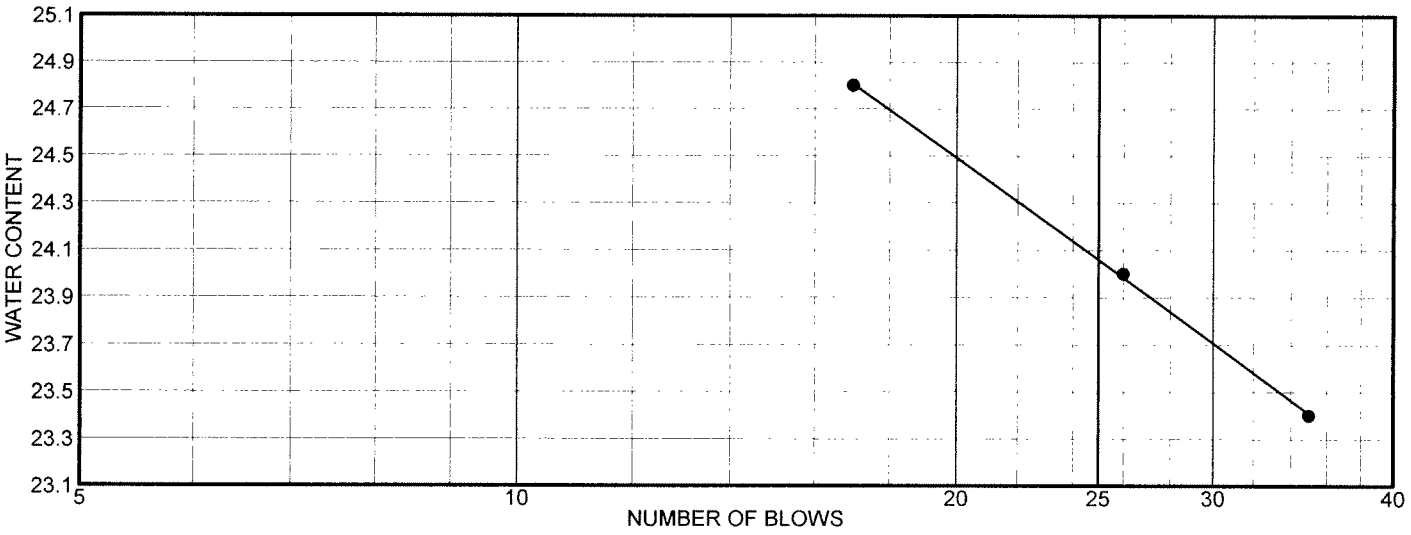
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Very dark brown Silty clay with sand	24	17	7	93.6	83.4	CL-ML

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 5A **Elev./Depth:** 13-13.5

Remarks:

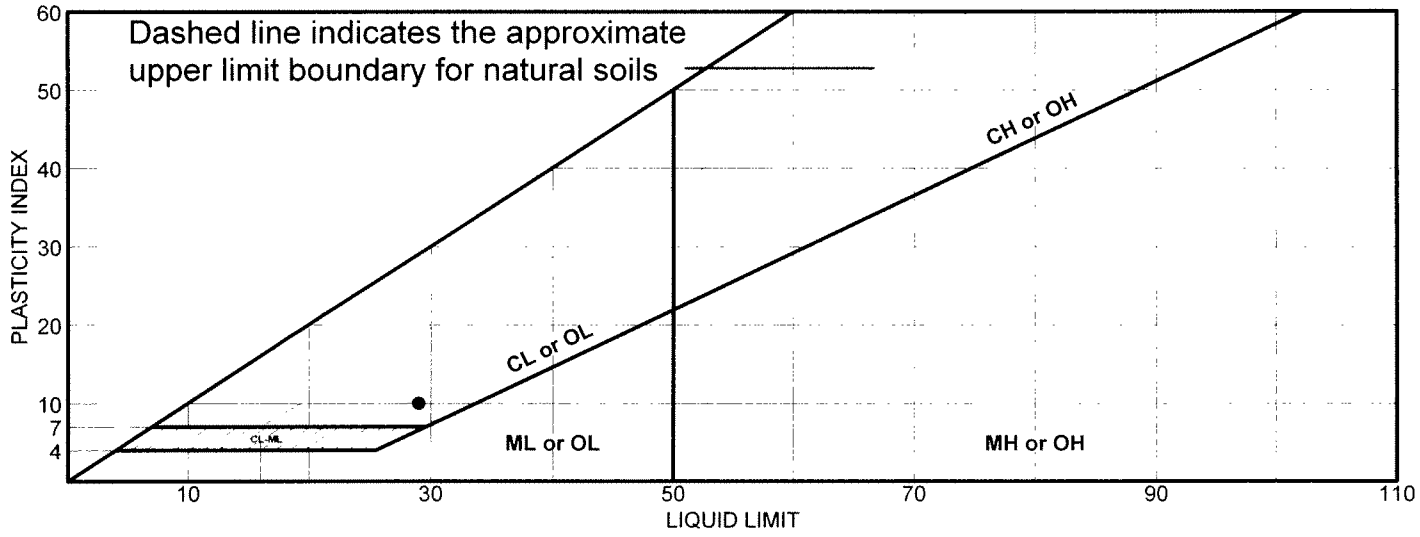
●

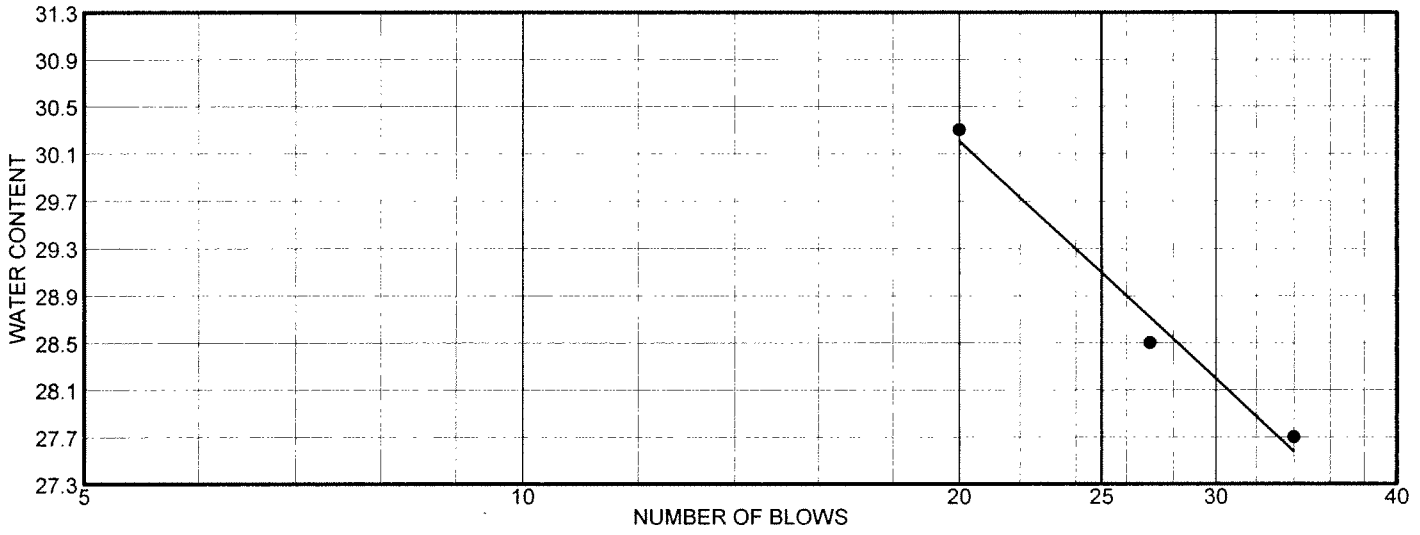
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Yellowish brown clay	29	19	10			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 7B **Elev./Depth:** 18.5-19

Remarks:

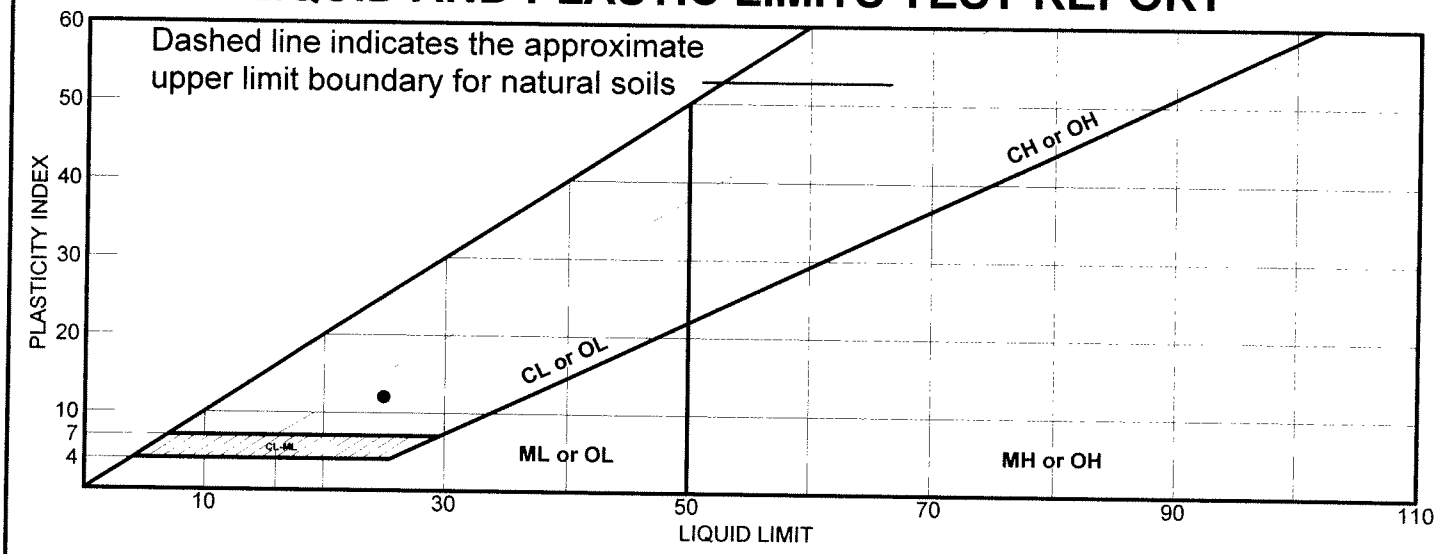
●

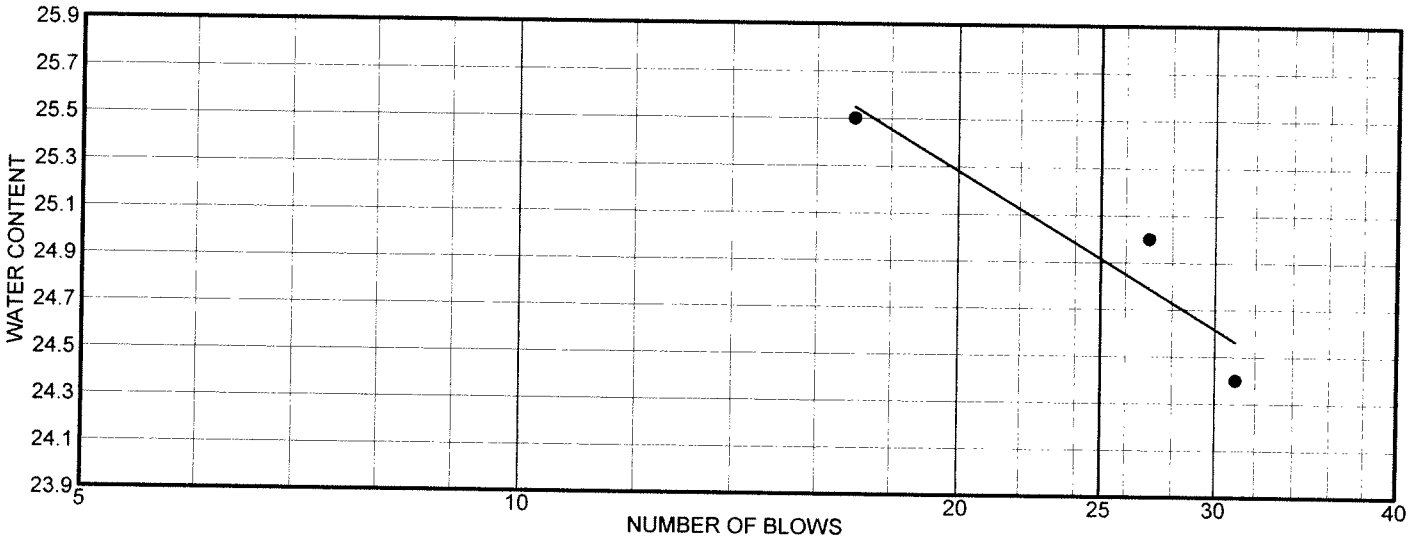
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown sandy clay	25	13	12			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 9 Top Section **Elev./Depth:** 22.5-25

Remarks:

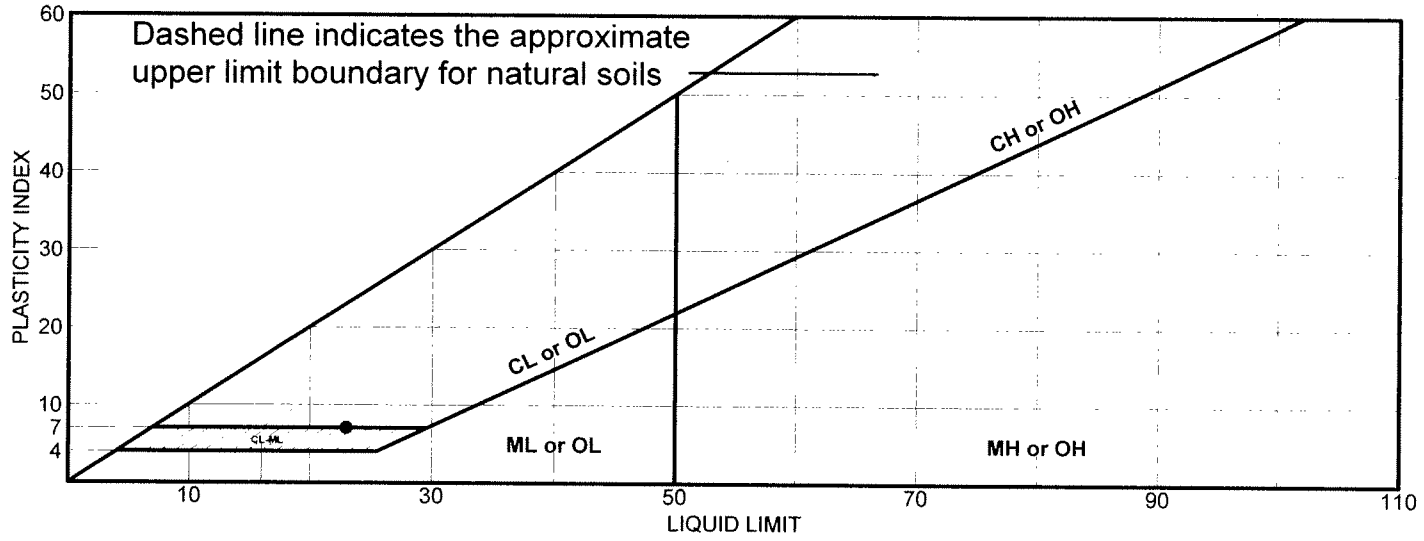
●

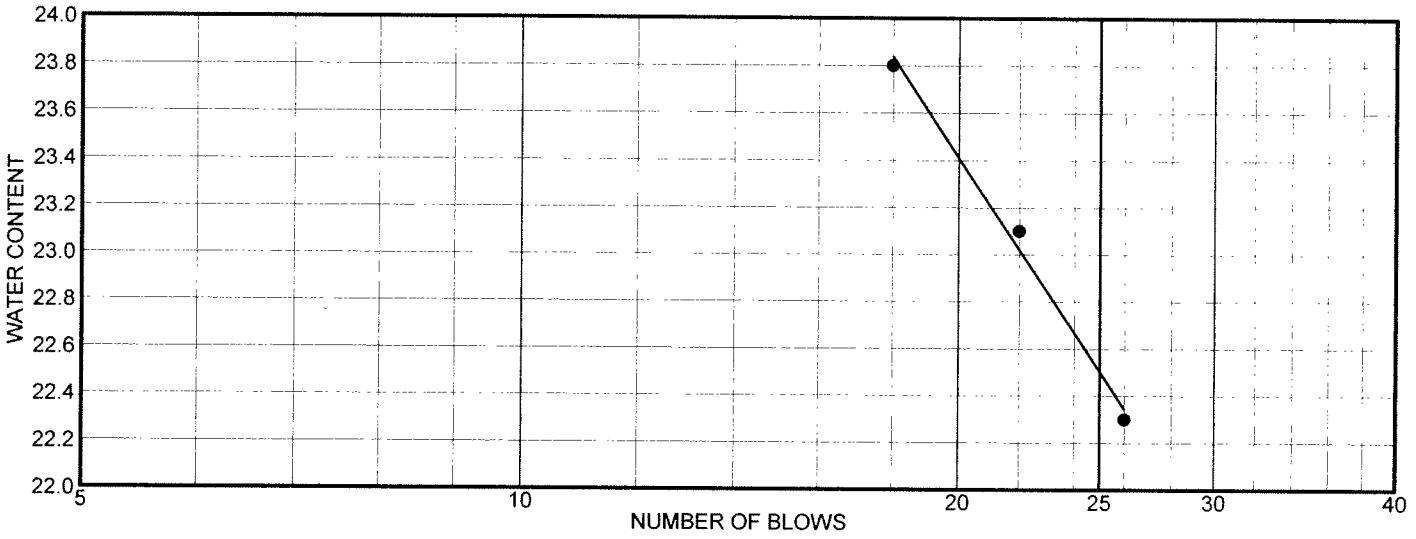
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown Silty, clayey sand	23	16	7	95.3	47.2	SC-SM

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 9 Bottom **Elev./Depth:** 22.5-25

Remarks:

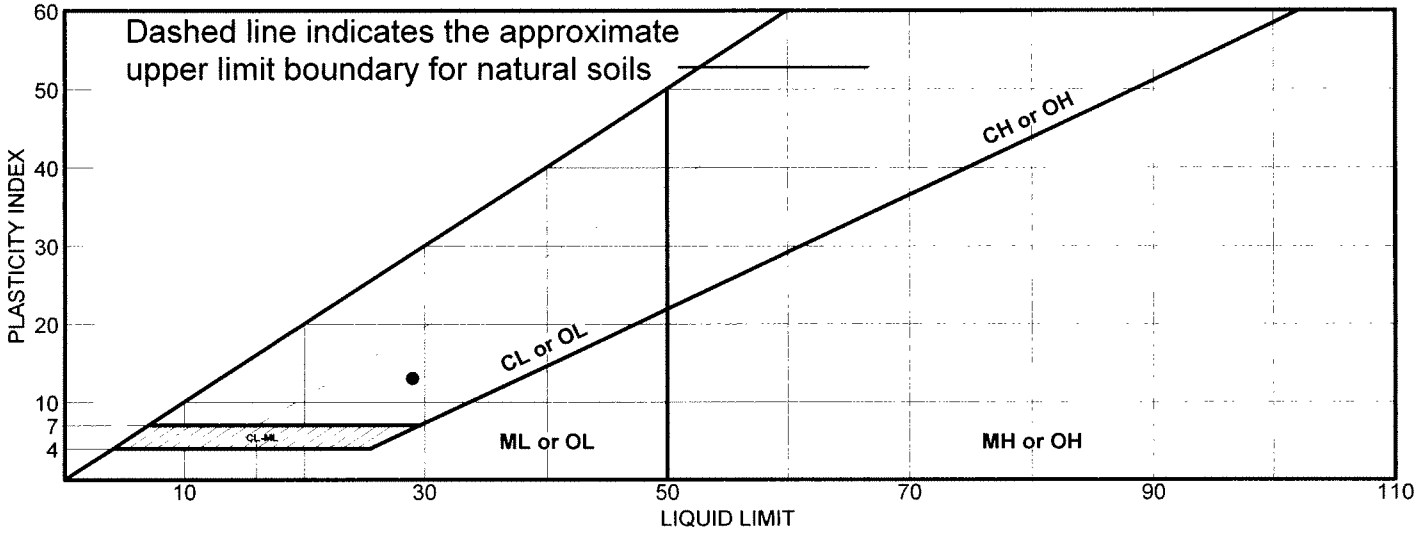
●

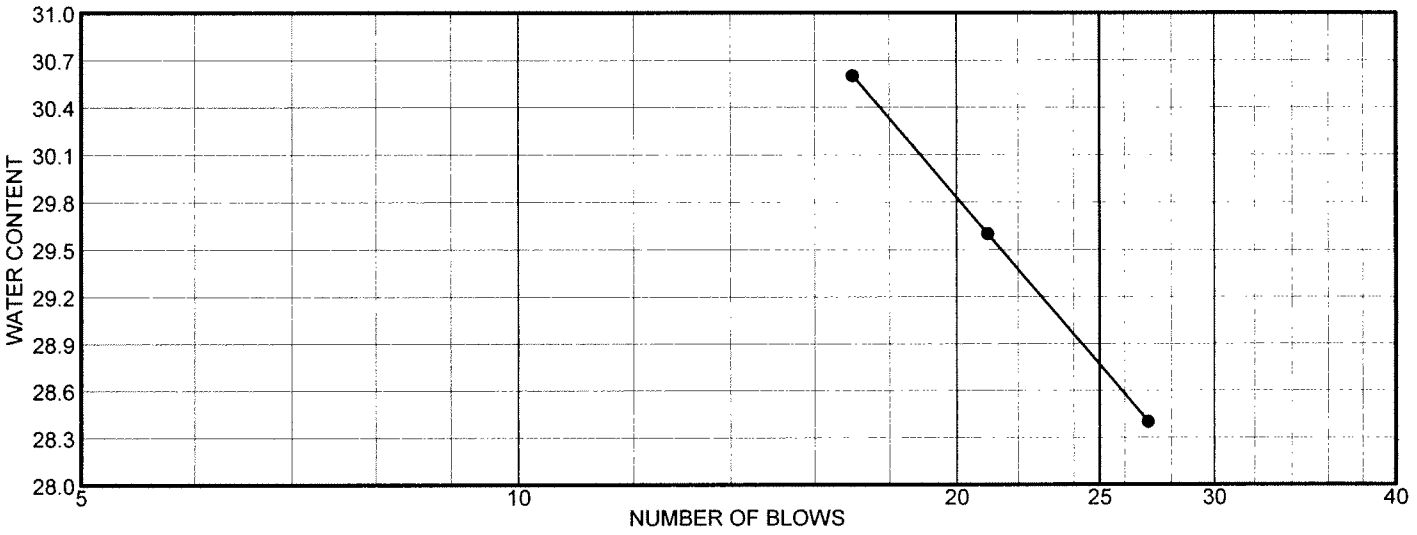
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clay with gravel	29	16	13			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 16A **Elev./Depth:** 43-43.5

Remarks:

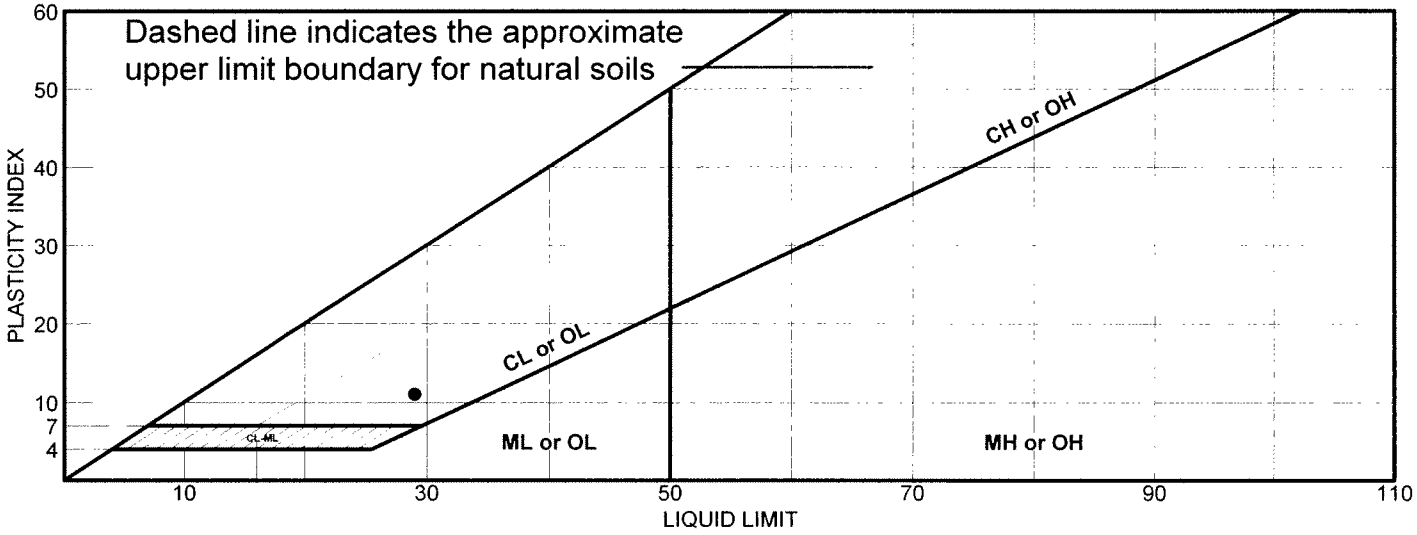
●

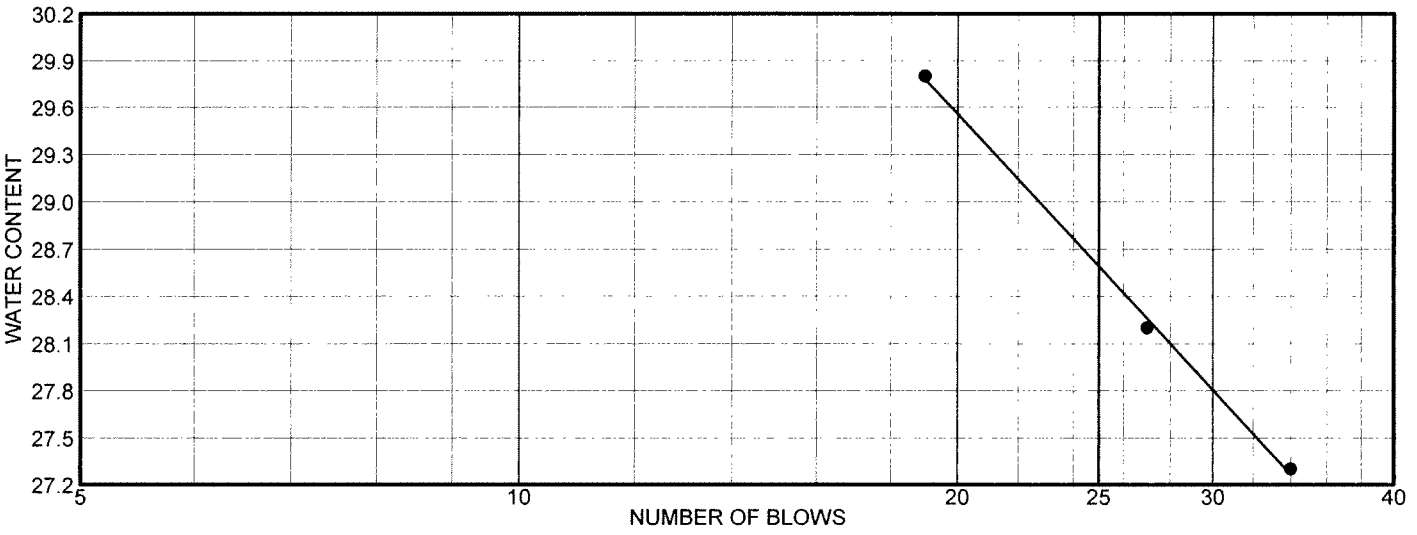
LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish brown clay with gravel	29	18	11			

Project No. EA04- **Client:** Arup

Project: Doyle Drive Replacement Project

● **Source:** RW8-R1 **Sample No.:** 16B **Elev./Depth:** 43.5-44

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

SIGNET TESTING LABS, INC.

Figure

Reviewed For Adequacy (RFA)

By: TC

Date: 7/10/2008

RECD JUL 10 2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

POINT LOAD TEST
ASTM D 5731

DIAMETRAL POINT LOAD TEST
ASTM D 5731

CLIENT: ARUP PB JOB NO.: 2653-13

ROJECT: Doyle Drive Replacement DATE TESTED: 6/18/08 HN

Specimen ID Borhole, Depth (ft.), Rock	Length (in.)	Diameter (in.)	De^2 (in^2)	Gauge Failure Load (psig)	P (lb)	Is	F	Is(50)	C	Compressive Strength (psi)	Loading with respect to Fracture	Failure Mode
RW6- R1, 49.55-49.80, Sandstone	2.683	2.369	5.612	2045	4233.2	754.3	1.1	814.0	24.8	20,180	N/A	S
RW8-R1, 122.15-122.35, Serpentinite	2.555	2.365	5.593	86	178.0	31.8	1.1	34.3	24.8	850	Parallel	C

Notes:
L: Sample Length
D: Sample Diameter
De^2: Exquivalent Diameter = D^2
Piston Area (in^2): 2.07
P: Gauge Failure Load * Piston area (in^2)
Is: Point Load Index Strength = P/De^2
F: Size Correction Factor to 2.0 in = (De/2.0)^0.45
Is(50): Size Corrected Index Strength = F* Is
C: Factor to Estimate Compressive Strength related to Core Diameter
Compressive Strength in psi = C * Is(50)

Failure Modes:
F: Fracture Controlled
S: Substance Controlled
C: Combination Substance & Fracture

Data Entered By: HN Date: 06/19/2008
Data Checked By: CJ Date: 06/20/08
Filename: ARPTLOA4

5 6 7 8 9
RLS
ARUP PB
RW6-R1, 49.55-
49.80
PL I
AR2653\ARDP4955.jpg
06-16-08

ARUP PB
RW 8- R1, 122.15-
122.35
PLI
AR2653\ARDP1221.jpg
06-19-08

AR2653\ARDP495A.jpg
06-19-08

ARUP PB
RW8-R1, 122.15-
122.35
(After test PLI)
AR2653\ARDP122A.jpg
06-19-08

Reviewed For Adequacy (RFA)

By: TC

Date: 7/10/2008

RECD JUL 10 2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

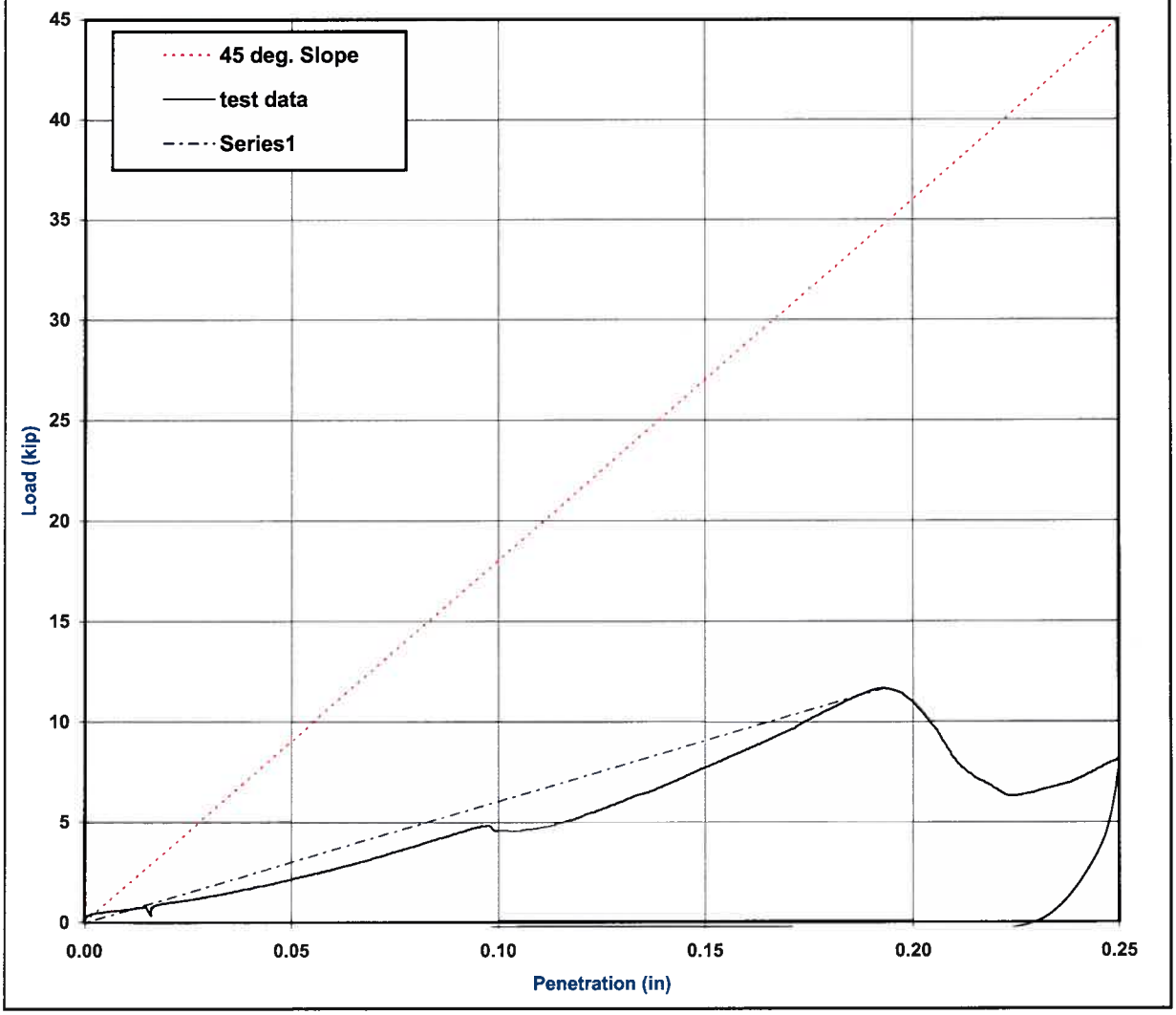
Earth Mechanics Institute
Mining Engineering Department, CSM

Punch Penetration Index Test (Ver. 3.0)

Project: *Doyle Drive Replacement*
Location: *n/a*
Rock Type: *Sedimentary*
Rock Name: *Sandstone*
Characteristics:
Core ID: *BTSB-R3@25.35-25.55*
File Name: *BTSB-R3@25.35-25.56_PP*
Test Performed by: *BM*
Date Tested: *6/18/2008*
Data Reduced by: *BM*
Date Reduced: *6/18/2008*

Moisture Condition: *As-received*
Penetration: *0.001* in/sec
Max. Load: 11,712 lbs

45 Degree (Standard) Index: ***175***
Peak Slope Index: ***61***



Earth Mechanics Institute

Project Name : Doyle Drive Replacement

Location: n/a

Client: Advanced Terra Testing, Inc.

Colorado School of Mines

Mining Engineering Department

Date: 6/18/2008	Rock Type	Punch Penetration Test
Sample ID		Peak Slope (kips/in)
BTSB-R3@25.35-25.55	Sedimentary	61

ARUP PB
BT SB - R3, 25.35 - 25.55
Punch Penetration
AR2653\ARDP2535.jpg
06-16-08

PROJECT: ATT
DATE: 6/18/2008
STATION: BTSB-R3
CORE ID: @2535-2555
AR2653\ARDP3RPS\pd
06-24-08

PROJECT: A.T.T.
DATE: 6/18/2008
STATION: BTSB-R3
CORE ID: @25.35-25.55
AR2653\ARDP35BA.jpg
06-24-08

Reviewed For Adequacy (RFA)

By: TC

Date: 7/10/2008

RECD JUL 10 2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

SLAKE DURABILITY
ASTM D 4644

SLAKE DURABILITY
ASTM D 4644

CLIENT:	ARUP PB	JOB NO.:	2653-13
PROJECT:	Doyle Drive Replacement	DATE TESTED:	6/14-18/08 HN

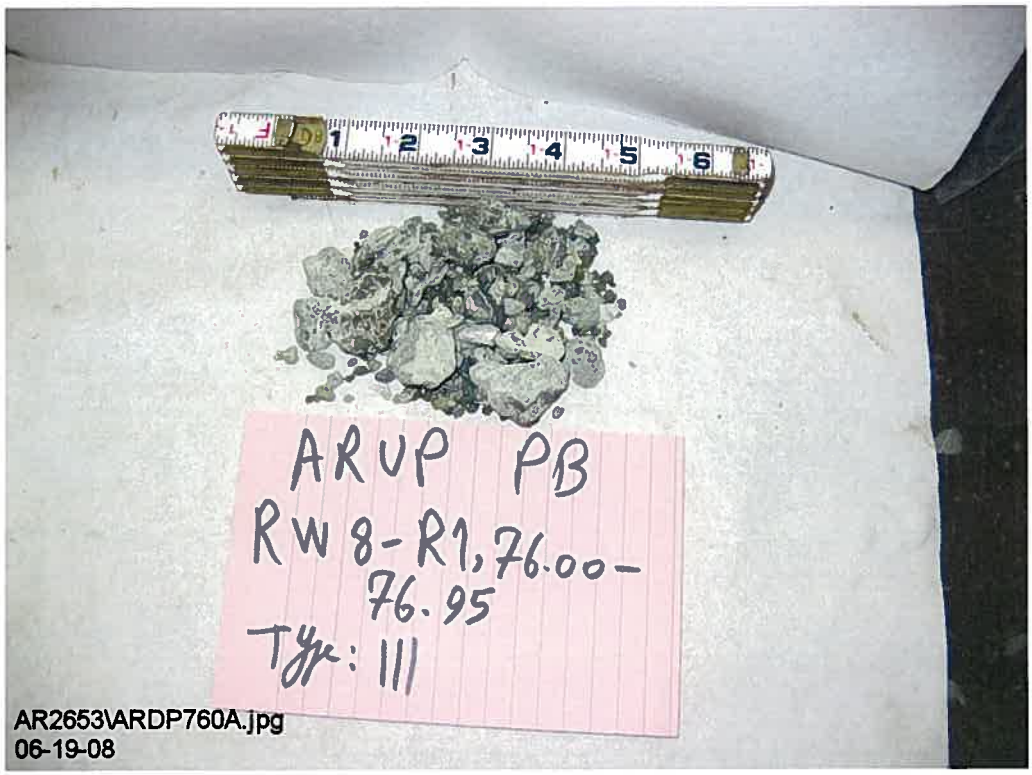
Borehole ID	BTNB-R4	BTNB-R4	RW8-R1
Sample No.			
Depth (ft)	69.8-70.6	75.2-76.0	76.00-76.95
Rock Type	Serpentinite	Serpentinite	Serpentinite
Initial Wt. wet Sample & Drum (g)	1651.6	1678.2	1683.4
Initial Wt. dry Sample & Drum (g)	1616.4	1650.2	1645.1
1st Cycle Wt. Sample & Drum (g)	1587.9	1498.8	1309.8
2nd Cycle Wt. Sample & Drum (g)	1576.0	1486.7	1266.3
Wt. of Drum (g)	1127.2	1186.4	1147.5
Initial Wt Dry Sample (g)	489.2	463.8	497.6
1st Cycle Wt. Sample (g)	460.7	312.4	162.3
2nd Cycle Wt. Sample (g)	448.8	300.3	118.8
1st Cycle Durability (%)	94.17	67.35	32.62
2nd Cycle Durability (%)	91.75	64.73	23.88
Moisture Content (%)	7.20	6.03	7.69
Type (I, II, III)	I	II	III

Comments:

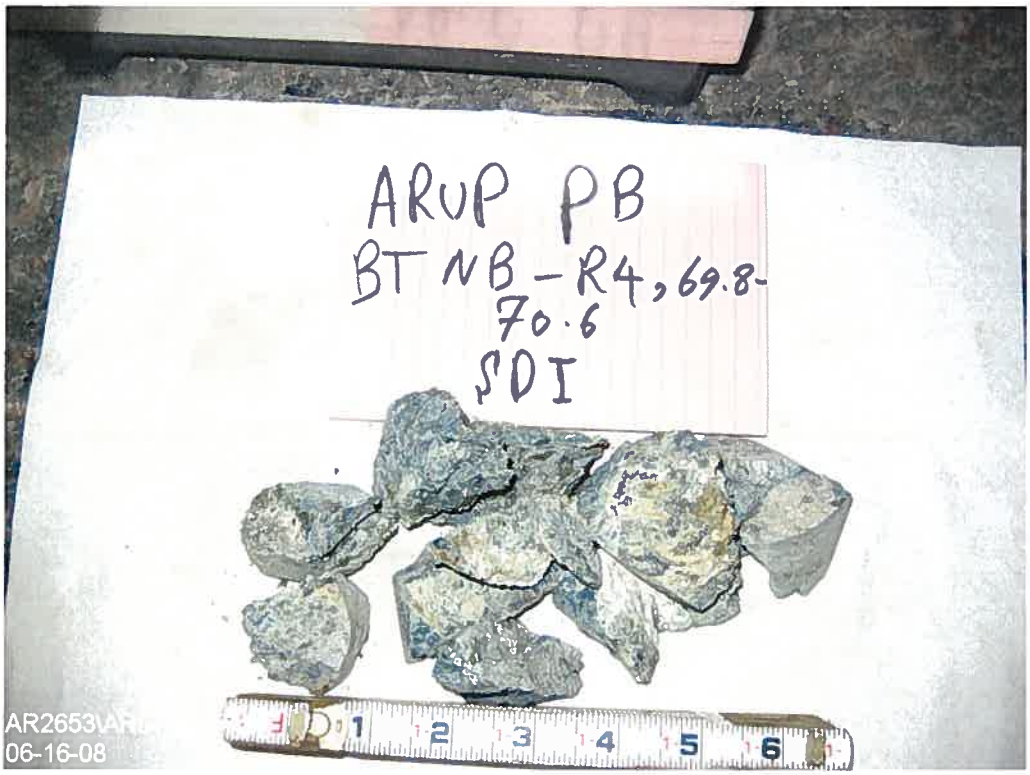
Data Entered By: HN Date: 06/18/2008
Data Checked By: [illegible] Date: 06/18/08
Filename ARSLAKE1

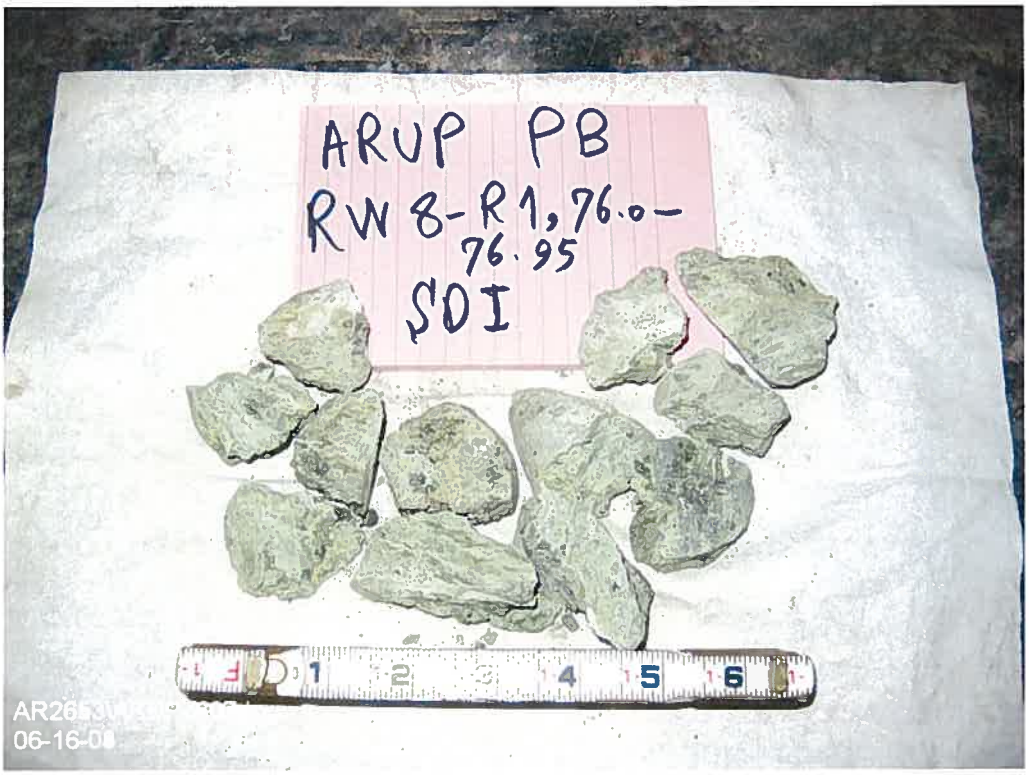
ARUP PB
BTNB-R4, 69.8-70.6
Type: 1
AR2653\ARDP6987.jpg
06-19-08

5
6
7
8
9
ARUP PB
BTNB-R4,75.2-
76.0
Type: II
AR2653\ARDP475A.jpg
06-19-08

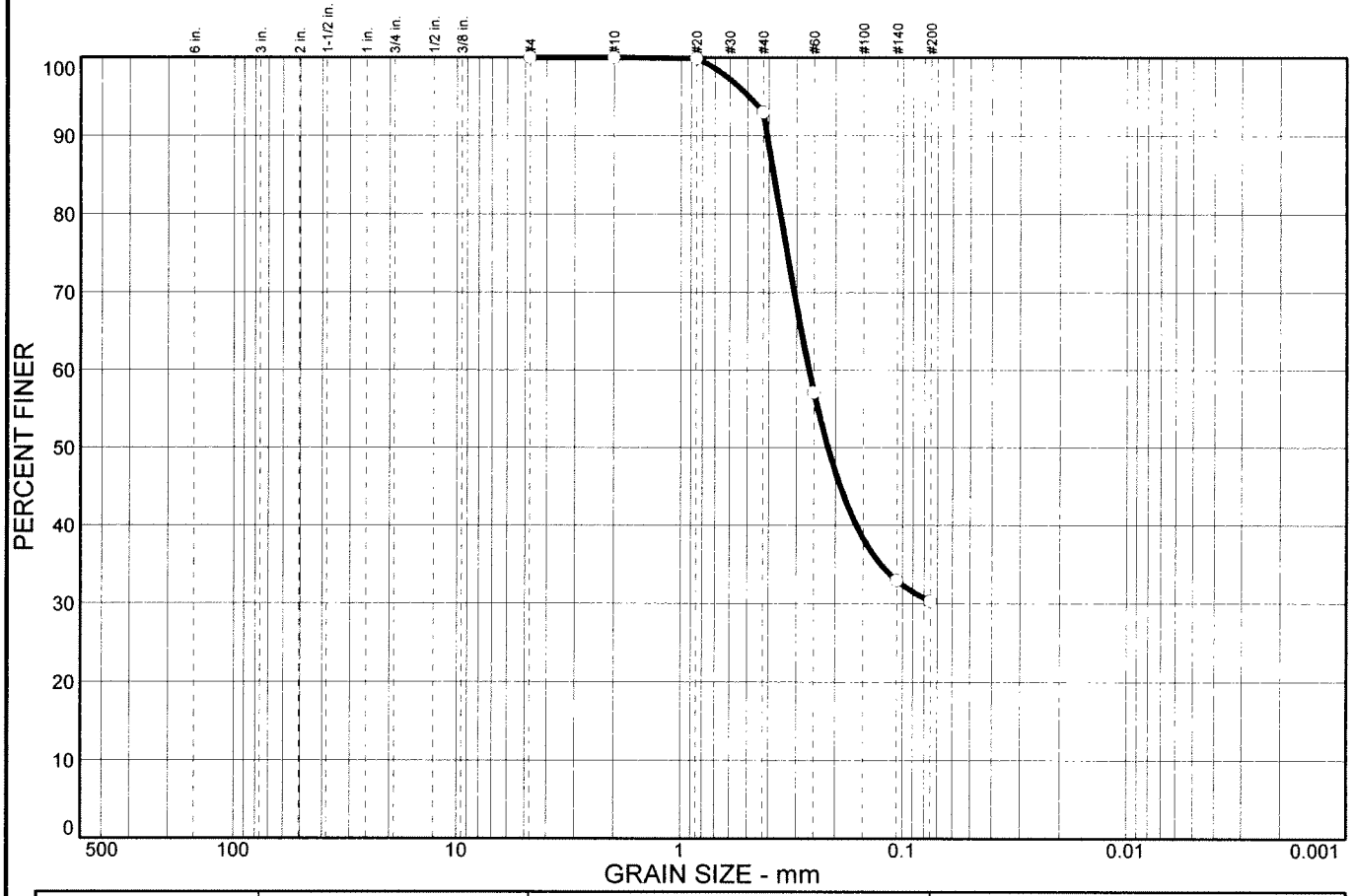

1 2 3 4 5 6
ARUP PB
RW 8-R1, 76.00-
76.95
Tyr: III
AR2653\ARDP760A.jpg
06-19-08

ARUP PB
BT NB-R4, 75.2-
76.0
SDI
06-16-08


ARUP PB
BT NB - R4, 69.8-
70.6
SDI
AR2653\AR
06-16-08


ARUP PB
RW8-R1,76.0-
76.95
SOI
AR265
06-16-0

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	7.0	62.7	30.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	93.0		
#60	57.1		
#140	32.9		
#200	30.3		

* (no specification provided)

Soil Description

Brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.381 D_{60}= 0.263 D_{50}= 0.216
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

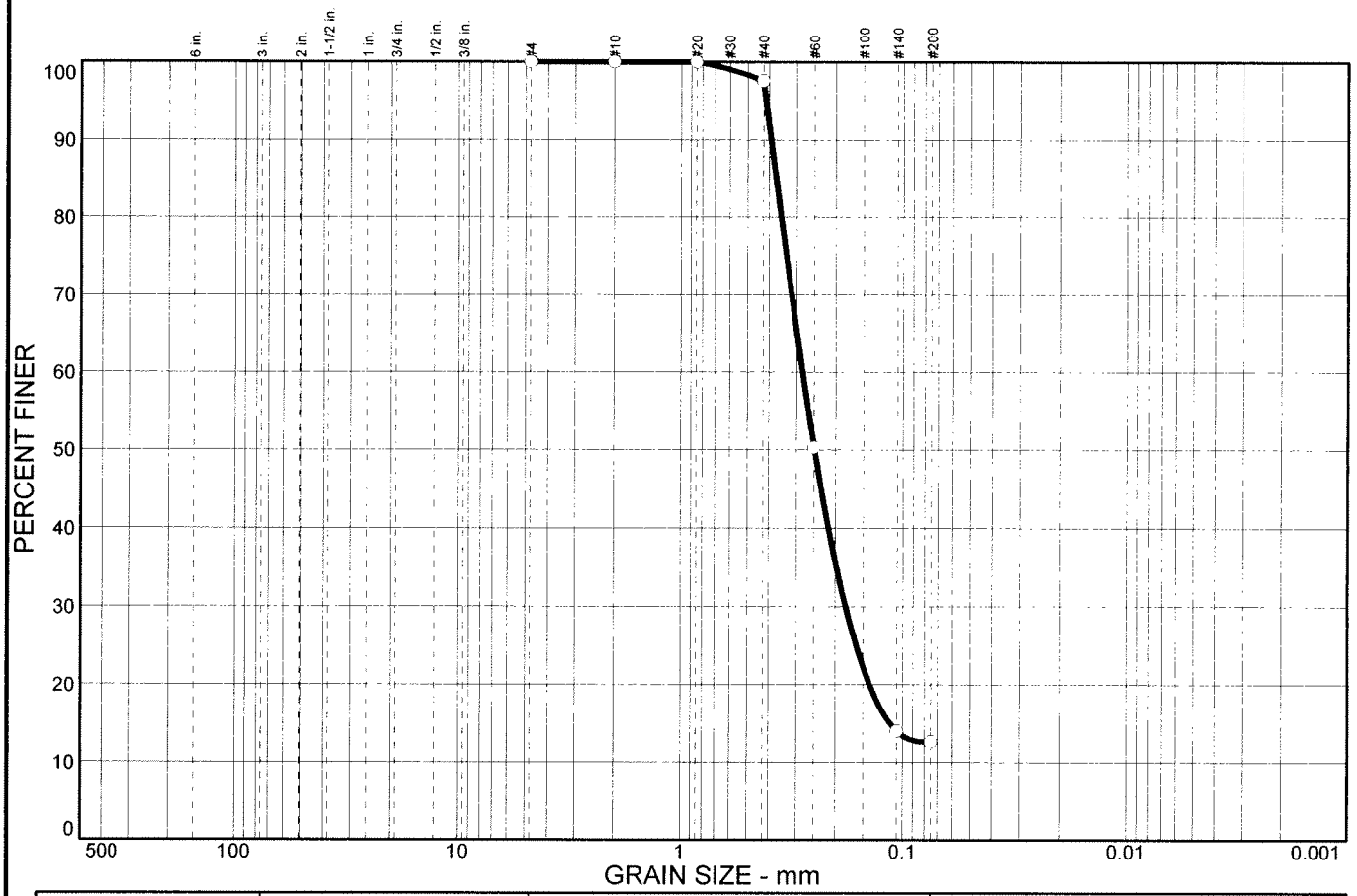
Remarks

Sample No.: 8 **Source of Sample:** BTNB-R3 **Date:**
Location: **Elev./Depth:** 17.5-19

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	2.4	85.0	12.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	97.6		
#60	50.3		
#140	14.0		
#200	12.6		

* (no specification provided)

Soil Description

Yellowish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.372 D_{60}= 0.282 D_{50}= 0.249
D_{30}= 0.180 D_{15}= 0.114 D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

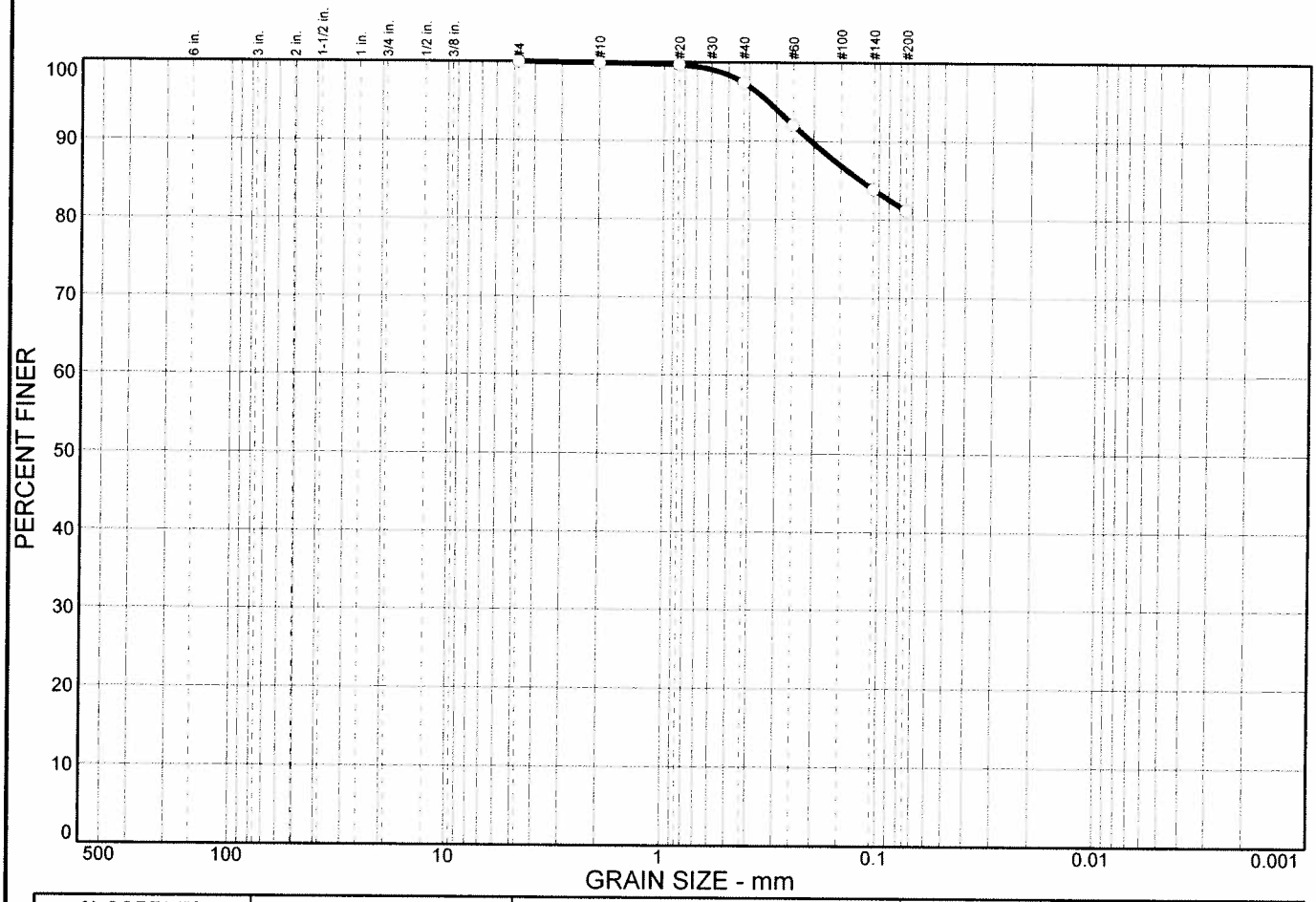
Sample No.: 13A **Source of Sample:** BTNB-R3 **Date:**
Location: **Elev./Depth:** 31.4-31.9

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	18.9	81.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.7		
#40	97.4		
#60	92.0		
#140	83.8		
#200	81.1		

* (no specification provided)

Soil Description

Brown Lean clay with sand

Atterberg Limits

PL= 16 LL= 32 PI= 16

Coefficients

D_{85}= 0.122 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

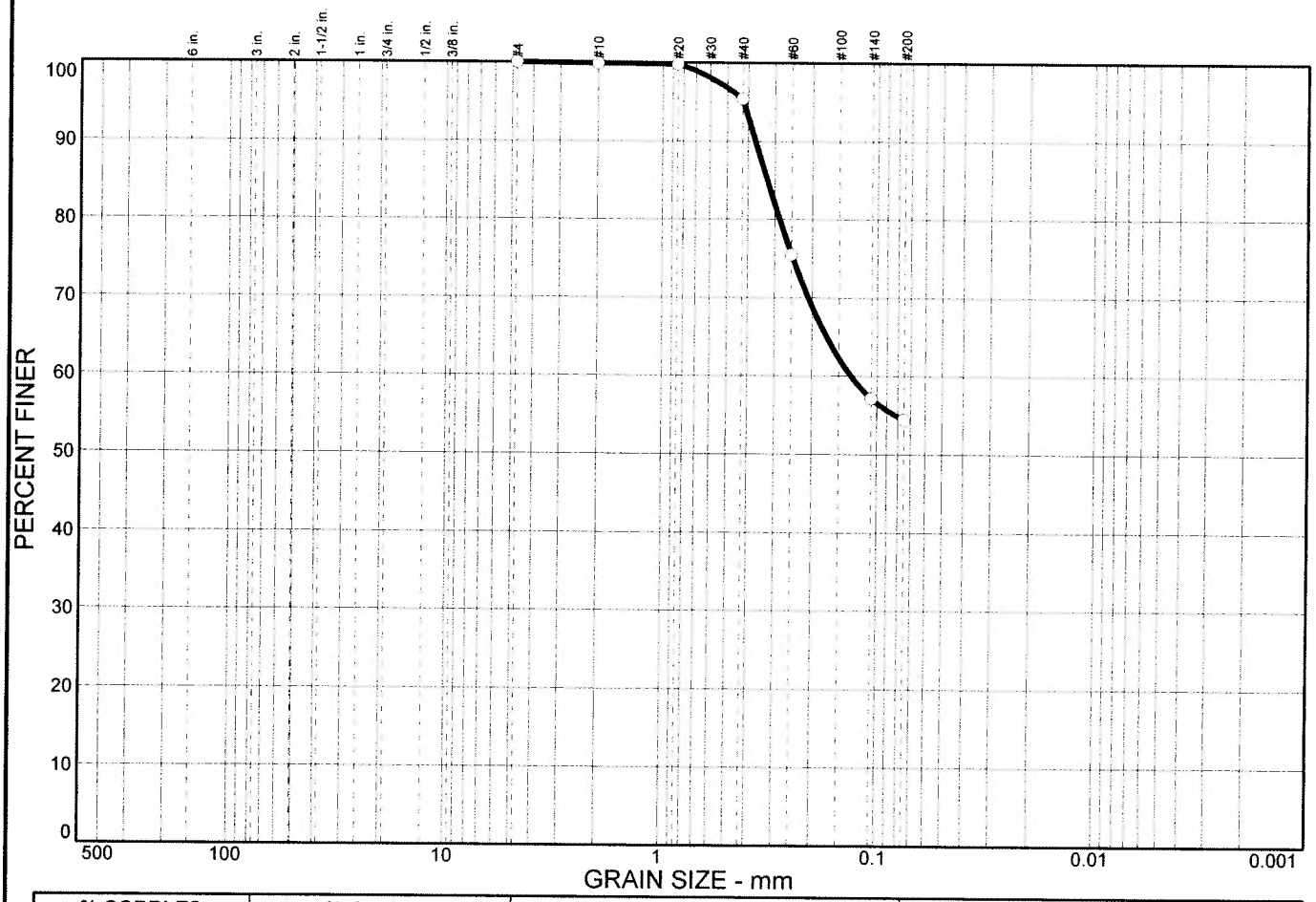
Remarks

Sample No.: 3A **Source of Sample:** BTNB-R4 **Date:**
Location: **Elev./Depth:** 8-8.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	45.6	54.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	95.4		
#60	75.5		
#140	57.1		
#200	54.4		

* (no specification provided)

Soil Description

Brown Sandy silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.325 D_{60}= 0.132 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO=

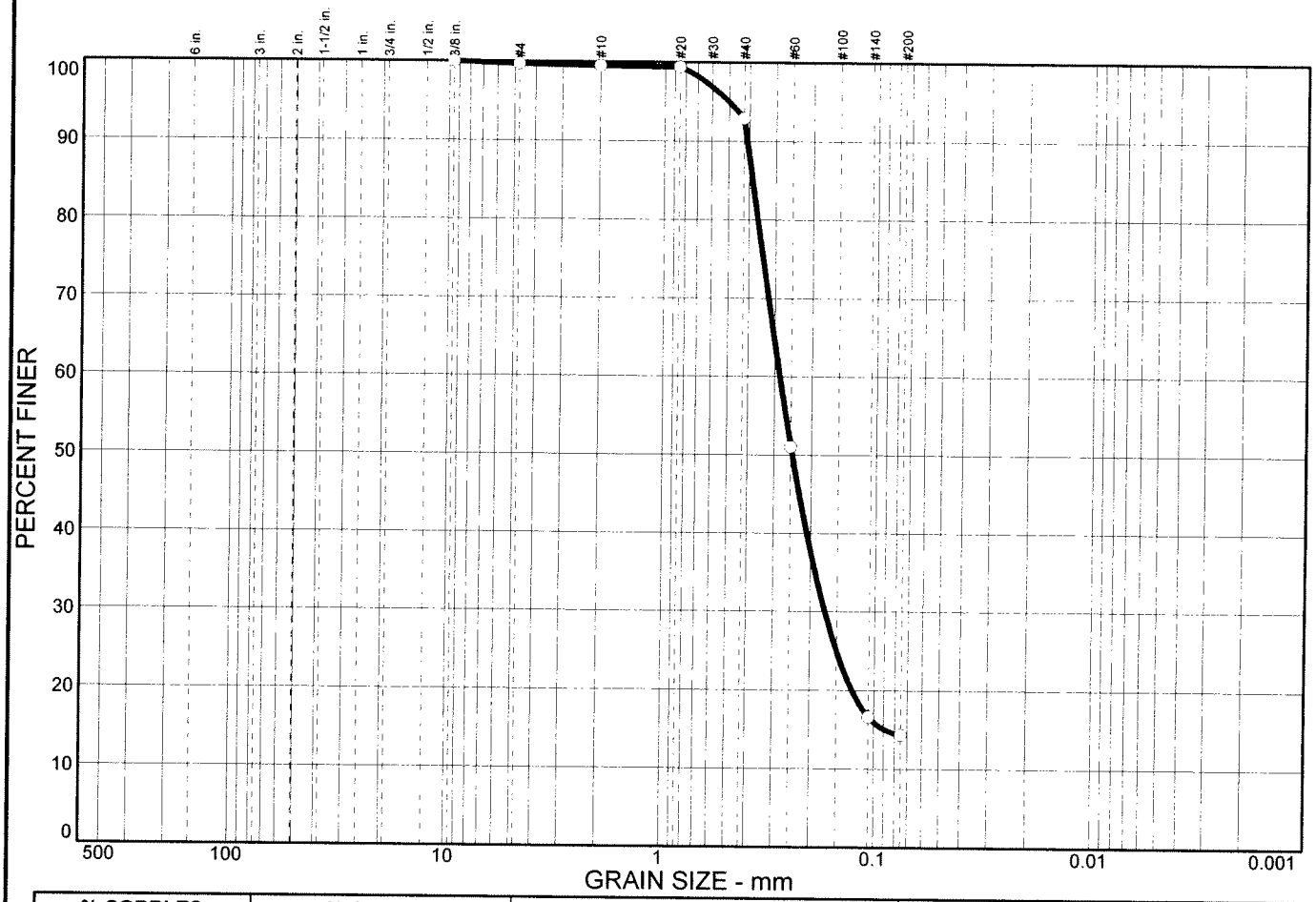
Remarks

Sample No.: 5B **Source of Sample:** BTNB-R4 **Date:**
Location: **Elev./Depth:** 13.1-13.6

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	85.4	14.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	99.5		
#20	99.4		
#40	92.9		
#60	51.0		
#140	16.6		
#200	14.3		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.387 D_{60}= 0.283 D_{50}= 0.246
D_{30}= 0.171 D_{15}= 0.0890 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

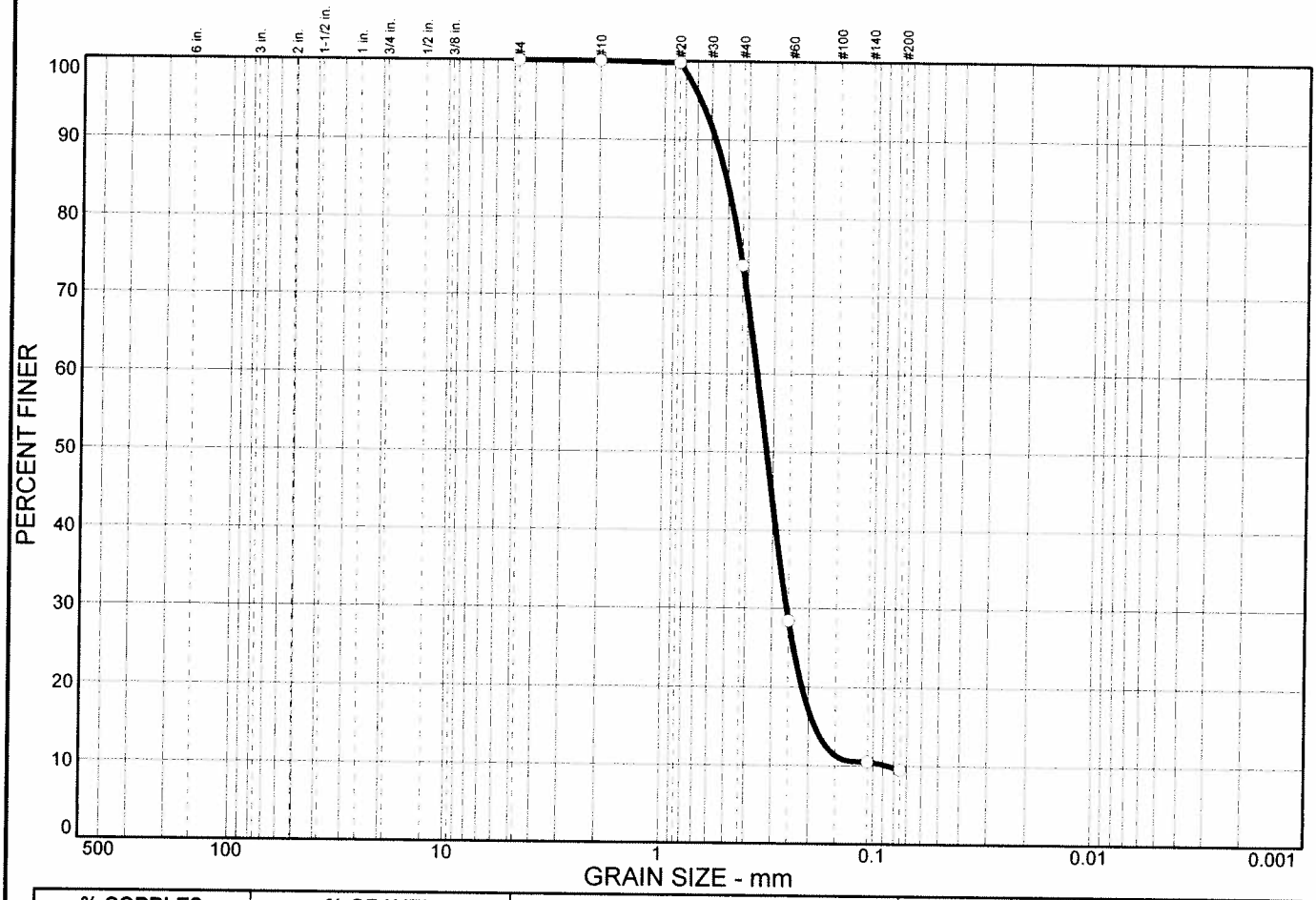
Remarks

Sample No.: 9B **Source of Sample:** BTNB-R4 **Date:**
Location: **Elev./Depth:** 23.2-23.7

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	90.5	9.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.8		
#40	73.9		
#60	28.4		
#140	10.5		
#200	9.5		

* (no specification provided)

Soil Description

Brown Poorly graded sand with clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.511 D_{60}= 0.360 D_{50}= 0.323
D_{30}= 0.256 D_{15}= 0.187 D_{10}= 0.0857
C_u= 4.20 C_c= 2.12

Classification

USCS= SP-SC AASHTO=

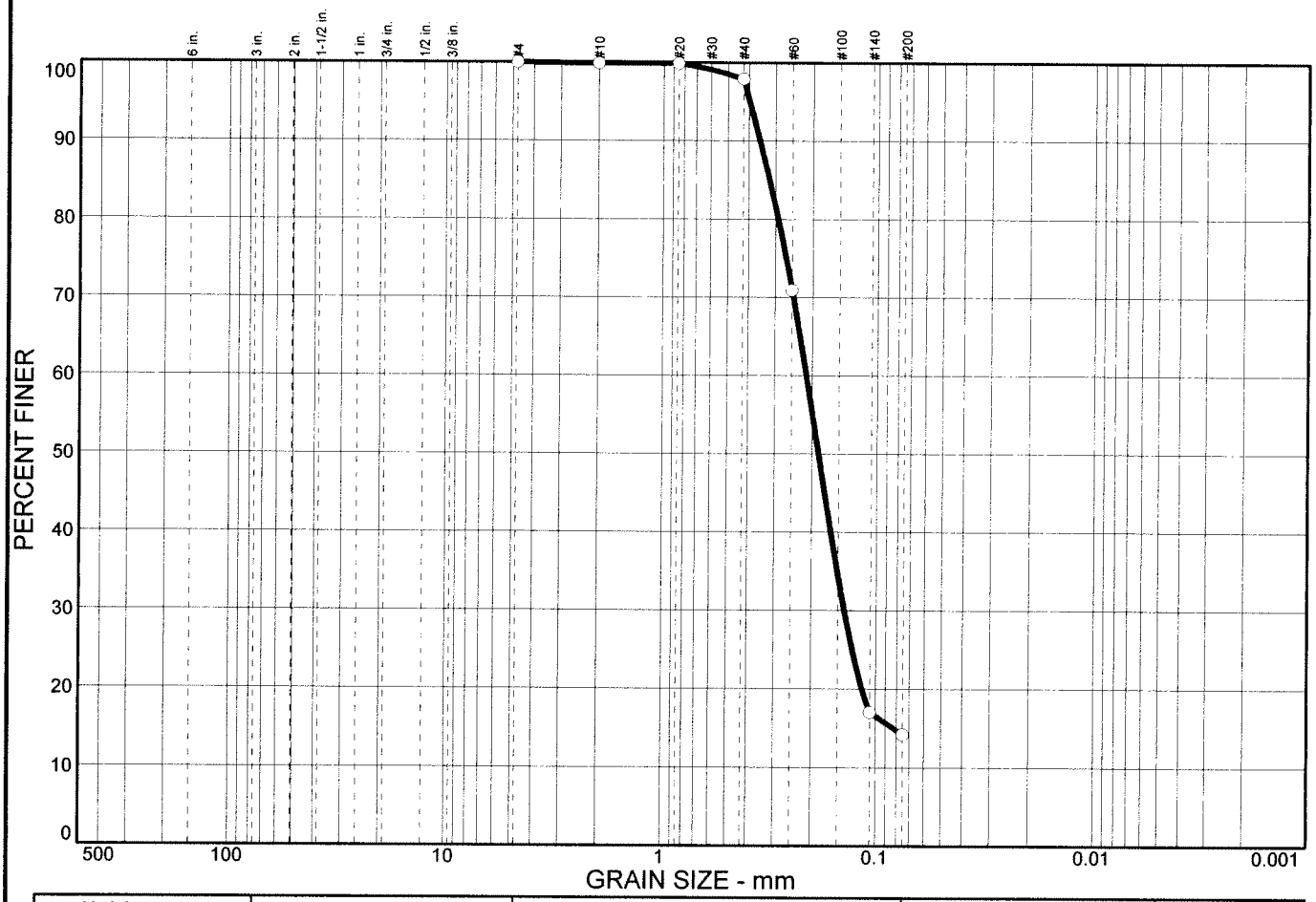
Remarks

Sample No.: 13A **Source of Sample:** BTNB-R4 **Date:**
Location: **Elev./Depth:** 32.8-33.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	85.8	14.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	97.9		
#60	70.9		
#140	17.0		
#200	14.2		

* (no specification provided)

Soil Description

Brown sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.321 D_{60}= 0.214 D_{50}= 0.187
D_{30}= 0.140 D_{15}= 0.0828 D_{10}=
C_u= C_c=

Classification

USCS= SP AASHTO=

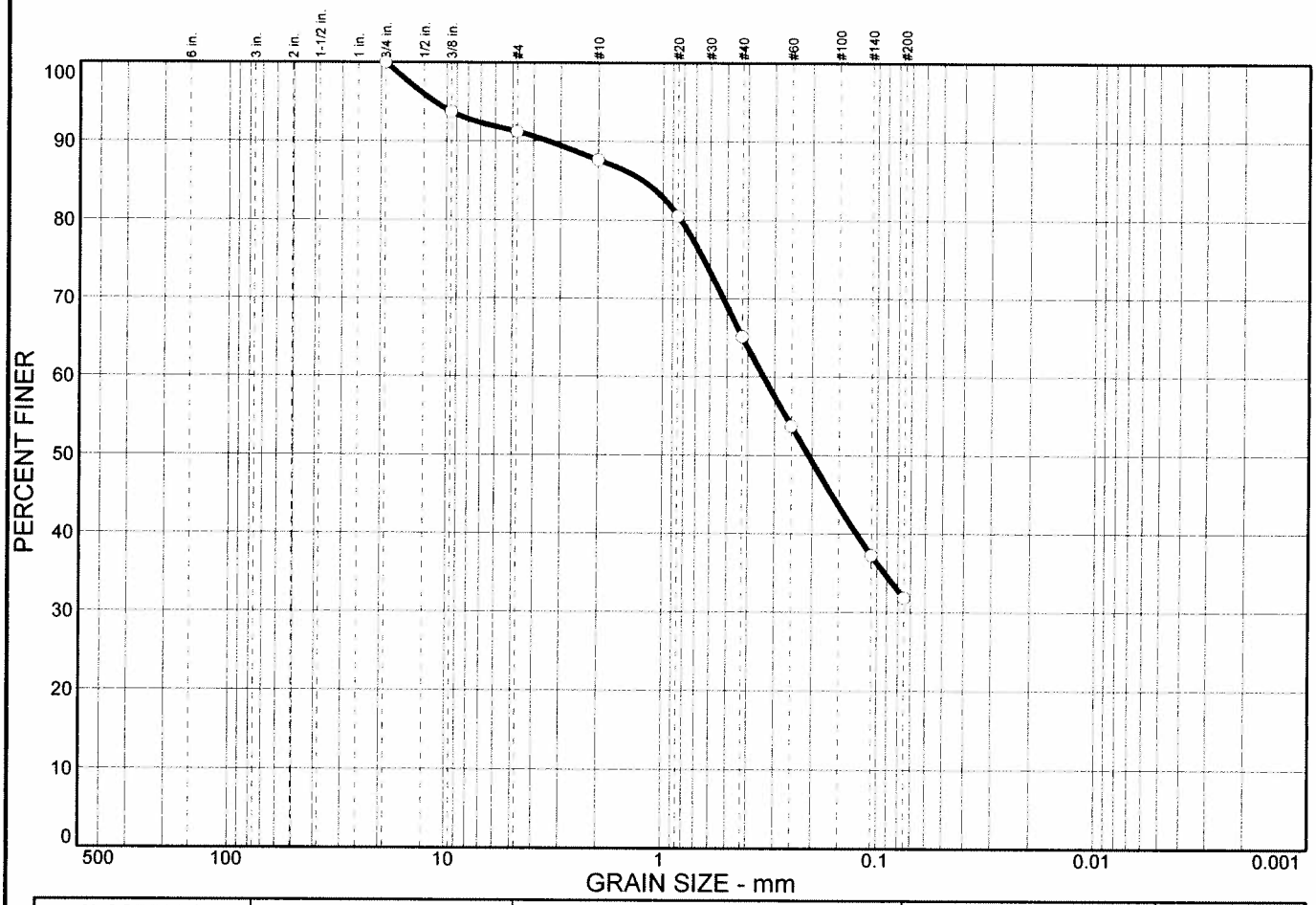
Remarks

Sample No.: 19A **Source of Sample:** BTNB-R4 **Date:**
Location: **Elev./Depth:** 47.8-48.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	8.8	59.4	31.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	93.7		
#4	91.2		
#10	87.6		
#20	80.5		
#40	65.1		
#60	53.7		
#140	37.2		
#200	31.8		

* (no specification provided)

Soil Description

Olive brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.25 D_{60}= 0.338 D_{50}= 0.209
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

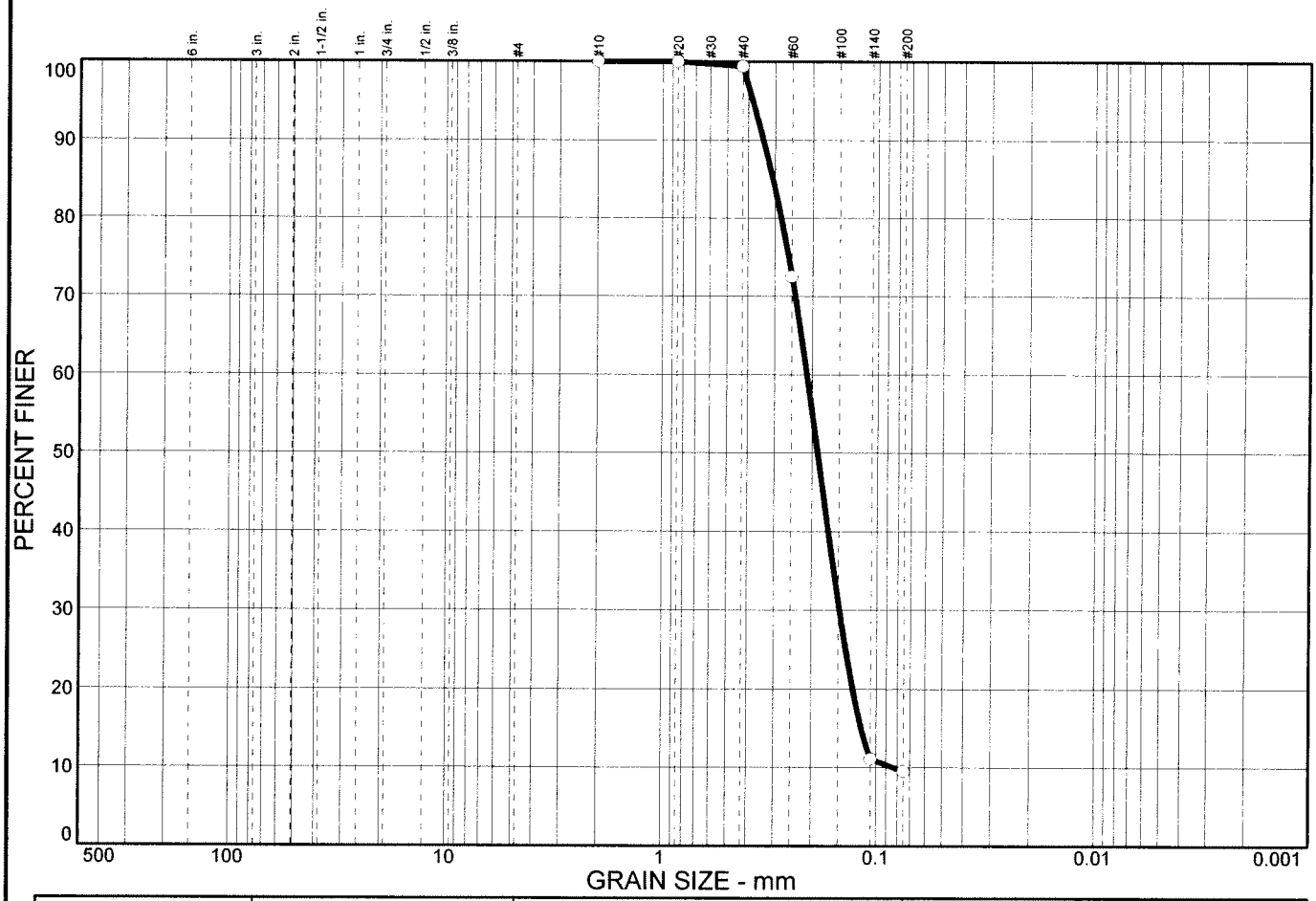
Remarks

Sample No.: 11B **Source of Sample:** BTNB-R6A **Date:**
Location: **Elev./Depth:** 28.3-28.8

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	90.5	9.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.4		
#60	72.5		
#140	11.1		
#200	9.5		

* (no specification provided)

Soil Description

Reddish brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.308 D_{60}= 0.213 D_{50}= 0.189
D_{30}= 0.149 D_{15}= 0.117 D_{10}= 0.0836
C_u= 2.54 C_c= 1.24

Classification

USCS= SP-SM AASHTO=

Remarks

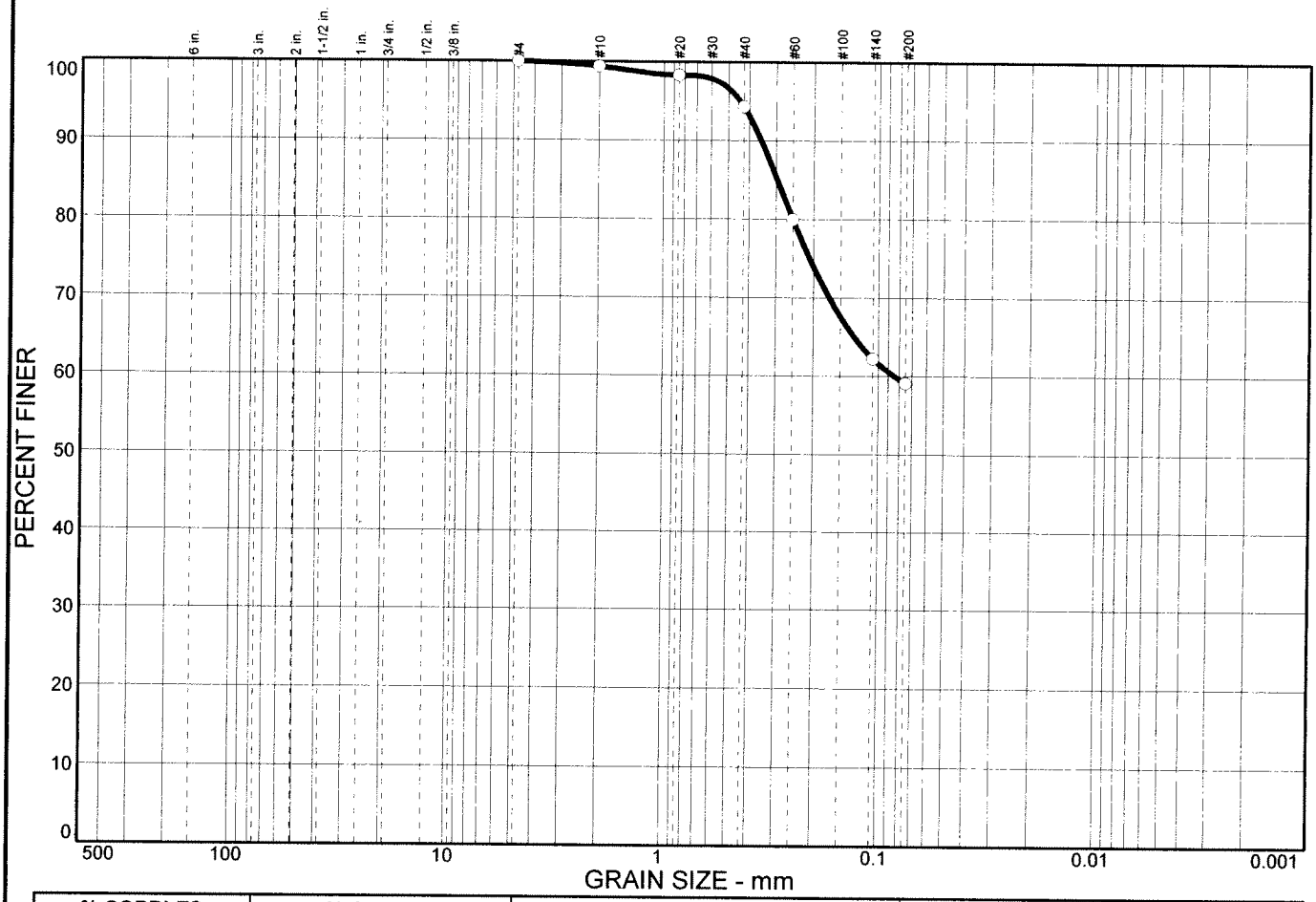
Sample No.: 3B **Source of Sample:** BTNB-R6 **Date:**
Location: **Elev./Depth:** 7.9-8.4

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	40.9	59.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.4		
#20	98.3		
#40	94.3		
#60	79.9		
#140	62.2		
#200	59.1		

* (no specification provided)

Soil Description

Brown Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.297 D_{60}= 0.0842 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

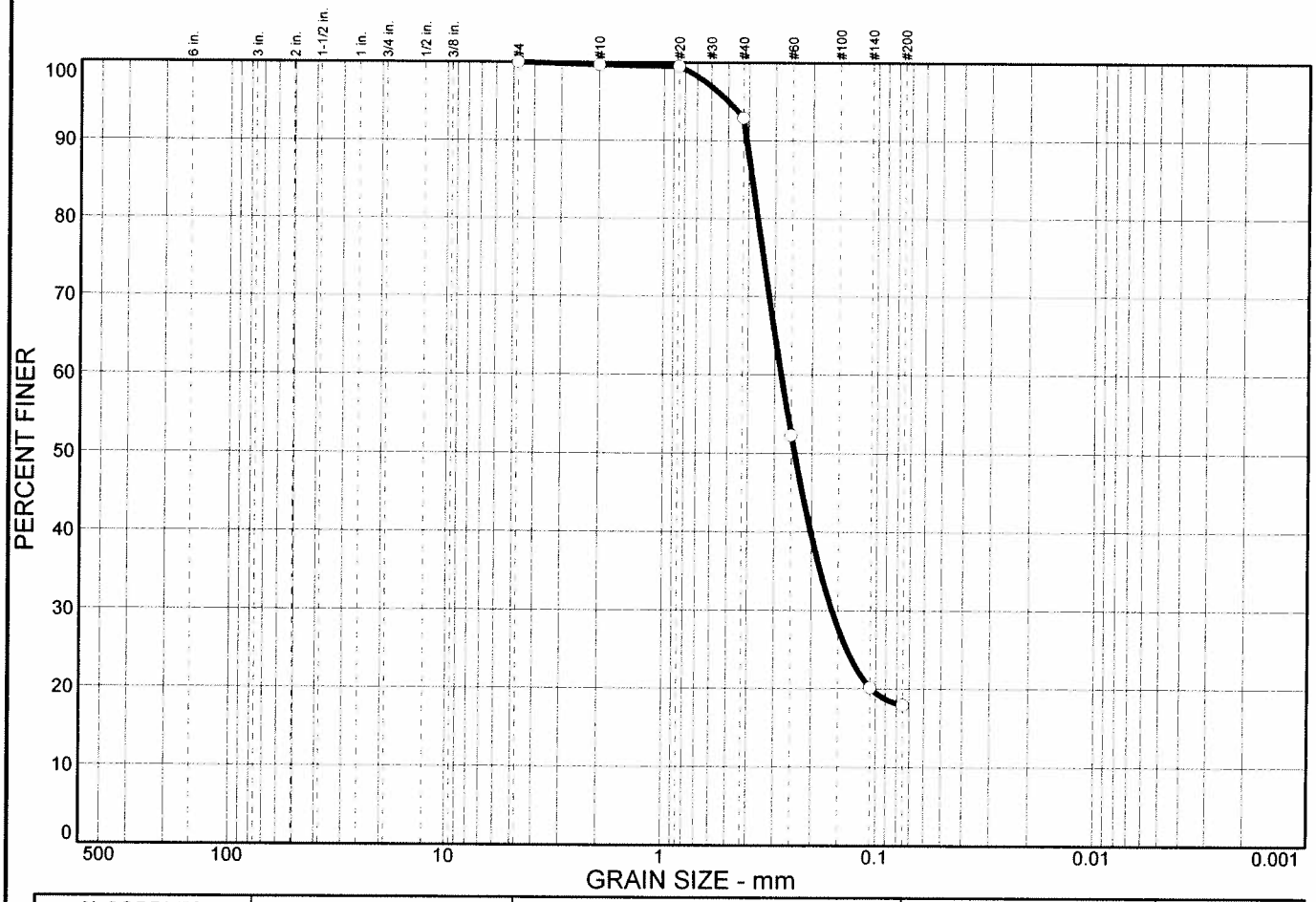
Sample No.: 7A **Source of Sample:** BTNB-R6 **Date:**
Location: **Elev./Depth:** 18-18.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	82.1	17.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.7		
#20	99.5		
#40	92.9		
#60	52.3		
#140	20.1		
#200	17.9		

* (no specification provided)

Soil Description

Strong brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.385 D_{60}= 0.280 D_{50}= 0.241
D_{30}= 0.160 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

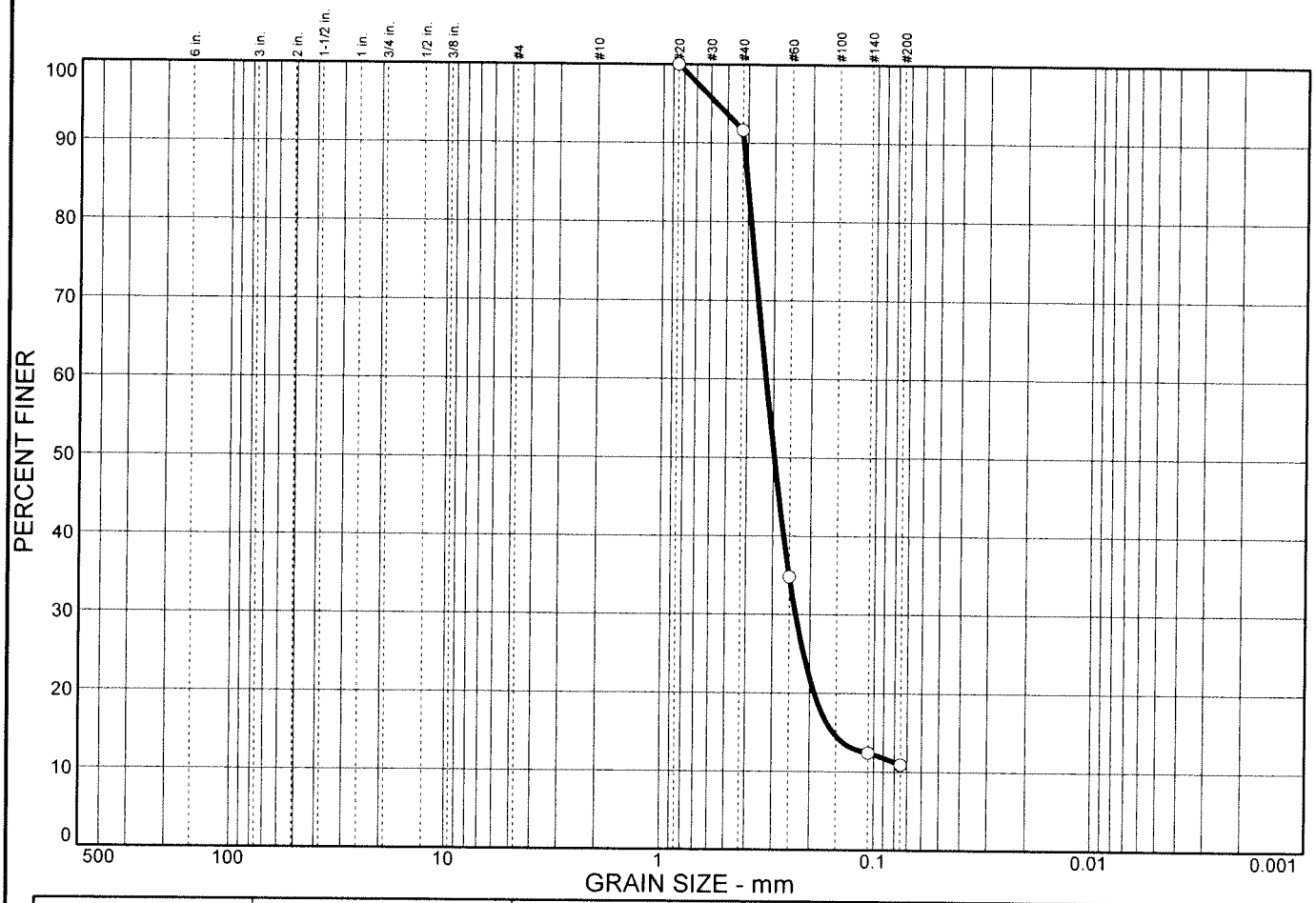
Sample No.: 9B **Source of Sample:** BTNB-R6 **Date:**
Location: **Elev./Depth:** 23.3-23.8

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	89.1	10.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	91.6		
#60	34.8		
#140	12.4		
#200	10.9		

* (no specification provided)

Soil Description

Brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.403 D_{60}= 0.326 D_{50}= 0.296
D_{30}= 0.233 D_{15}= 0.155 D_{10}=
C_u= C_c=

Classification

USCS= SP-SM AASHTO=

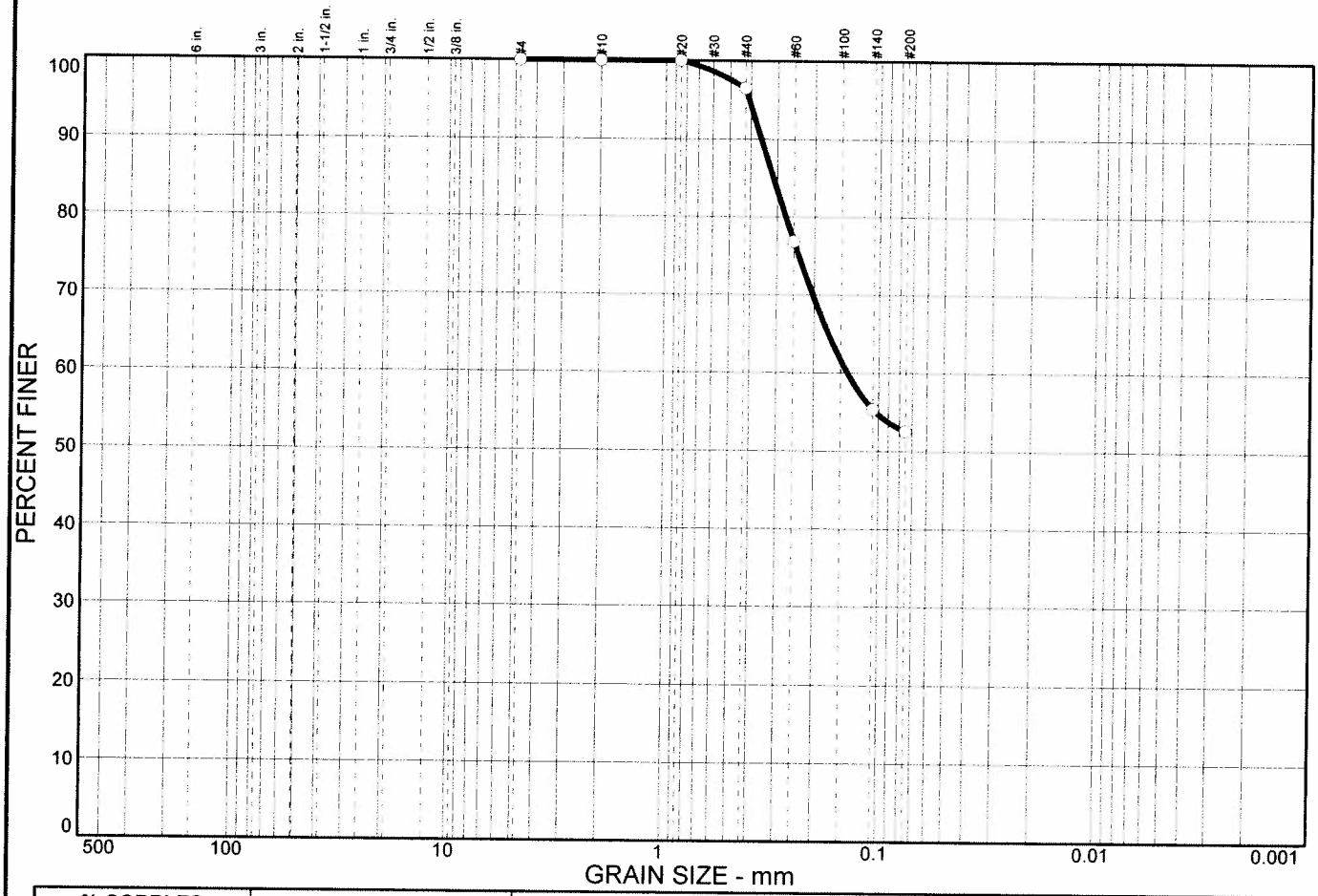
Remarks

Sample No.: 11 **Source of Sample:** BTNB-R6 **Date:**
Location: **Elev./Depth:** 27.3-27.8

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	47.5	52.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	96.5		
#60	76.8		
#140	55.3		
#200	52.5		

* (no specification provided)

Soil Description

Reddish brown Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.313 D_{60}= 0.140 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

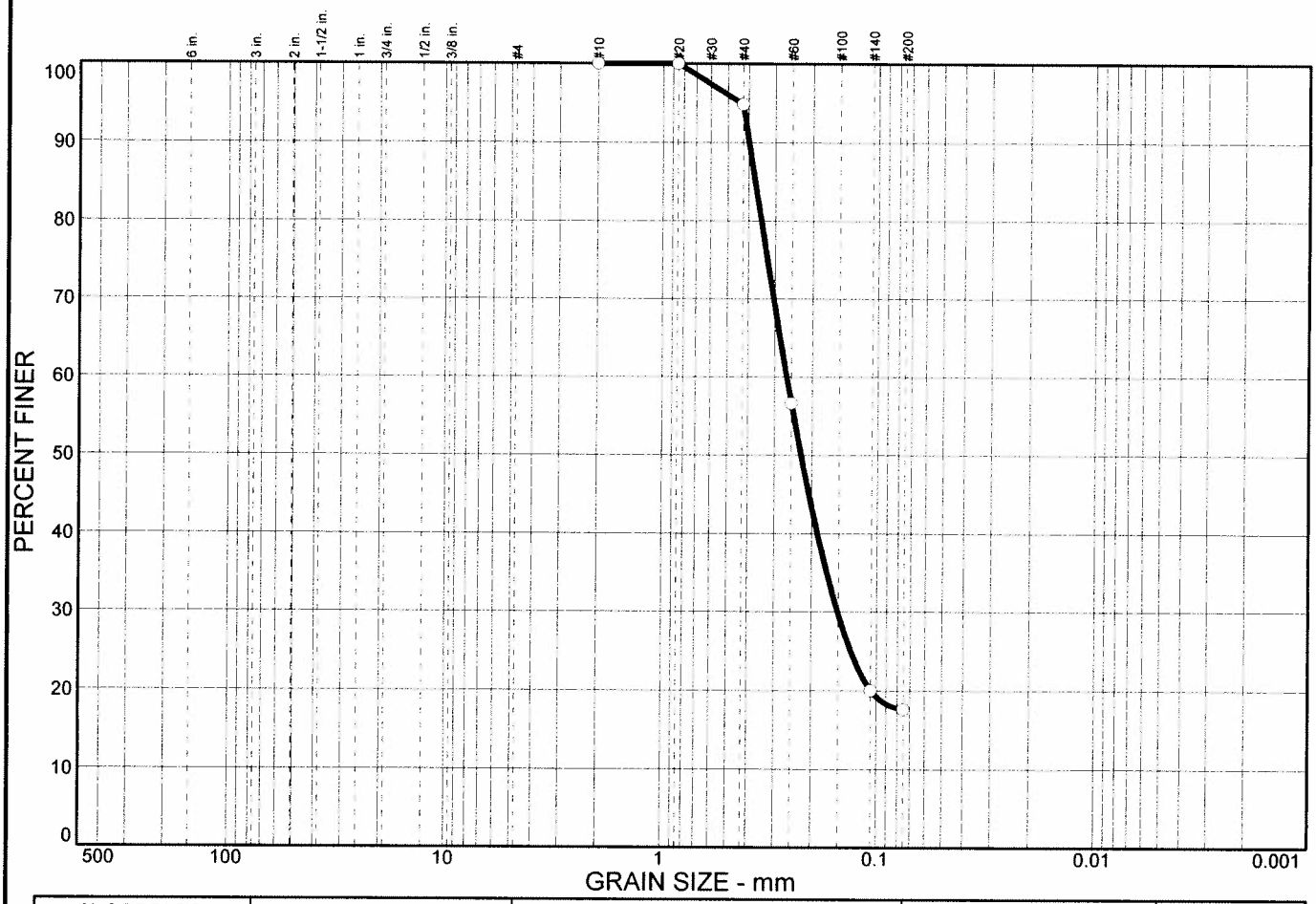
Remarks

Sample No.: 7B **Source of Sample:** BTNB-R7A **Date:**
Location: **Elev./Depth:** 18.3-18.8

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	82.4	17.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	94.8		
#60	56.6		
#140	20.0		
#200	17.6		

* (no specification provided)

Soil Description

Dark brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.373 D_{60}= 0.263 D_{50}= 0.225
D_{30}= 0.151 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

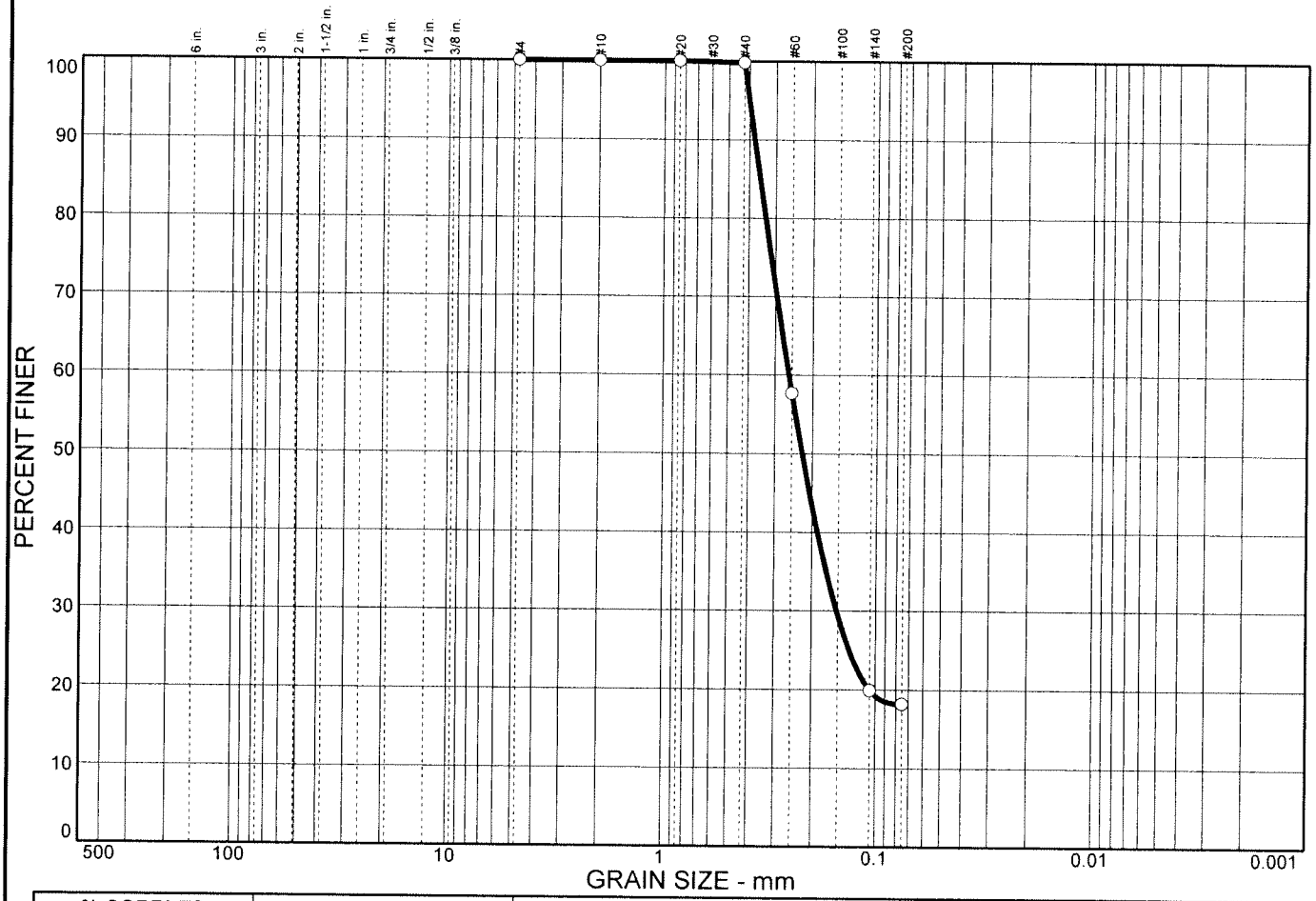
Sample No.: 9A **Source of Sample:** BTNB-R7A **Date:**
Location: **Elev./Depth:** 22.8-23.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	81.8	18.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.8		
#60	57.7		
#140	19.9		
#200	18.2		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.356 D_{60}= 0.258 D_{50}= 0.223
D_{30}= 0.153 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

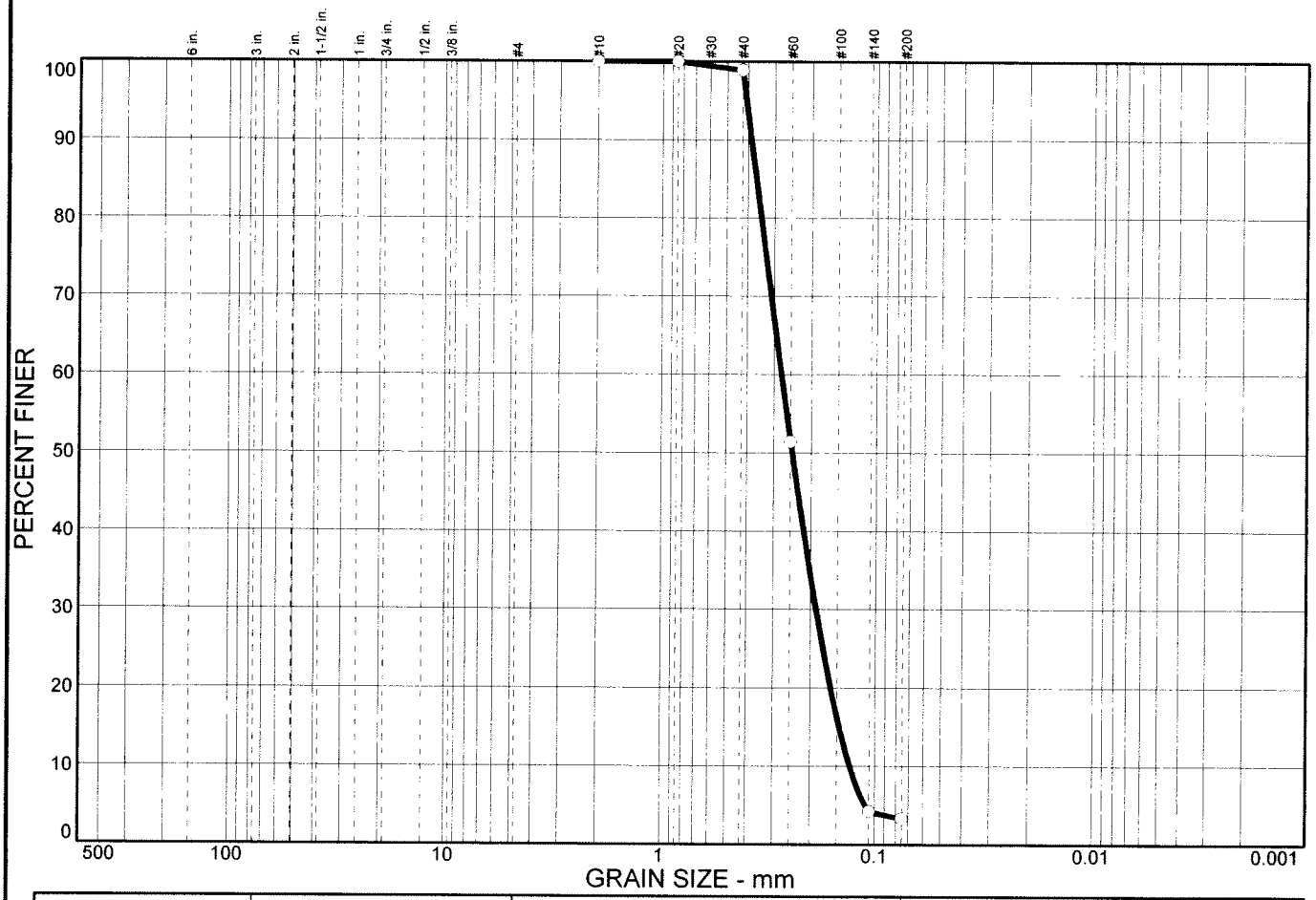
Remarks

Sample No.: 13A **Source of Sample:** BTNB-R7A **Date:**
Location: **Elev./Depth:** 33-33.5

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	96.7	3.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	98.9		
#60	51.4		
#140	4.2		
#200	3.3		

* (no specification provided)

Soil Description

Brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.366 D_{60}= 0.277 D_{50}= 0.246
D_{30}= 0.189 D_{15}= 0.146 D_{10}= 0.131
C_u= 2.12 C_c= 0.98

Classification

USCS= SP AASHTO=

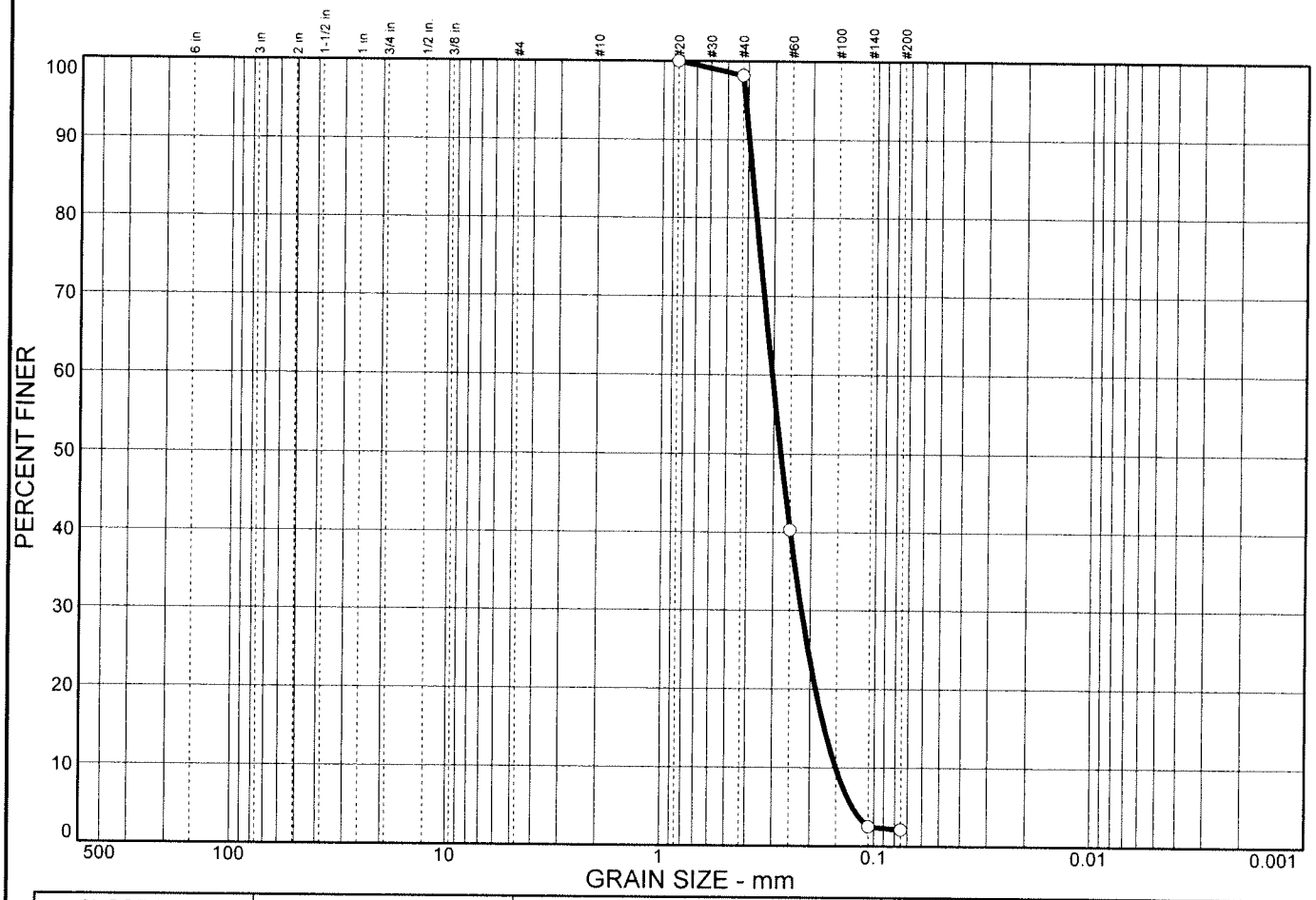
Remarks

Sample No.: 5B **Source of Sample:** BTSB-R1 **Date:**
Location: **Elev./Depth:** 13-13.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	97.9	2.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	98.2		
#60	40.3		
#140	2.5		
#200	2.1		

* (no specification provided)

Soil Description

Brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.380 D_{60}= 0.305 D_{50}= 0.277
D_{30}= 0.220 D_{15}= 0.171 D_{10}= 0.151
C_u= 2.02 C_c= 1.05

Classification

USCS= SP AASHTO=

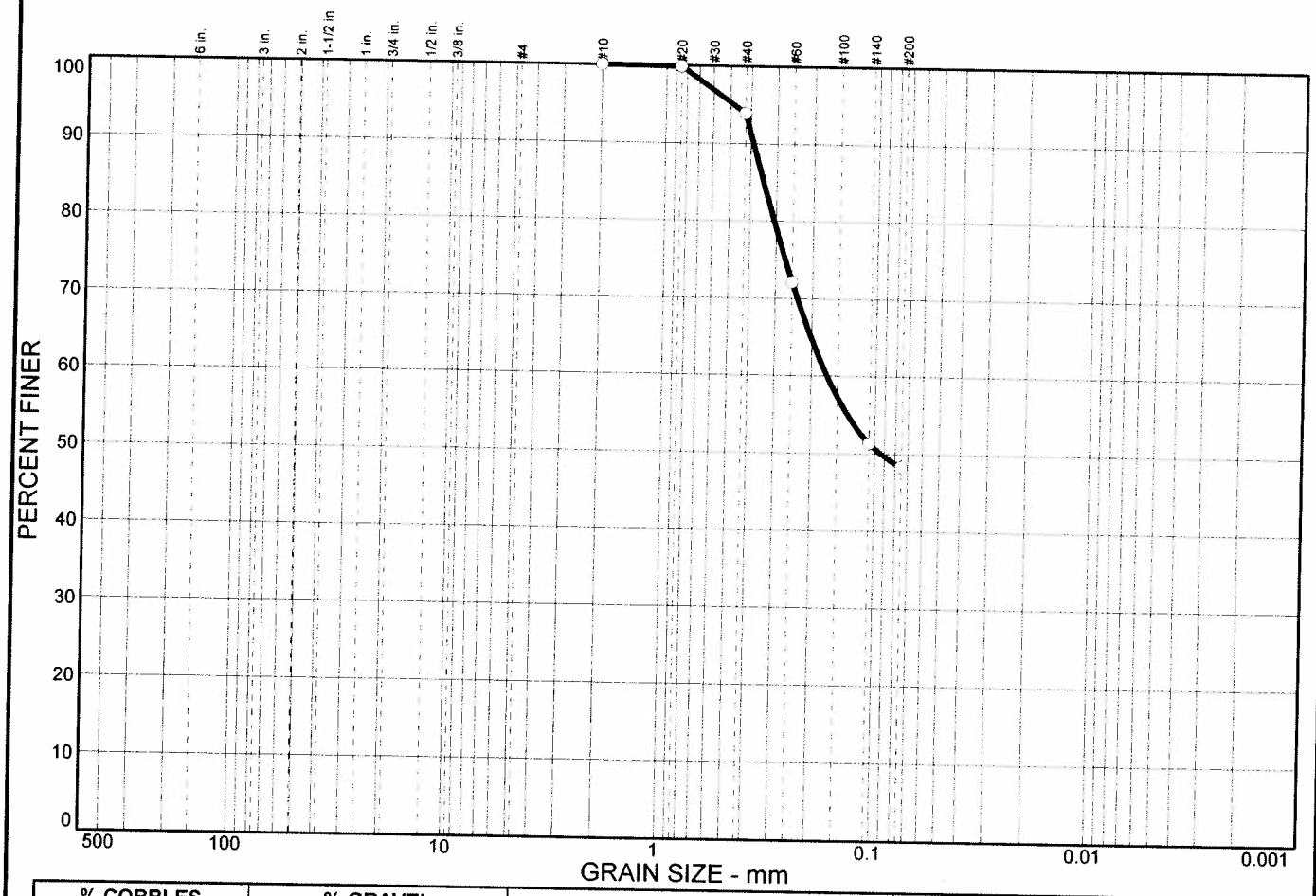
Remarks

Sample No.: 9 **Source of Sample:** BTSB-R1 **Date:**
Location: **Elev./Depth:** 22.5-23

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	51.7	48.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	93.9		
#60	72.1		
#140	51.3		
#200	48.3		

* (no specification provided)

Soil Description

Reddish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.346 D_{60}= 0.169 D_{50}= 0.0936
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

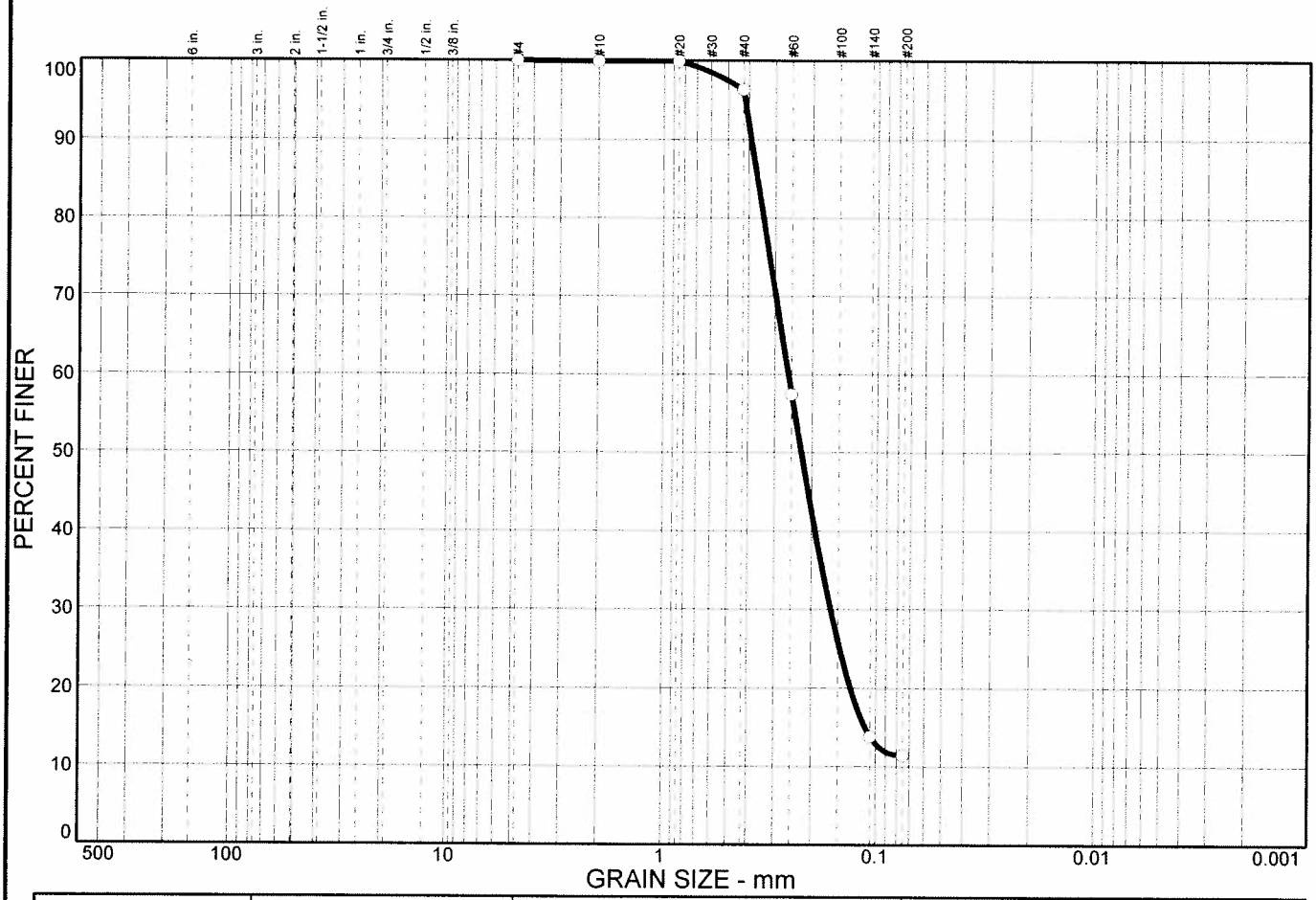
Remarks

Sample No.: 7A **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 17.8-18.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	88.6	11.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	96.3		
#60	57.4		
#140	13.8		
#200	11.4		

* (no specification provided)

Soil Description

Reddish brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.365 D_{60}= 0.259 D_{50}= 0.225
D_{30}= 0.163 D_{15}= 0.112 D_{10}=
C_u= C_c=

Classification

USCS= SP-SM AASHTO=

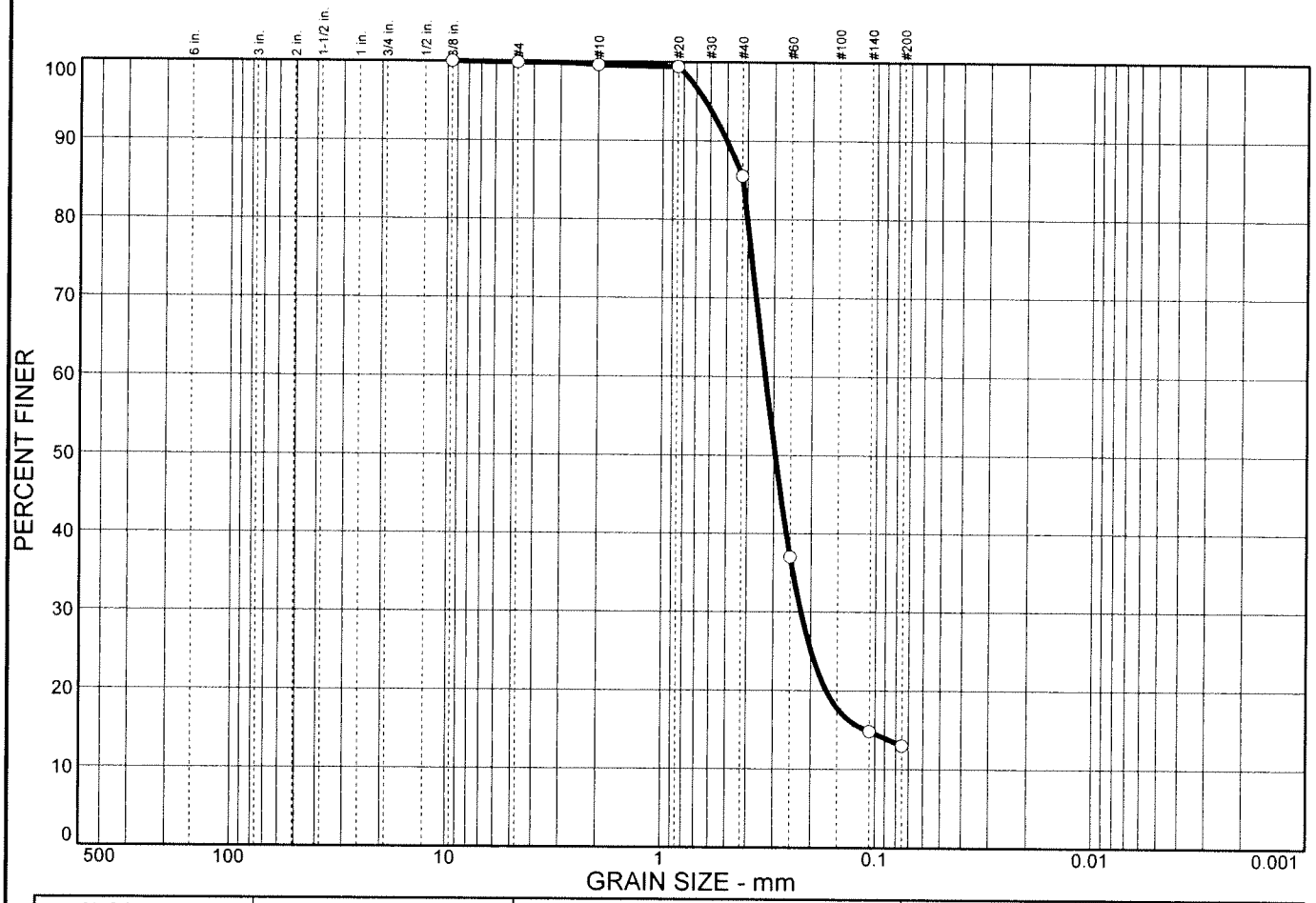
Remarks

Sample No.: 11B **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 28.1-28.4

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	86.9	13.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.6		
#20	99.4		
#40	85.5		
#60	37.0		
#140	14.8		
#200	13.0		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.423 D_{60}= 0.329 D_{50}= 0.295
D_{30}= 0.222 D_{15}= 0.110 D_{10}=
C_u= C_c=

Classification

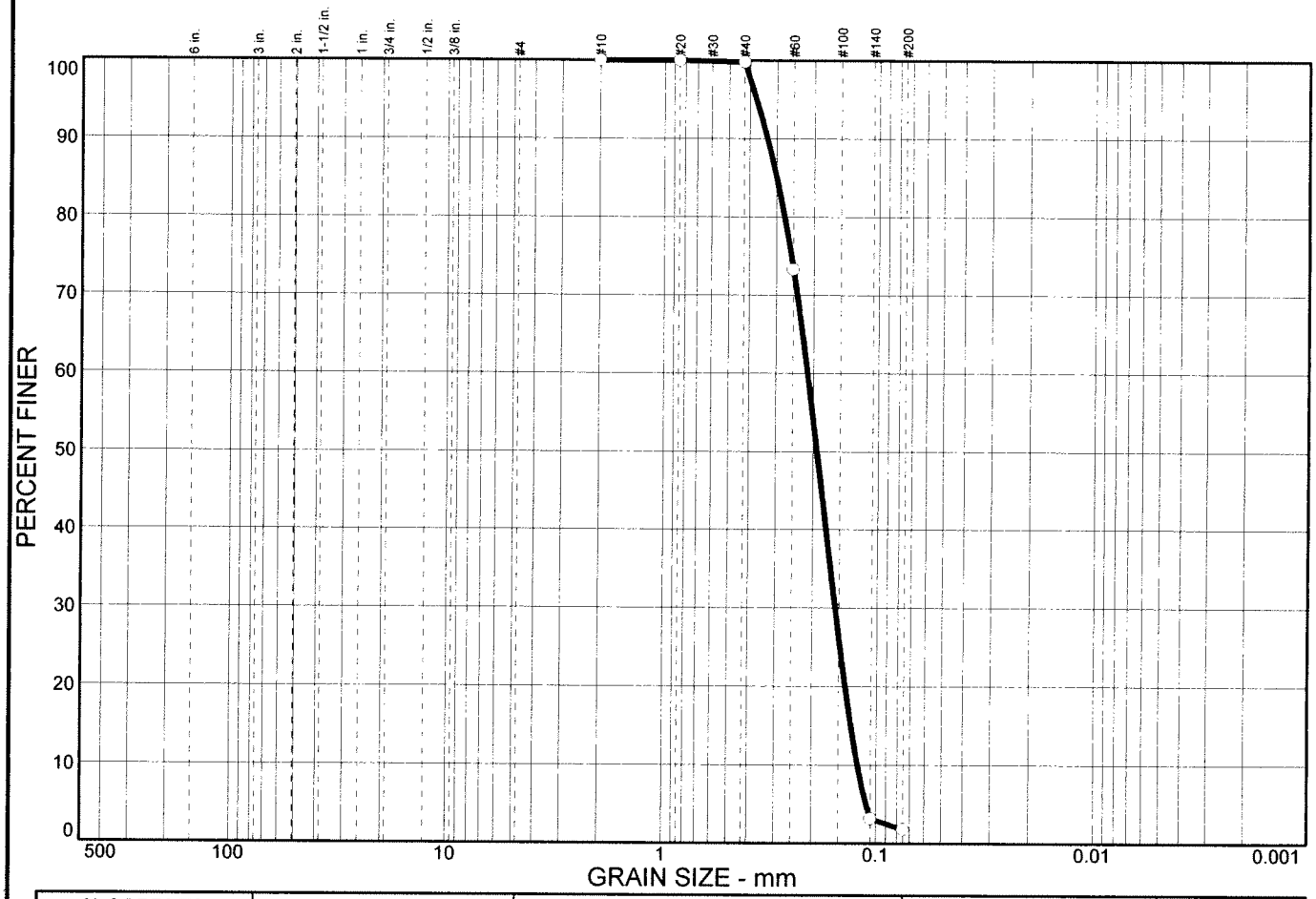
USCS= SM AASHTO=

Remarks

Sample No.: 13B **Source of Sample:** BTSB-R2 **Date:**
Location: **Elev./Depth:** 33.3-33.8

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.2	1.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.8		
#60	73.3		
#140	3.2		
#200	1.8		

* (no specification provided)

Soil Description

Brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.300 D_{60}= 0.214 D_{50}= 0.193
D_{30}= 0.157 D_{15}= 0.131 D_{10}= 0.122
C_u= 1.75 C_c= 0.94

Classification

USCS= SP AASHTO=

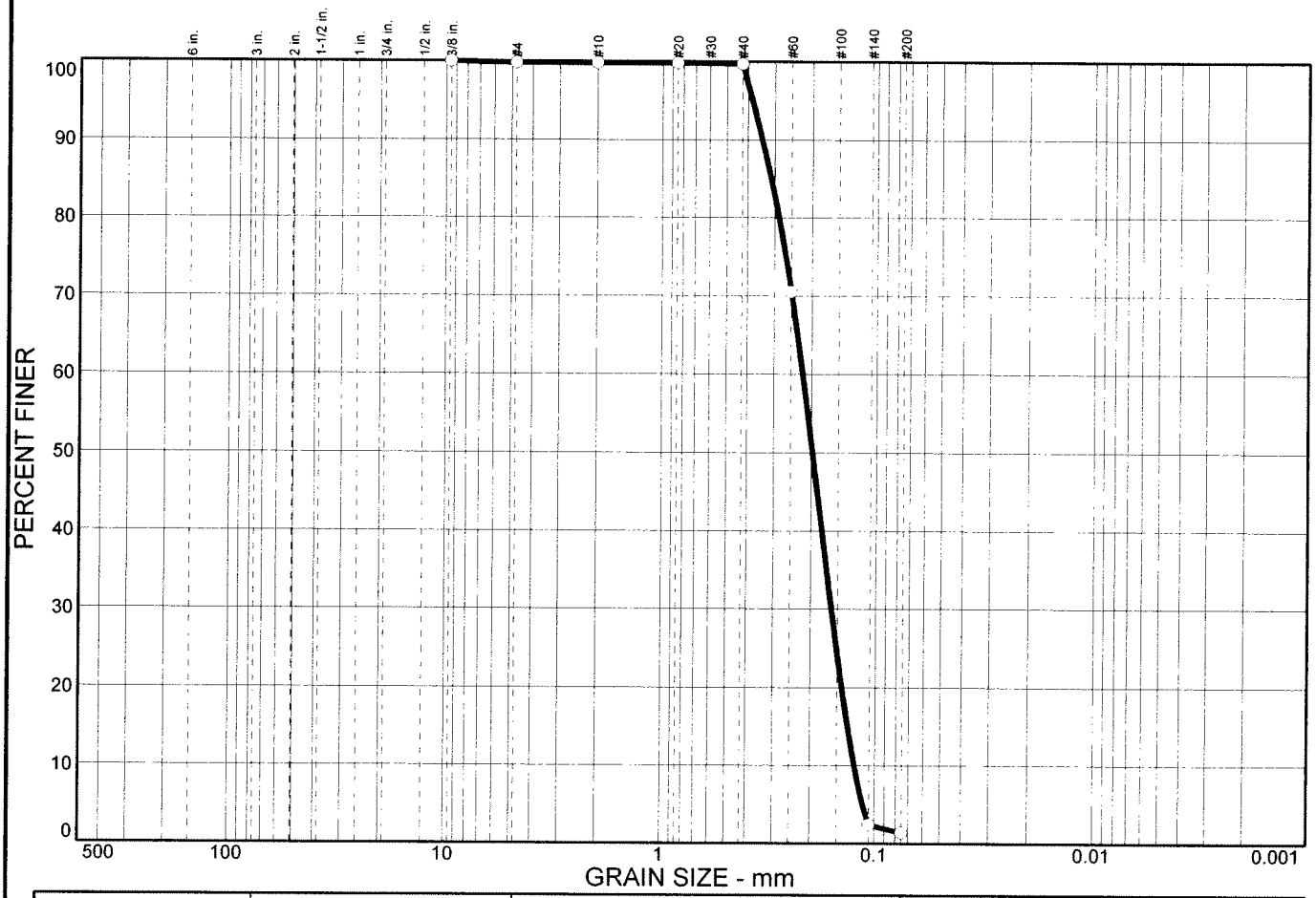
Remarks

Sample No.: 3A **Source of Sample:** BTSB-R3A **Date:**
Location: **Elev./Depth:** 2.8-3.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	98.4	1.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	99.8		
#20	99.8		
#40	99.7		
#60	70.5		
#140	2.4		
#200	1.4		

* (no specification provided)

Soil Description

Brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.312 D_{60}= 0.221 D_{50}= 0.198
D_{30}= 0.160 D_{15}= 0.134 D_{10}= 0.125
C_u= 1.77 C_c= 0.94

Classification

USCS= SP AASHTO=

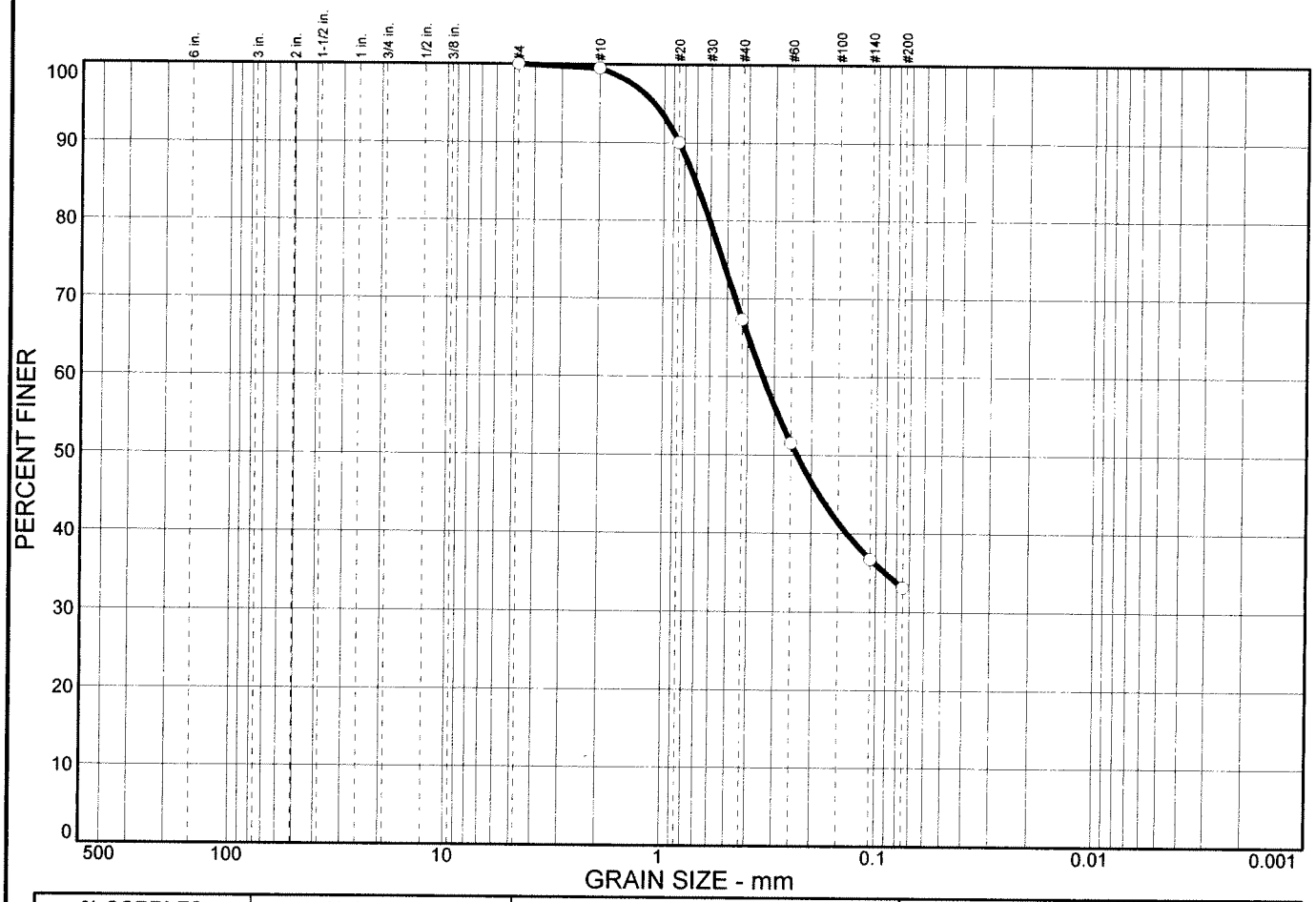
Remarks

Sample No.: 7B **Source of Sample:** BTSB-R3A **Date:**
Location: **Elev./Depth:** 9-9.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	66.9	33.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.5		
#20	90.0		
#40	67.3		
#60	51.5		
#140	36.7		
#200	33.1		

* (no specification provided)

Soil Description

Yellowish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.710 D_{60}= 0.340 D_{50}= 0.235
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

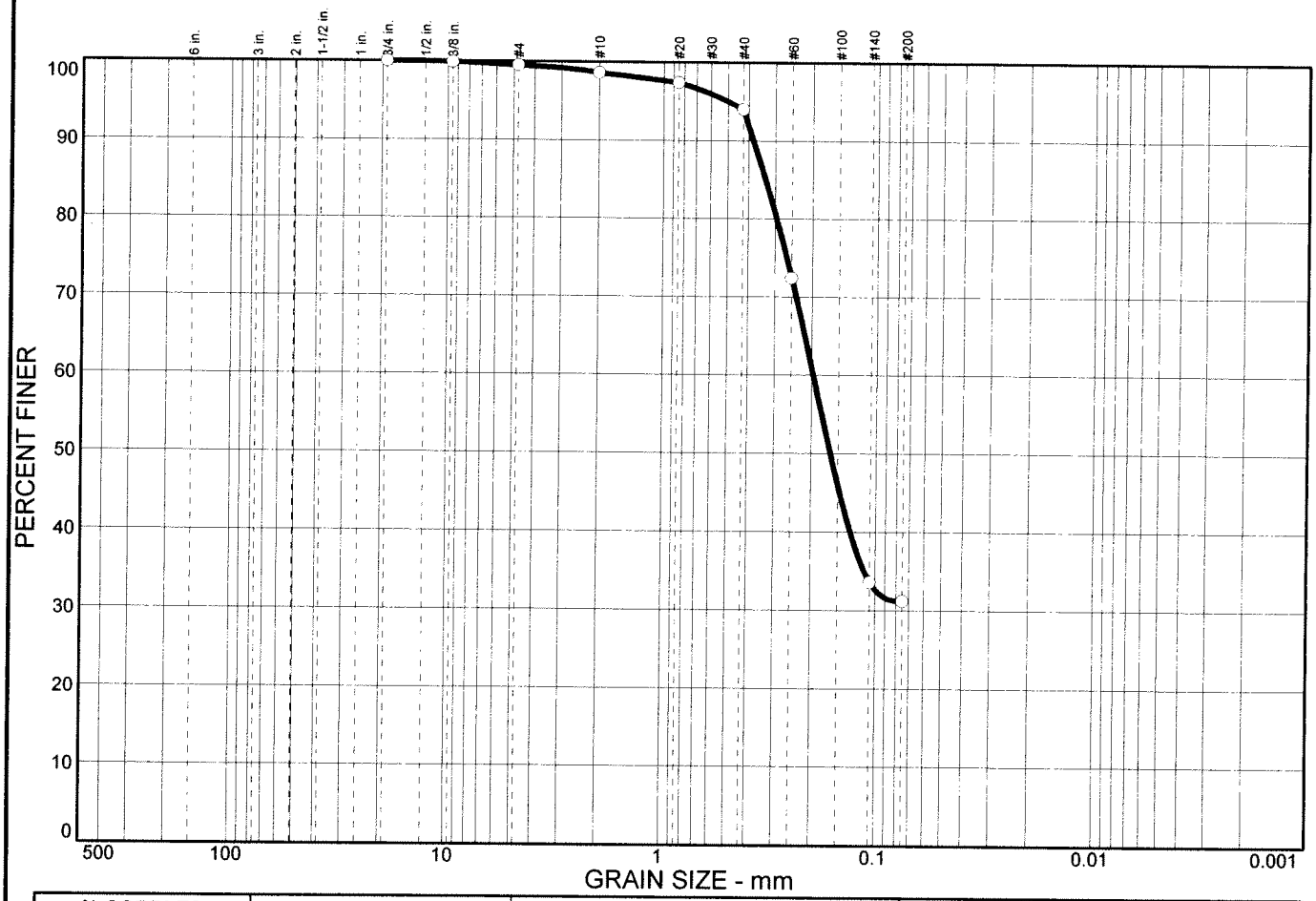
Remarks

Sample No.: 11 **Source of Sample:** BTSB-R3A **Date:**
Location: **Elev./Depth:** 17.8-18.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	68.3	31.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	99.9		
#4	99.5		
#10	98.6		
#20	97.4		
#40	94.0		
#60	72.4		
#140	33.6		
#200	31.2		

* (no specification provided)

Soil Description

Black Silty sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.334 D_{60}= 0.197 D_{50}= 0.163
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

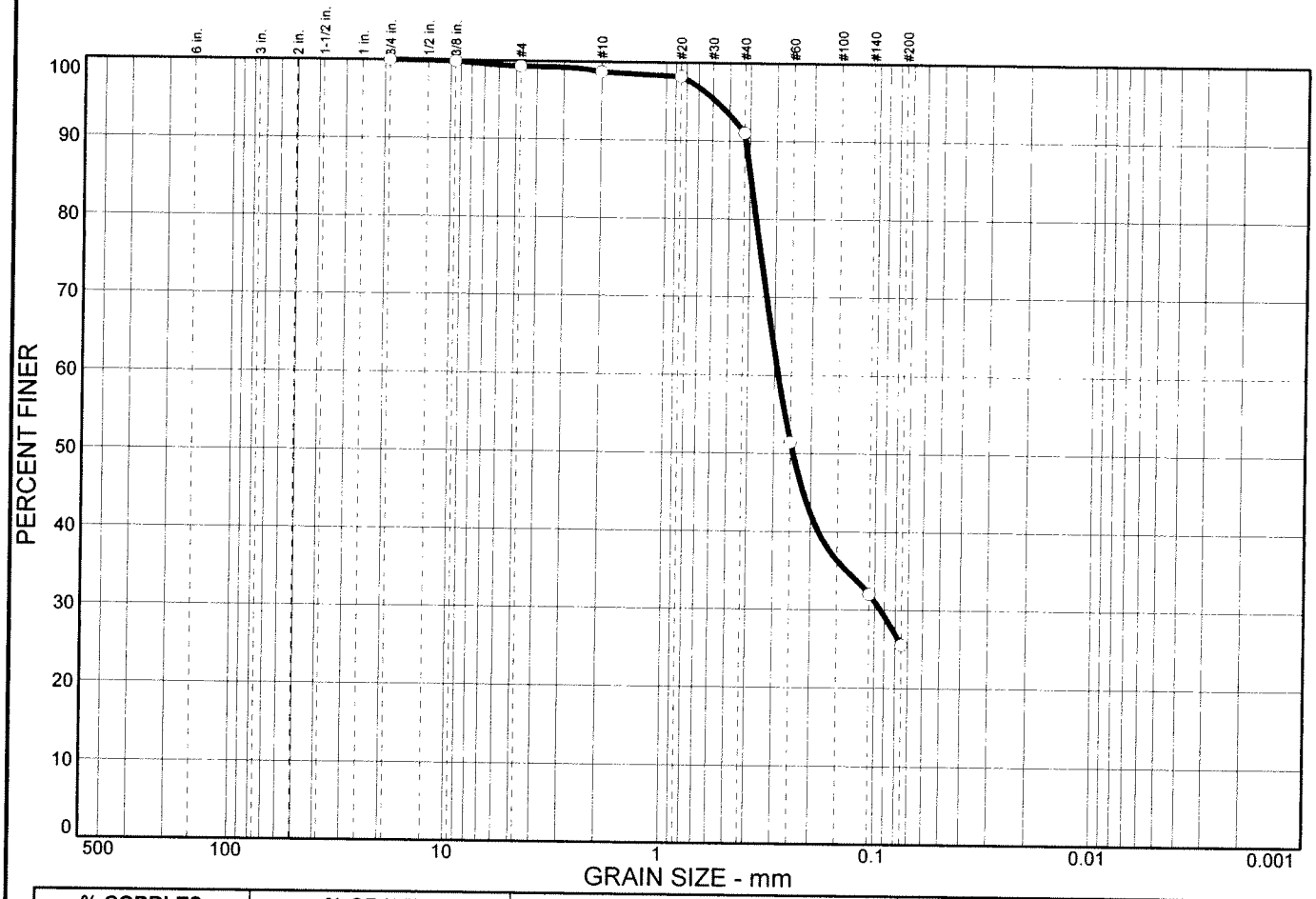
Remarks

Sample No.: 3B **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 6-6.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	73.8	25.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	99.9		
#4	99.3		
#10	98.7		
#20	98.2		
#40	91.0		
#60	51.4		
#140	32.0		
#200	25.5		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.396 D_{60}= 0.288 D_{50}= 0.243
D_{30}= 0.0940 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

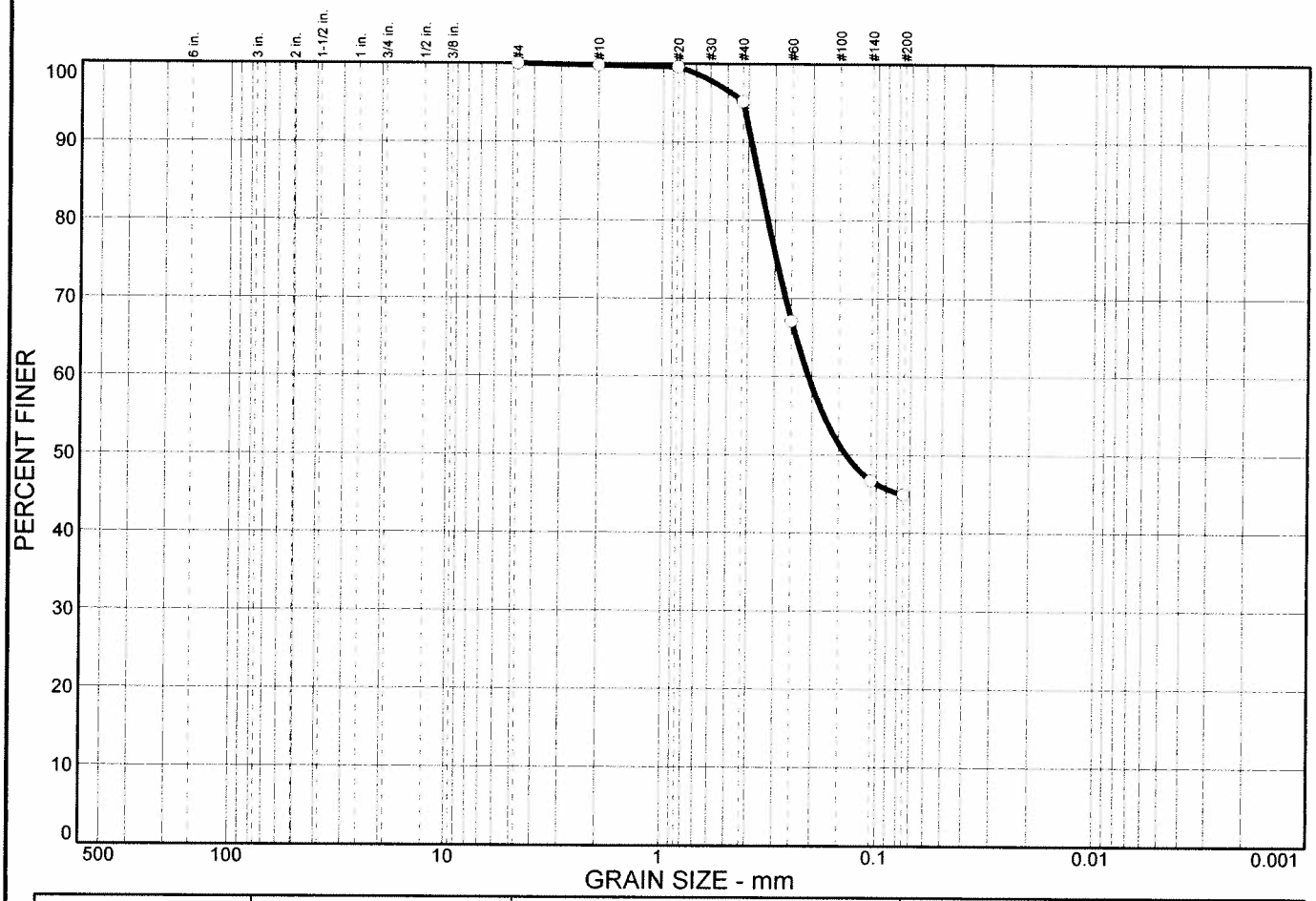
Remarks

Sample No.: 6 **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 12-13.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	55.1	44.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.6		
#40	95.2		
#60	67.1		
#140	46.7		
#200	44.9		

* (no specification provided)

Soil Description

Gray clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.355 D_{60}= 0.208 D_{50}= 0.139
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

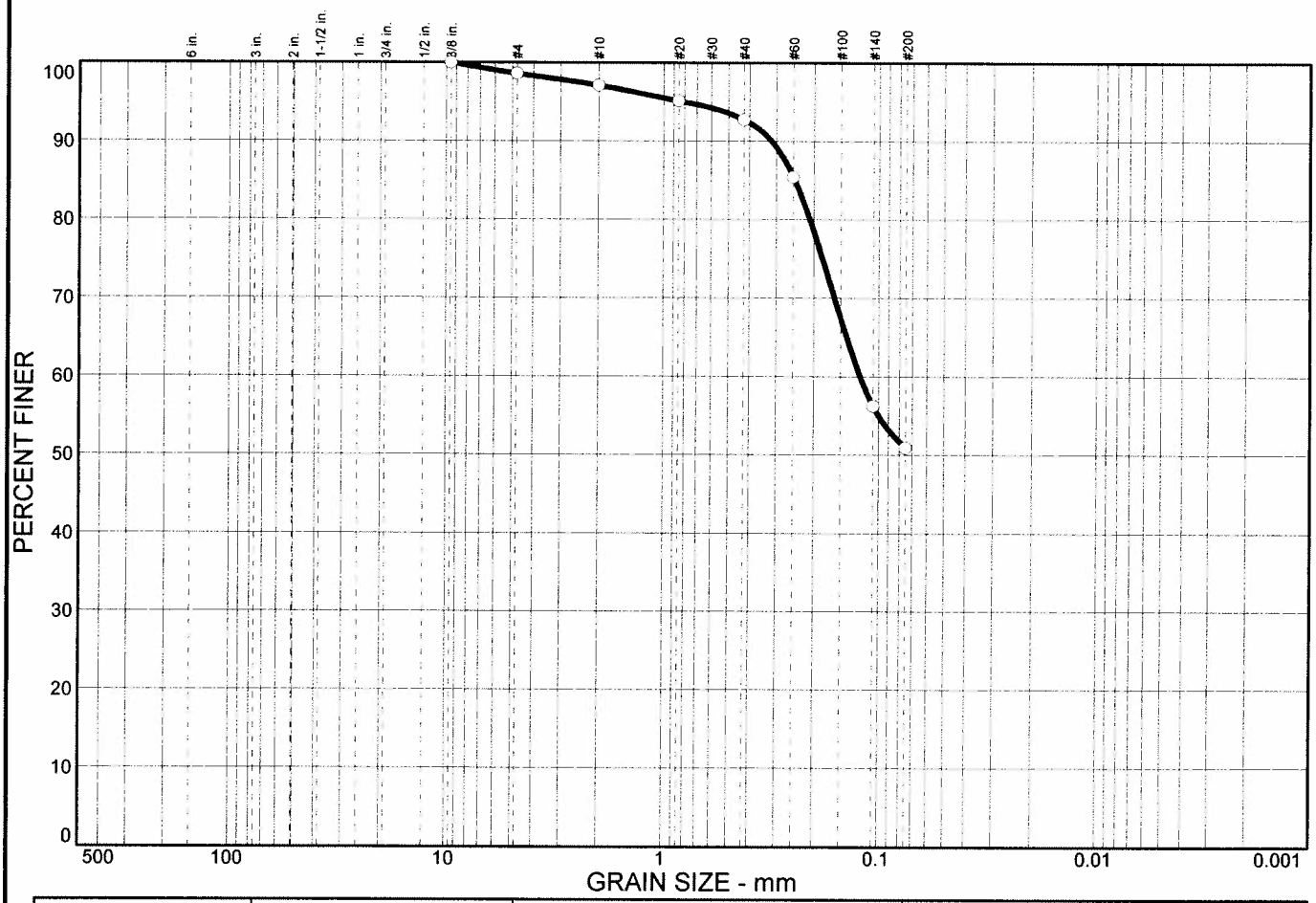
Remarks

Sample No.: 8 **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 16.5-18

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.4	47.7	50.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.6		
#10	97.1		
#20	95.1		
#40	92.7		
#60	85.4		
#140	56.2		
#200	50.9		

* (no specification provided)

Soil Description

Brown Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.246 D_{60}= 0.122 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

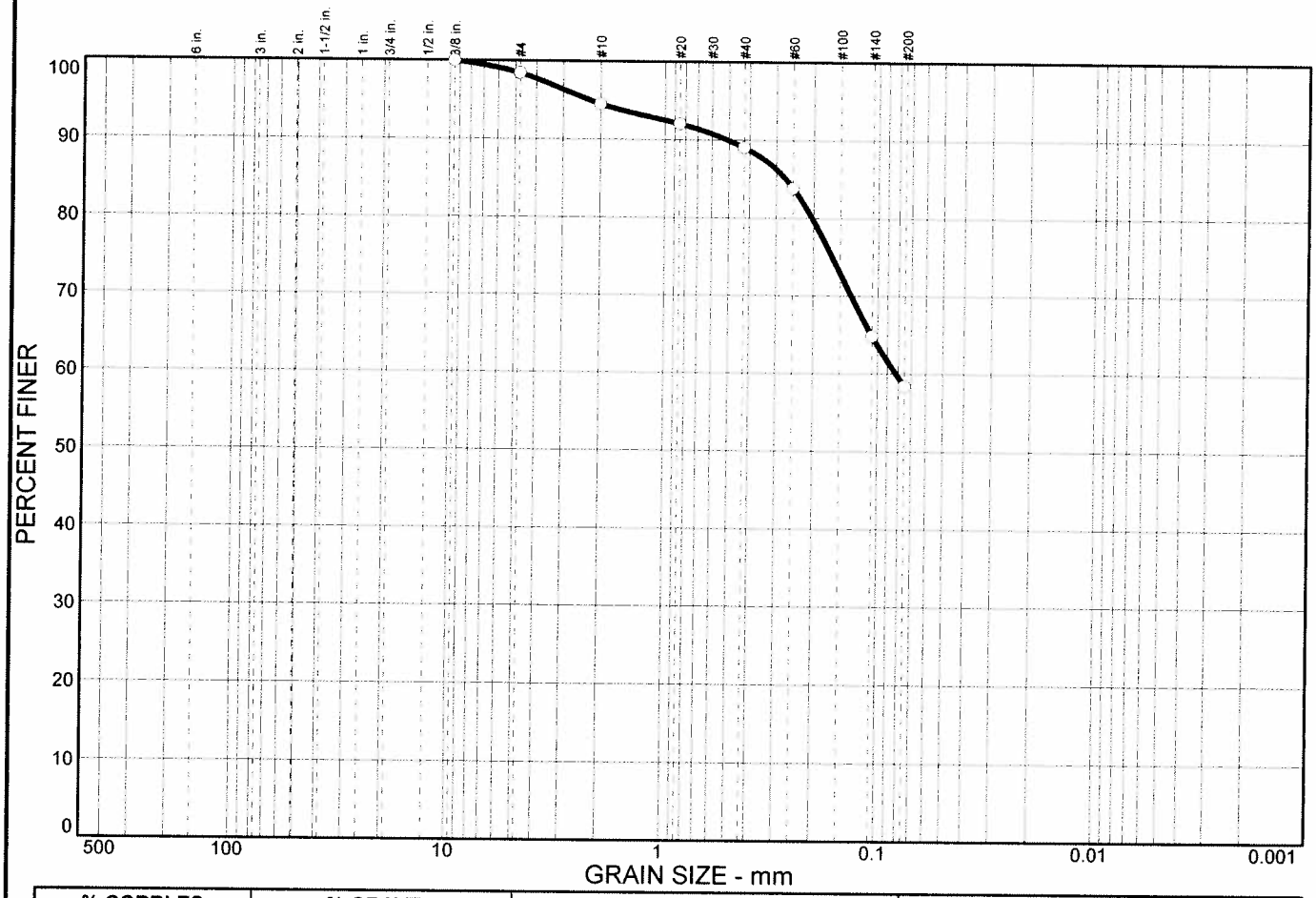
Sample No.: 11B **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 25.8-26.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	40.0	58.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.4		
#10	94.5		
#20	92.0		
#40	89.0		
#60	83.8		
#140	64.8		
#200	58.4		

* (no specification provided)

Soil Description

Olive gray Sandy clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.271 D_{60}= 0.0822 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

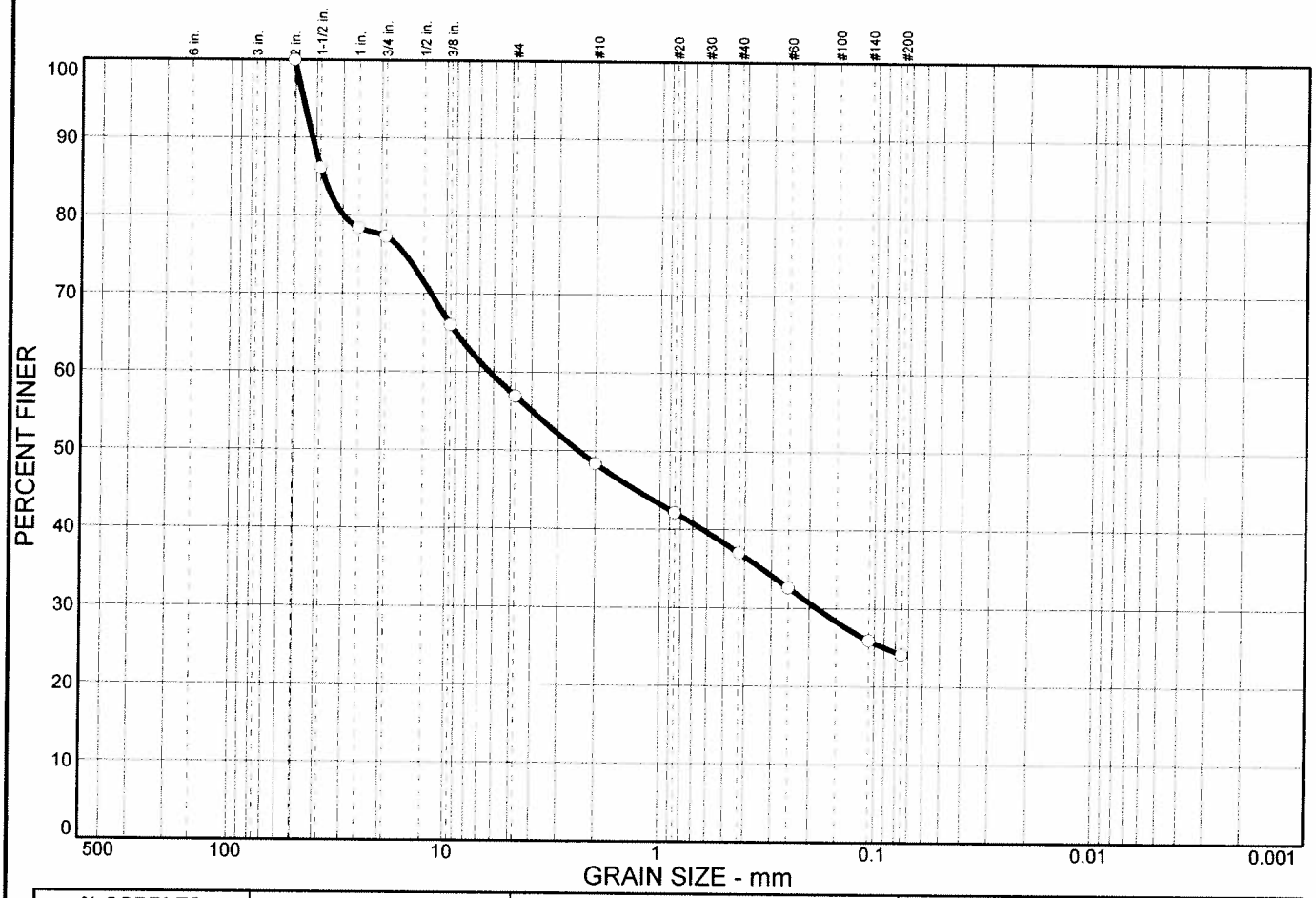
Remarks

Sample No.: 13B **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 30.5-31

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	43.1	32.8	24.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100.0		
1.5 in.	86.1		
1 in.	78.4		
.75 in.	77.3		
.375 in.	66.0		
#4	56.9		
#10	48.3		
#20	42.1		
#40	37.0		
#60	32.6		
#140	25.9		
#200	24.1		

* (no specification provided)

Soil Description

Olive gray clayey gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 36.9 D_{60}= 6.28 D_{50}= 2.42
D_{30}= 0.184 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= GC AASHTO=

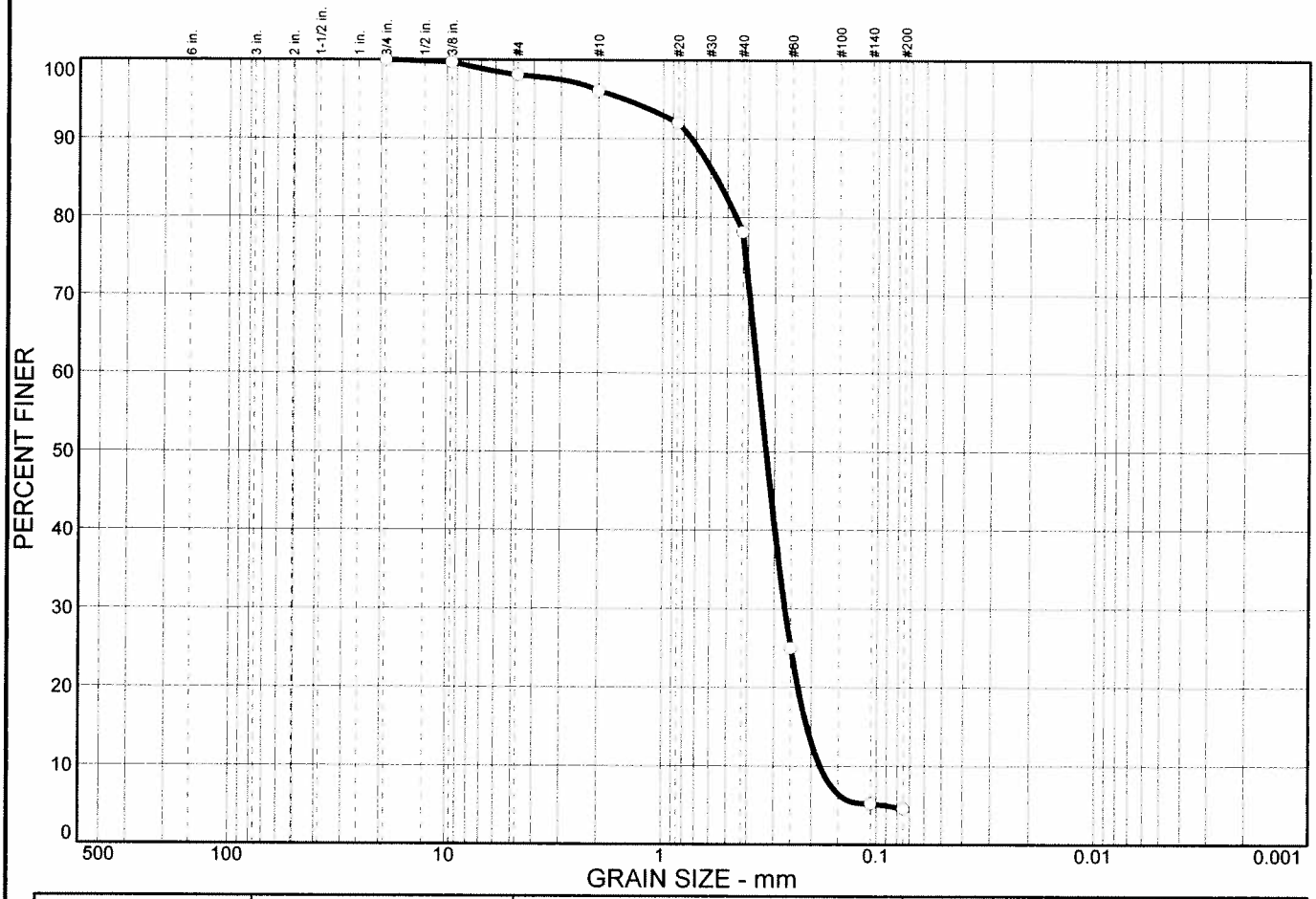
Remarks

Sample No.: 15 **Source of Sample:** M9/RW7-A1A **Date:**
Location: **Elev./Depth:** 35-35.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	93.5	4.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	99.7		
#4	98.1		
#10	96.1		
#20	92.0		
#40	78.1		
#60	25.0		
#140	5.2		
#200	4.6		

* (no specification provided)

Soil Description

Grayish brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.566 D_{60}= 0.362 D_{50}= 0.330
D_{30}= 0.267 D_{15}= 0.210 D_{10}= 0.182
C_u= 1.98 C_c= 1.08

Classification

USCS= SP AASHTO=

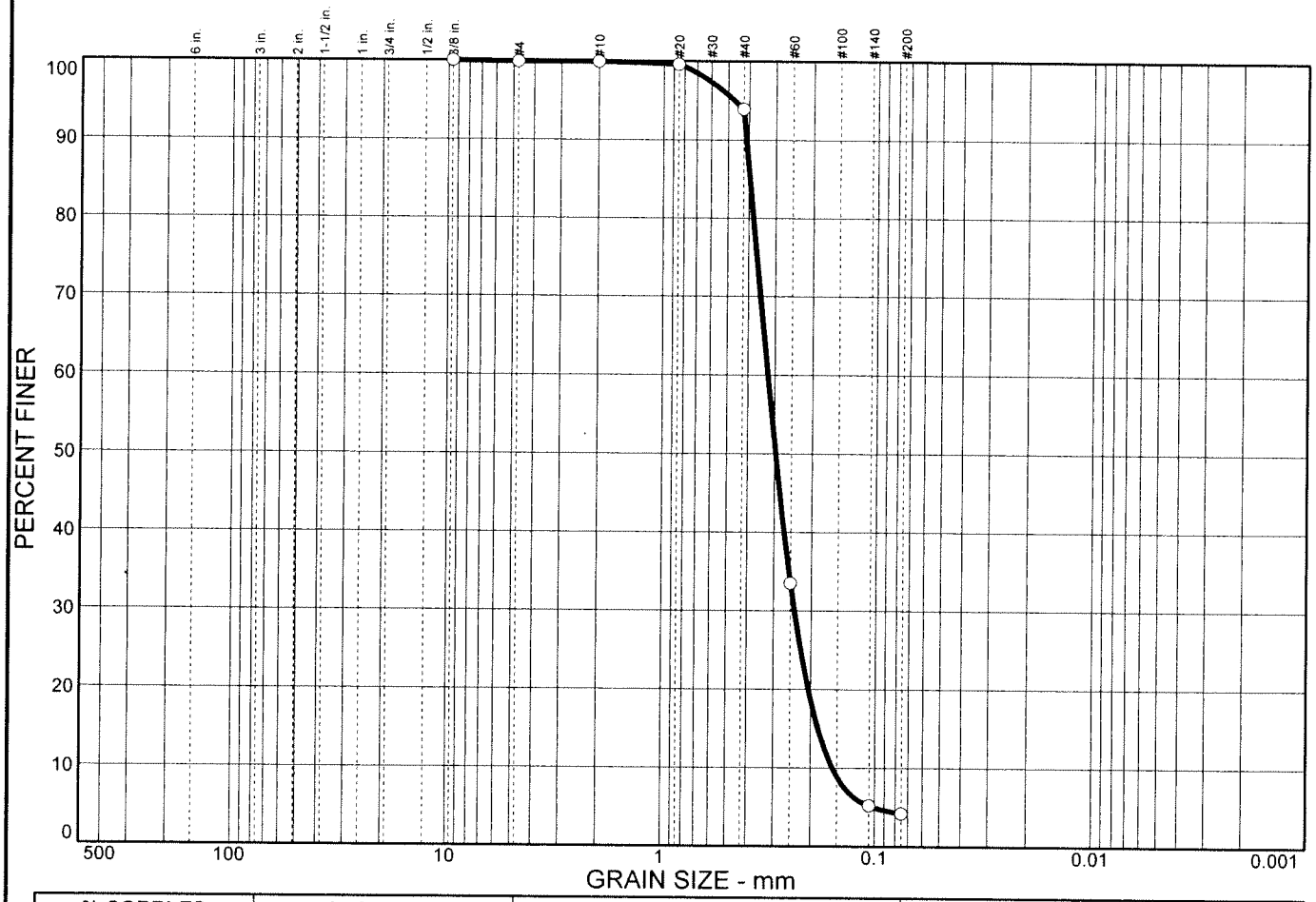
Remarks

Sample No.: 2 **Source of Sample:** M-10 **Date:**
Location: **Elev./Depth:** 4-5.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	95.7	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.9		
#20	99.6		
#40	93.9		
#60	33.5		
#140	5.2		
#200	4.2		

* (no specification provided)

Soil Description

Grayish brown Poorly graded sand with organics

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.396 D_{60}= 0.324 D_{50}= 0.296
D_{30}= 0.239 D_{15}= 0.184 D_{10}= 0.158
C_u= 2.05 C_c= 1.12

Classification

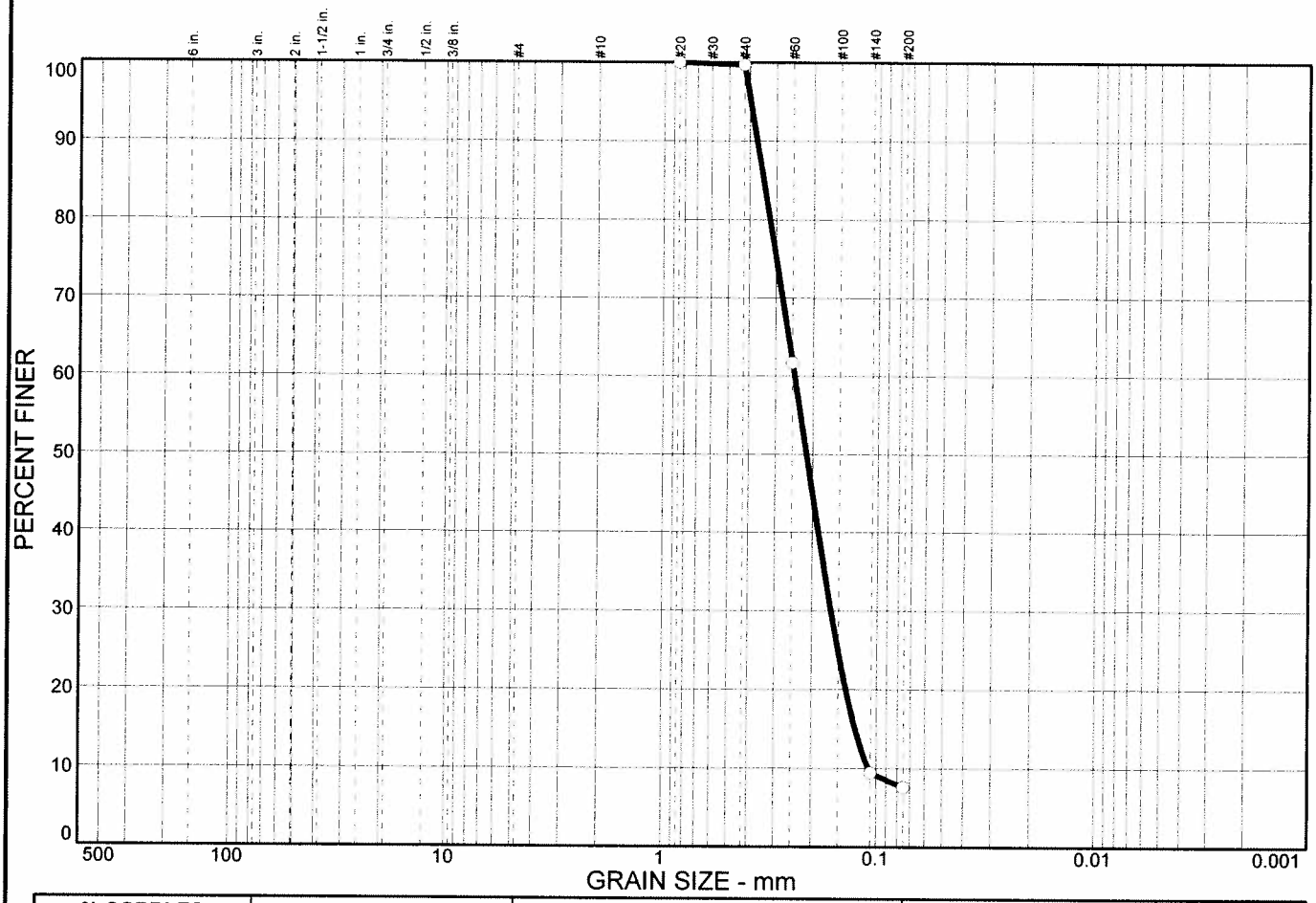
USCS= SP AASHTO=

Remarks

Sample No.: 5B **Source of Sample:** M-10 **Date:**
Location: **Elev./Depth:** 10.5-11

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	92.4	7.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	99.7		
#60	61.7		
#140	9.4		
#200	7.6		

* (no specification provided)

Soil Description

Light brown Poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.344 D_{60}= 0.244 D_{50}= 0.215
D_{30}= 0.163 D_{15}= 0.125 D_{10}= 0.109
C_u= 2.25 C_c= 1.00

Classification

USCS= SP-SM AASHTO=

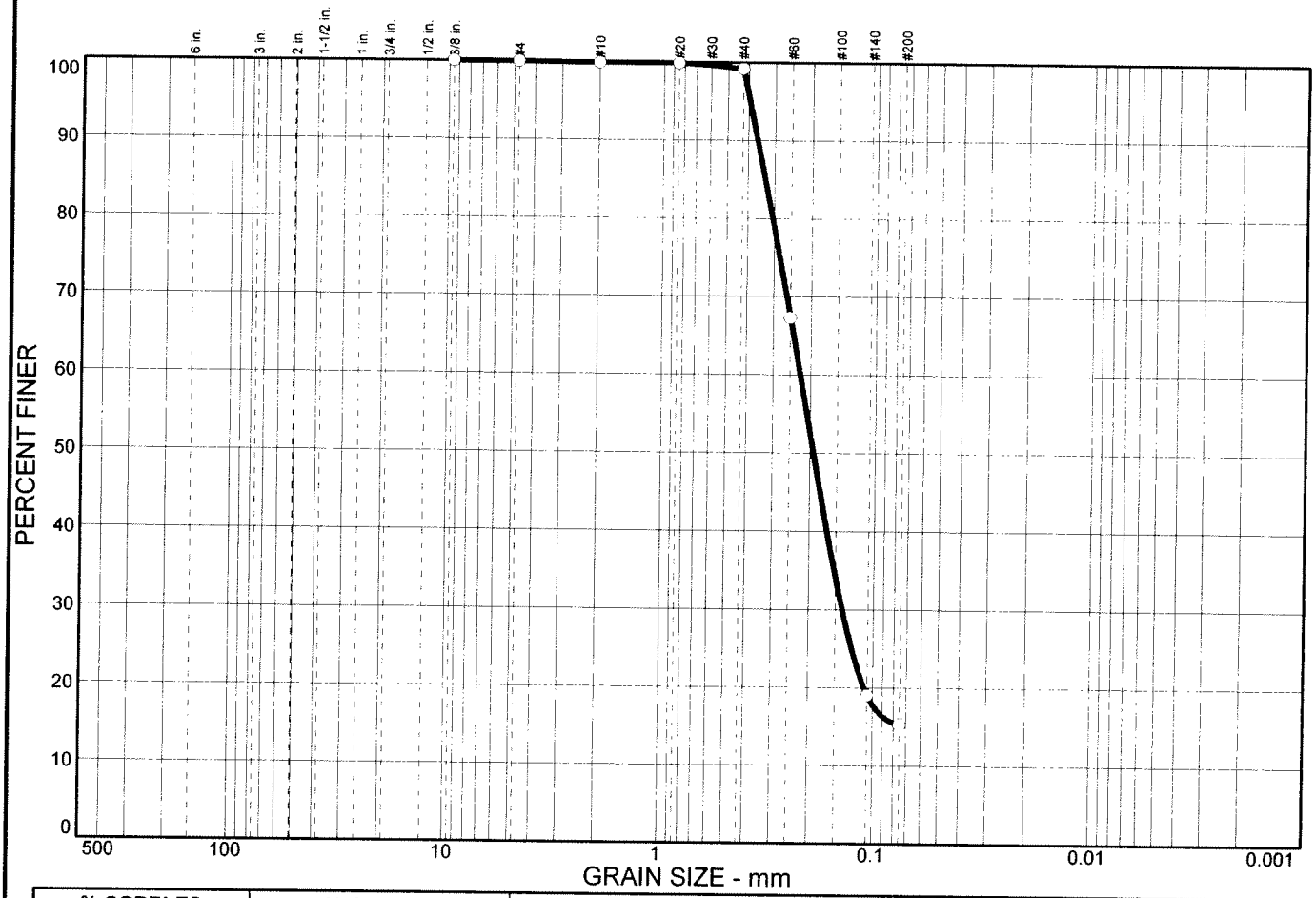
Remarks

Sample No.: 11A **Source of Sample:** M-10 **Date:**
Location: **Elev./Depth:** 24.3-24.8

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	84.7	15.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.2		
#60	67.3		
#140	19.0		
#200	15.3		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.333 D_{60}= 0.224 D_{50}= 0.193
D_{30}= 0.140 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

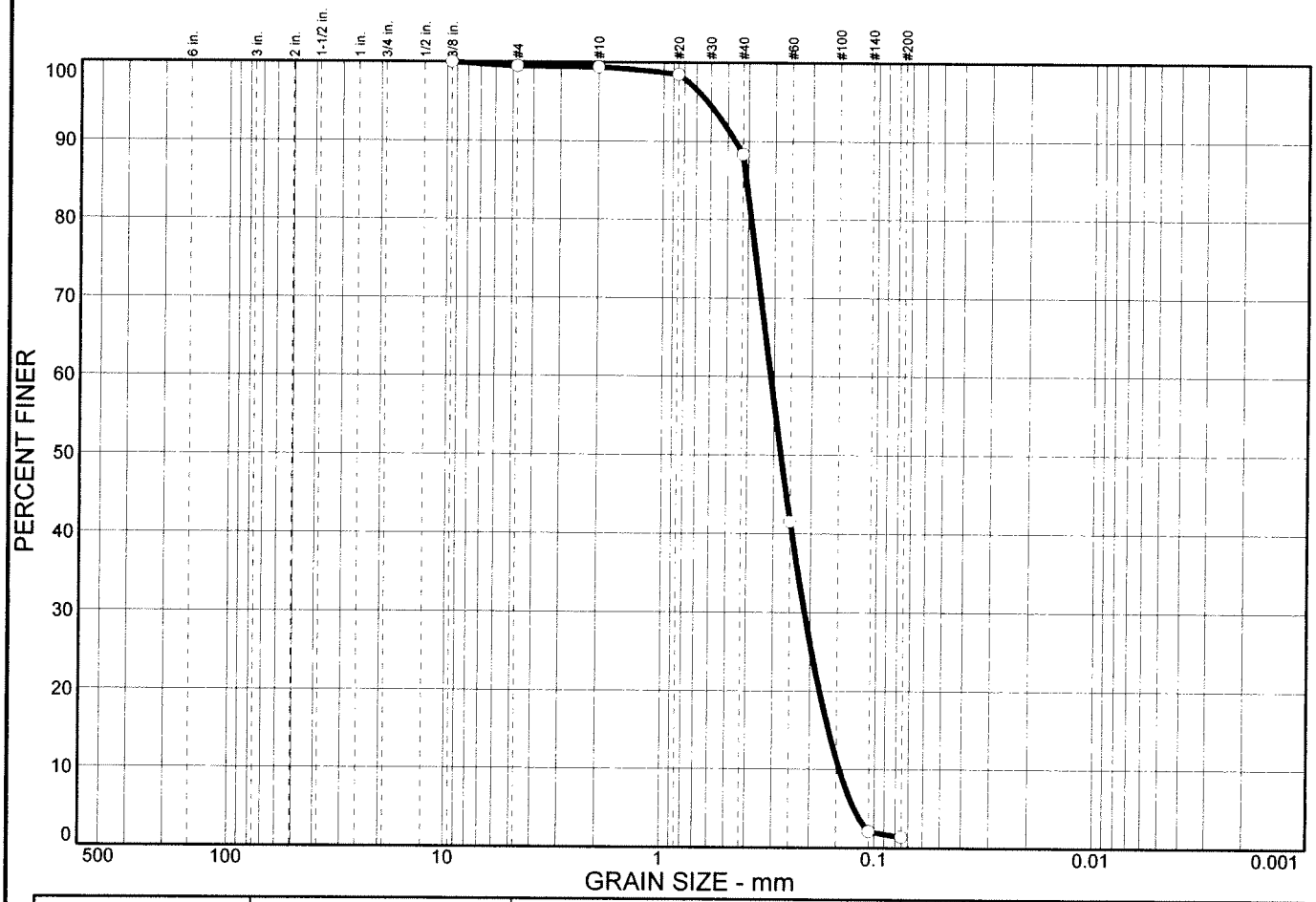
Remarks

Sample No.: 18 **Source of Sample:** M-10 **Date:**
Location: **Elev./Depth:** 40.5-42

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	98.1	1.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.5		
#10	99.4		
#20	98.5		
#40	88.3		
#60	41.5		
#140	2.1		
#200	1.4		

* (no specification provided)

Soil Description

Dark greenish gray Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.410 D_{60}= 0.312 D_{50}= 0.278
D_{30}= 0.213 D_{15}= 0.164 D_{10}= 0.145
C_u= 2.14 C_c= 1.00

Classification

USCS= SP AASHTO=

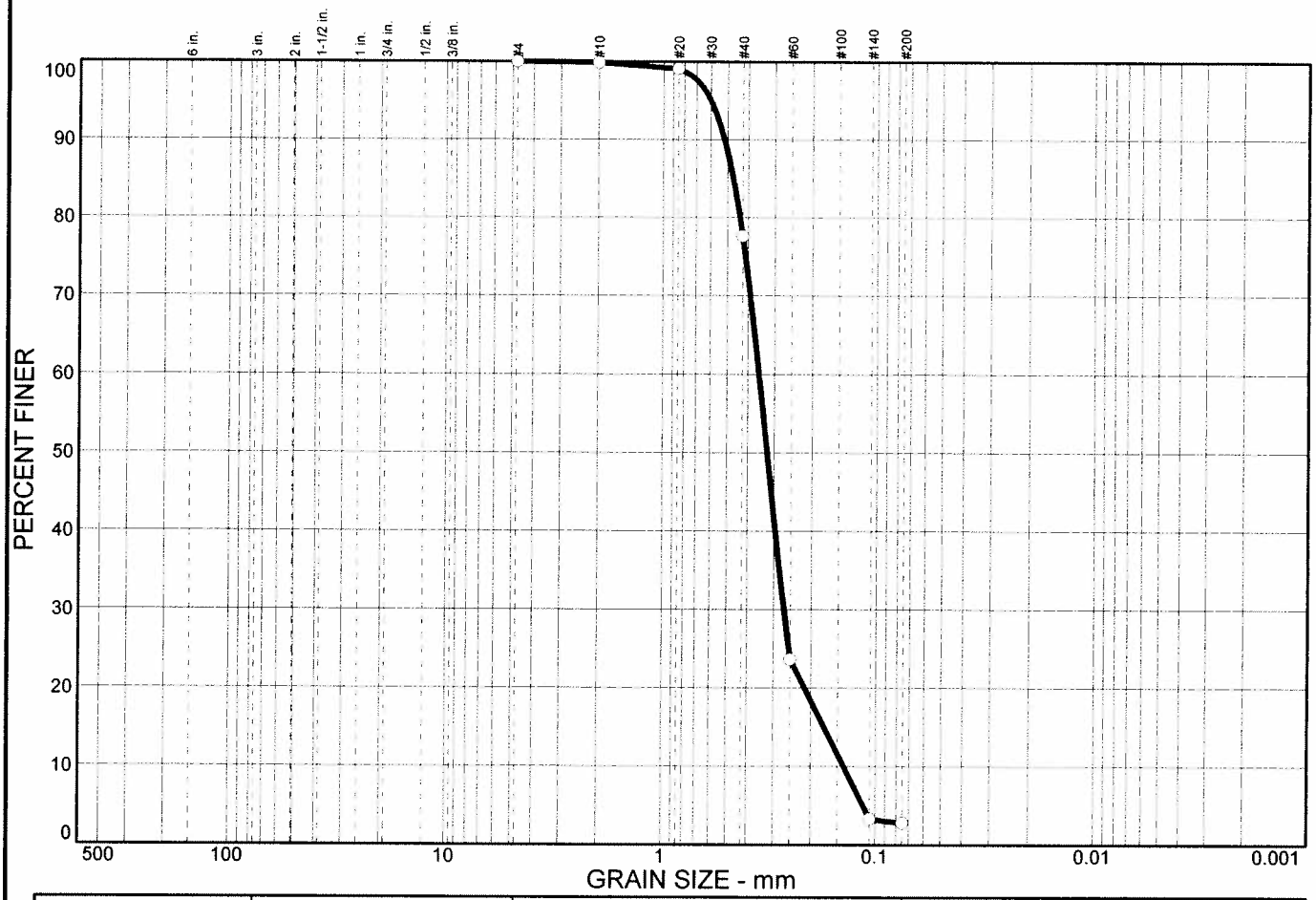
Remarks

Sample No.: 5B **Source of Sample:** M-11 **Date:**
Location: **Elev./Depth:** 15.8-16.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	97.2	2.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.1		
#40	77.6		
#60	23.6		
#140	3.3		
#200	2.8		

* (no specification provided)

Soil Description

Gray Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.472 D_{60}= 0.355 D_{50}= 0.324
D_{30}= 0.268 D_{15}= 0.174 D_{10}= 0.141
C_u= 2.52 C_c= 1.44

Classification

USCS= SP AASHTO=

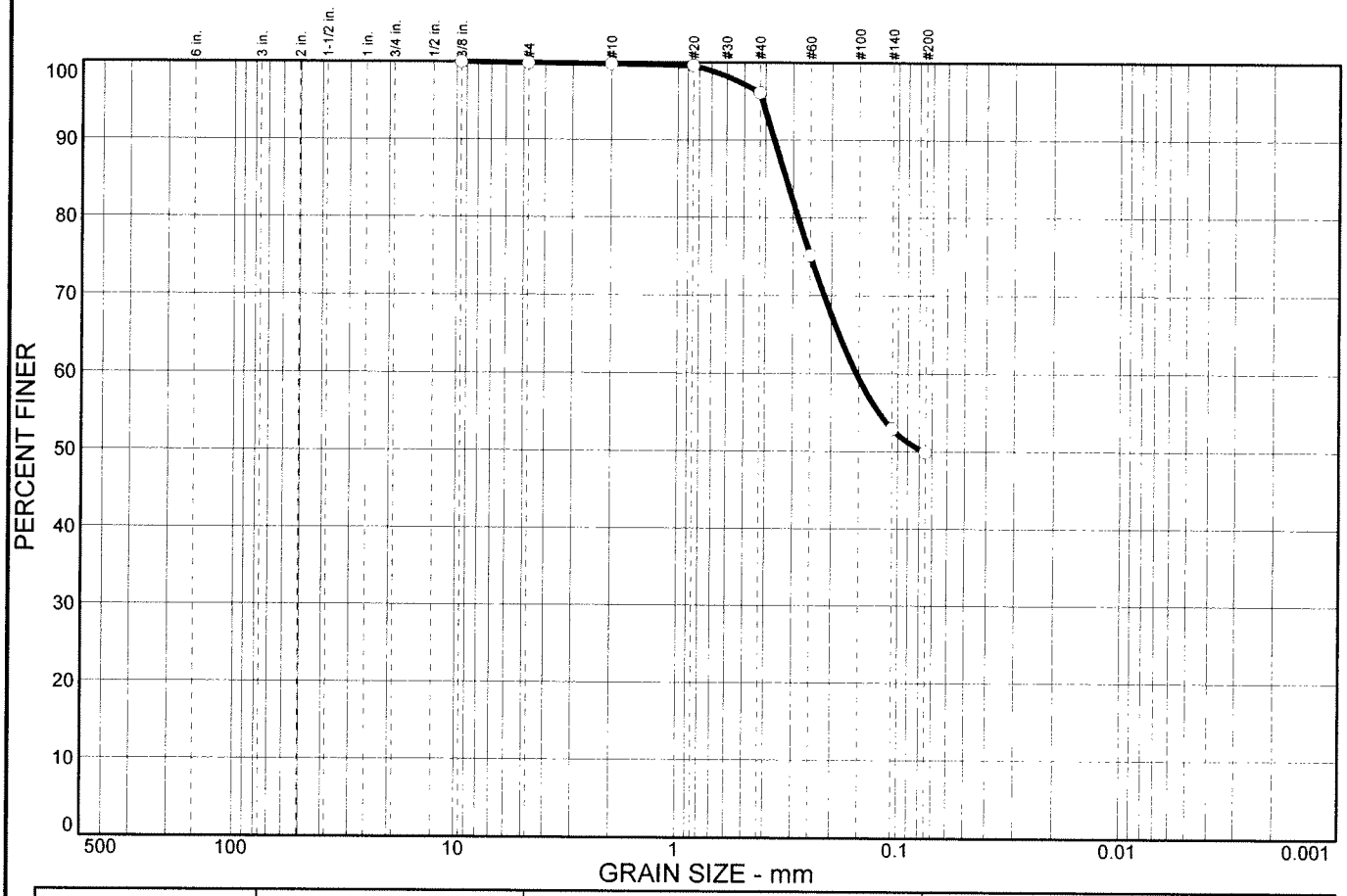
Remarks

Sample No.: 7B **Source of Sample:** M-11 **Date:**
Location: **Elev./Depth:** 20.9-31.4

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.1	3.7	46.2	49.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.8		
#20	99.6		
#40	96.1		
#60	75.1		
#140	52.9		
#200	49.9		

* (no specification provided)

Soil Description

Yellowish brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.323 D_{60}= 0.154 D_{50}= 0.0761
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

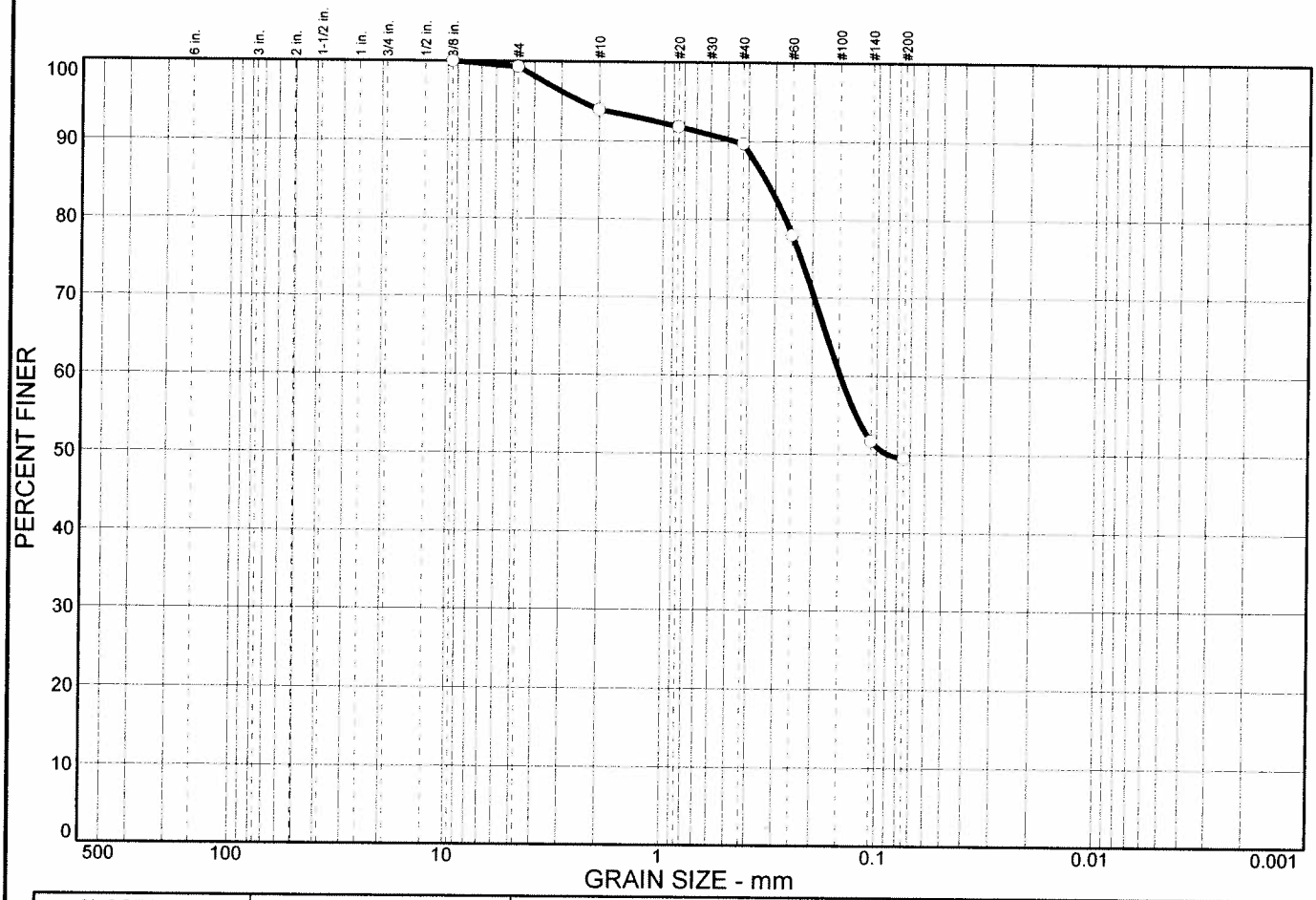
Remarks

Sample No.: 1A **Source of Sample:** RW5-R1 **Date:**
Location: **Elev./Depth:** 3-3.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	49.8	49.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.3		
#10	93.9		
#20	91.8		
#40	89.7		
#60	78.0		
#140	51.7		
#200	49.5		

* (no specification provided)

Soil Description

Brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.332 D_{60}= 0.148 D_{50}= 0.0885
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

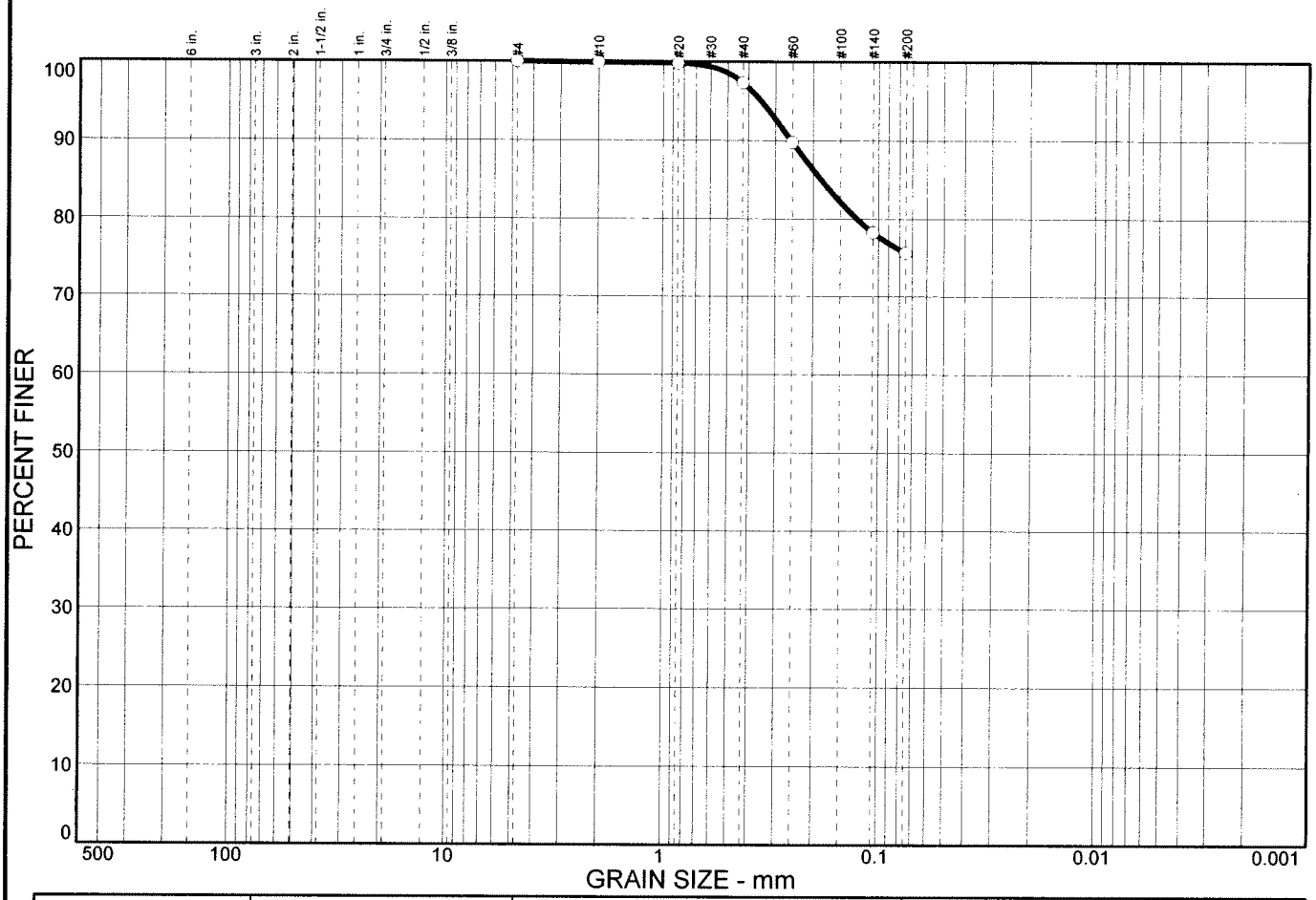
Sample No.: 1A **Source of Sample:** RW6-R1 **Date:**
Location: **Elev./Depth:** 2.8-3.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	24.4	75.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	97.3		
#60	89.7		
#140	78.2		
#200	75.6		

* (no specification provided)

Soil Description

Yellowish brown Lean clay with sand

Atterberg Limits

PL= 15 LL= 28 PI= 13

Coefficients

D_{85}= 0.185 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

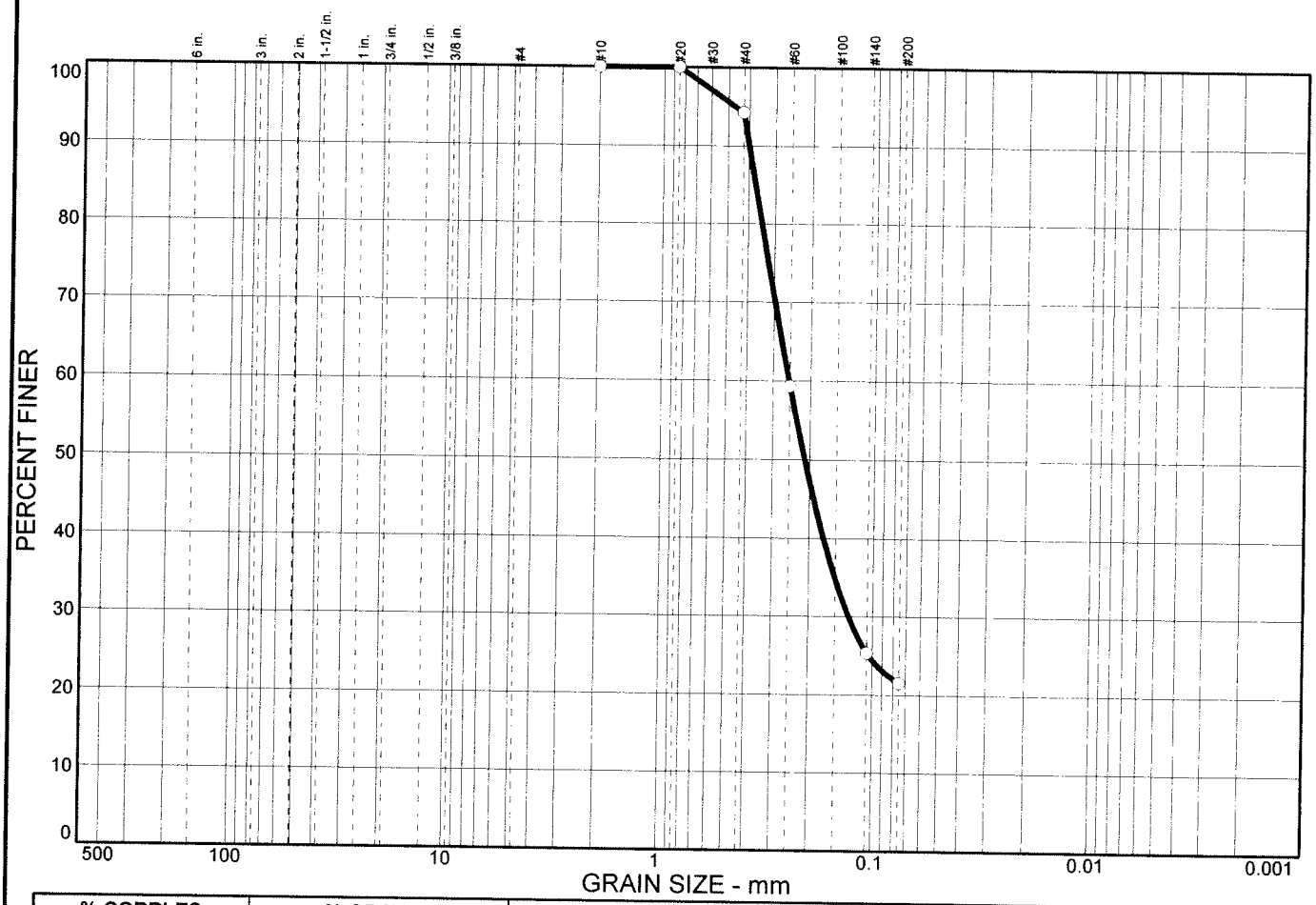
Sample No.: 3B **Source of Sample:** RW6-R1 **Date:**
Location: **Elev./Depth:** 7.6-8.1

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project

Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	78.5	21.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	94.2		
#60	59.3		
#140	25.3		
#200	21.5		

* (no specification provided)

Soil Description

Reddish brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.372 D_{60}= 0.253 D_{50}= 0.211
D_{30}= 0.130 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

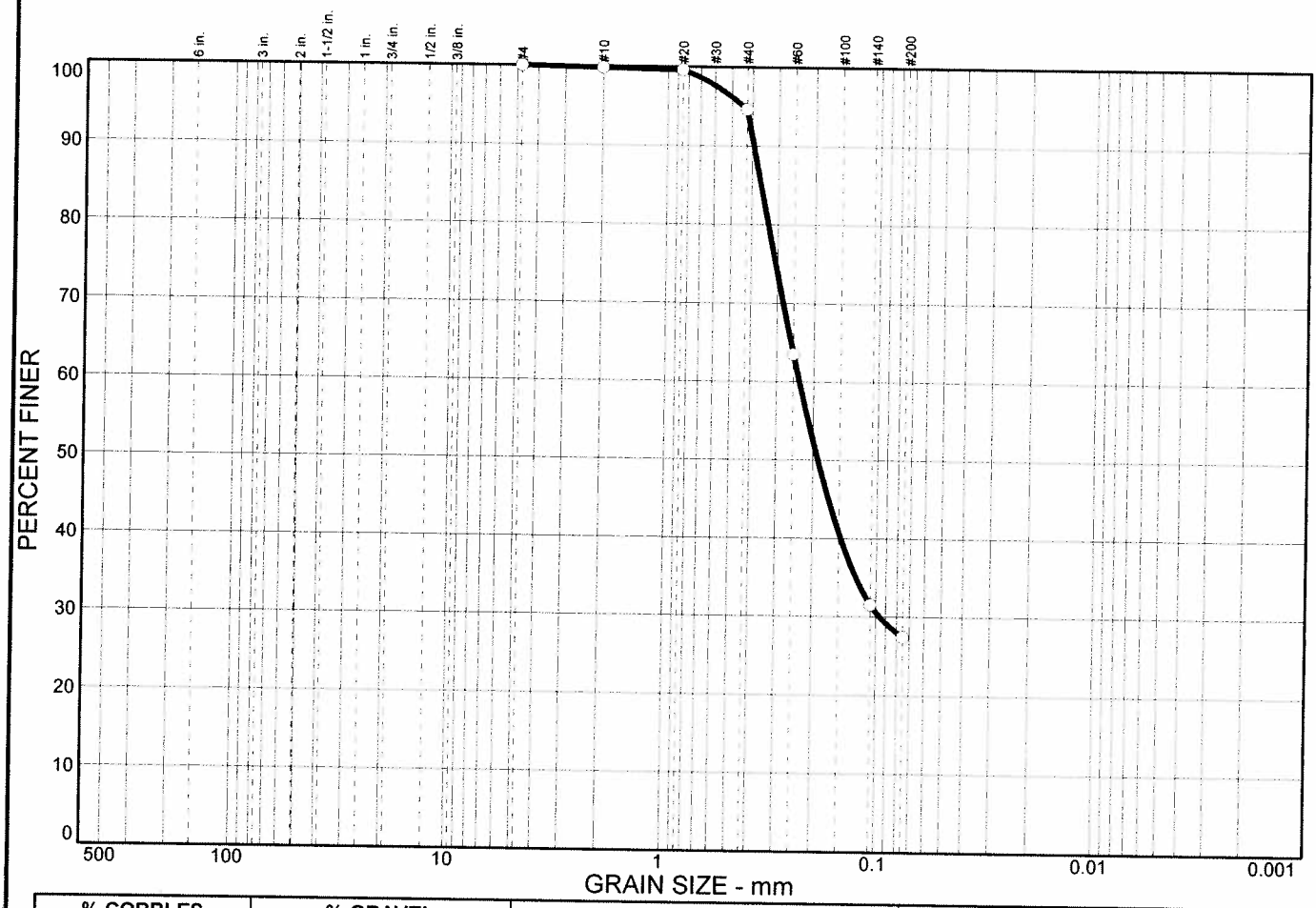
Remarks

Sample No.: 5B **Source of Sample:** RW6-R1 **Date:**
Location: **Elev./Depth:** 12.6-13.1

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	72.6	27.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.6		
#40	94.6		
#60	63.5		
#140	31.5		
#200	27.4		

* (no specification provided)

Soil Description

Dark yellowish brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.362 D_{60}= 0.234 D_{50}= 0.190
D_{30}= 0.0963 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

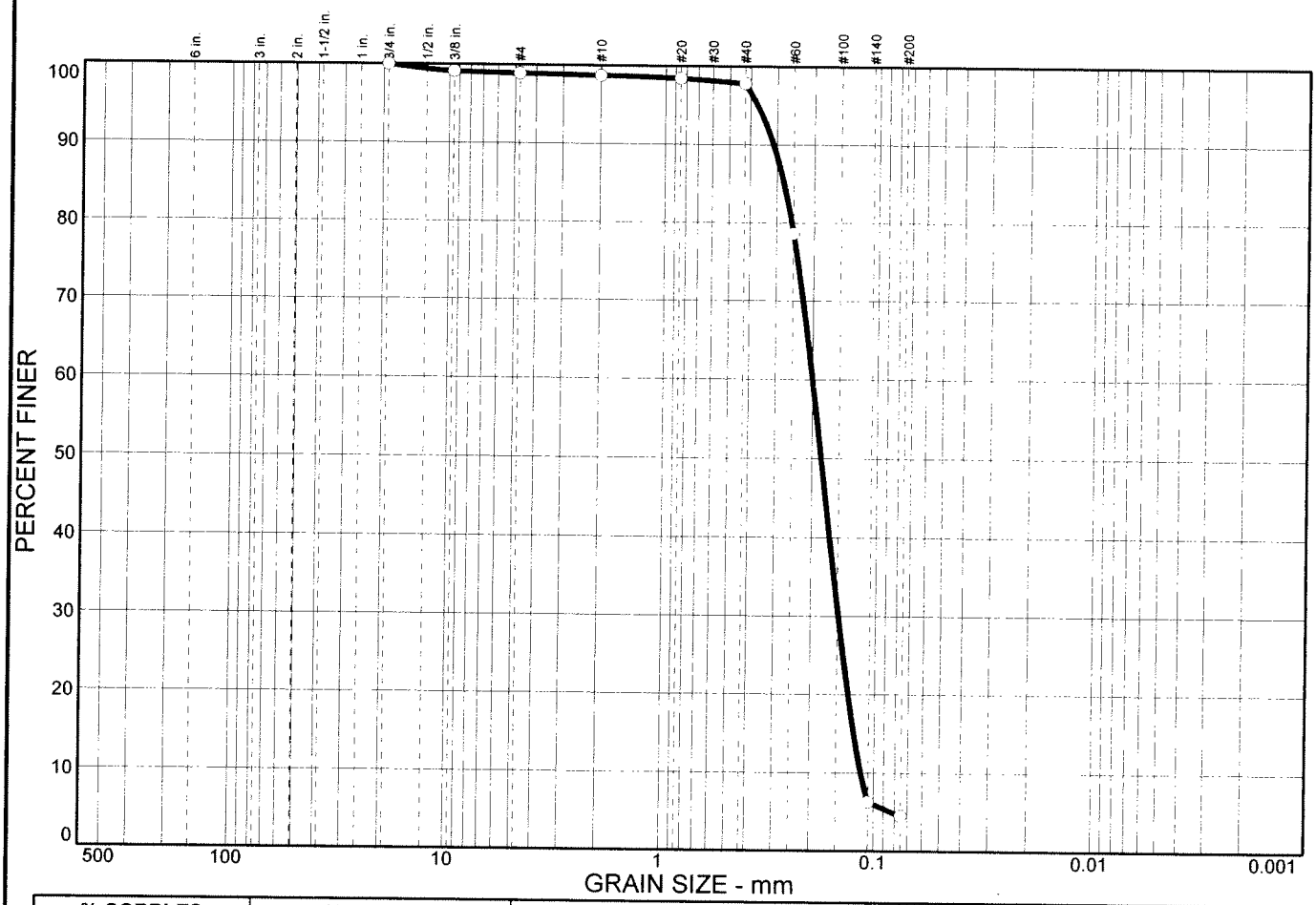
Remarks

Sample No.: 7A **Source of Sample:** RW6-R1 **Date:**
Location: **Elev./Depth:** 17-17.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.1	94.4	4.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.375 in.	99.1		
#4	98.9		
#10	98.7		
#20	98.4		
#40	97.8		
#60	78.6		
#140	6.3		
#200	4.5		

* (no specification provided)

Soil Description

Dark brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.278 D_{60}= 0.201 D_{50}= 0.182
D_{30}= 0.149 D_{15}= 0.124 D_{10}= 0.115
C_u= 1.75 C_c= 0.96

Classification

USCS= SP AASHTO=

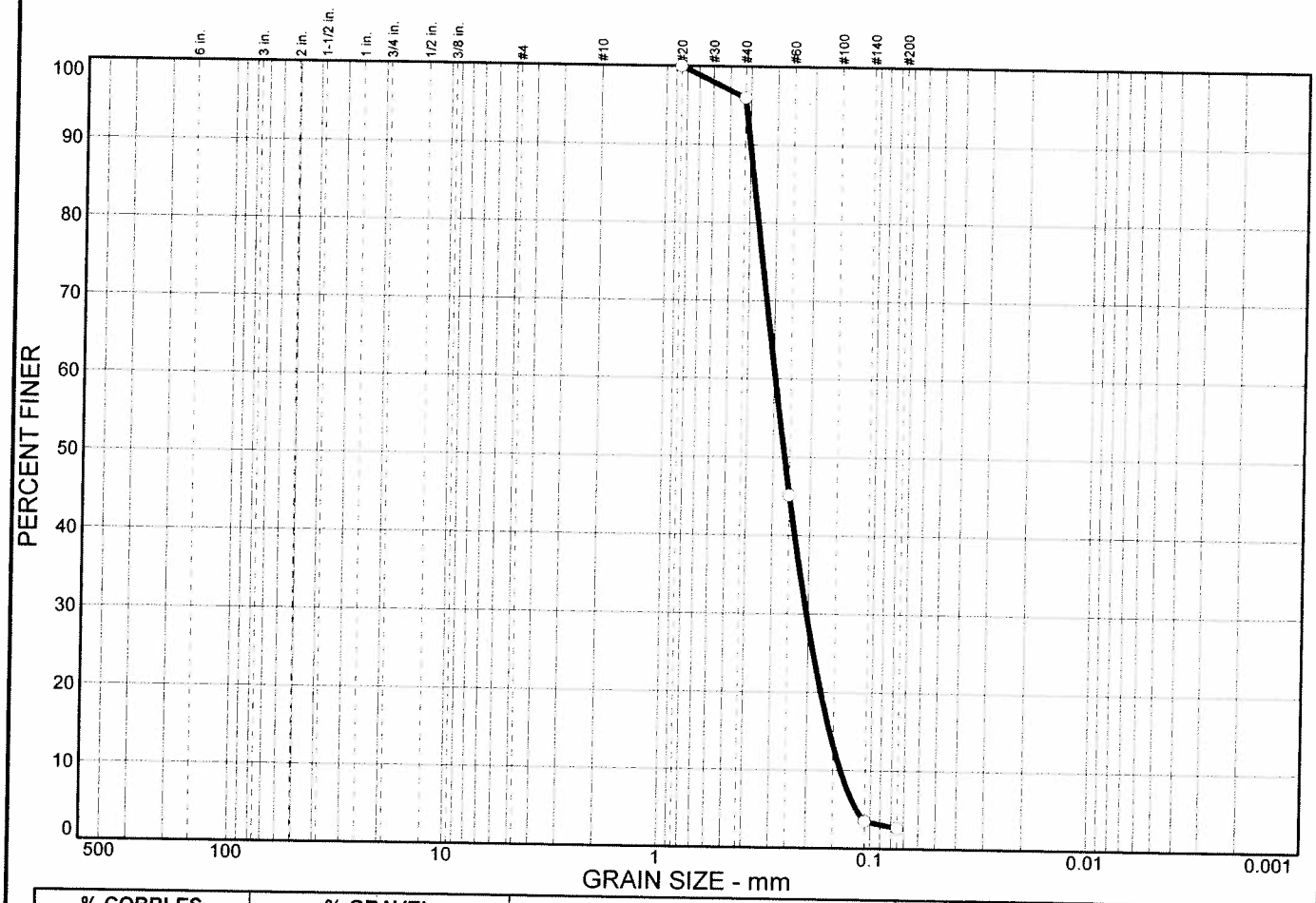
Remarks

Sample No.: 1B **Source of Sample:** RW6-R2A **Date:**
Location: **Elev./Depth:** 3.5-4

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	97.3	2.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#20	100.0		
#40	96.0		
#60	45.1		
#140	3.5		
#200	2.7		

* (no specification provided)

Soil Description

Brown Poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.382 D_{60}= 0.296 D_{50}= 0.265
D_{30}= 0.204 D_{15}= 0.157 D_{10}= 0.139
C_u= 2.13 C_c= 1.02

Classification

USCS= SP AASHTO=

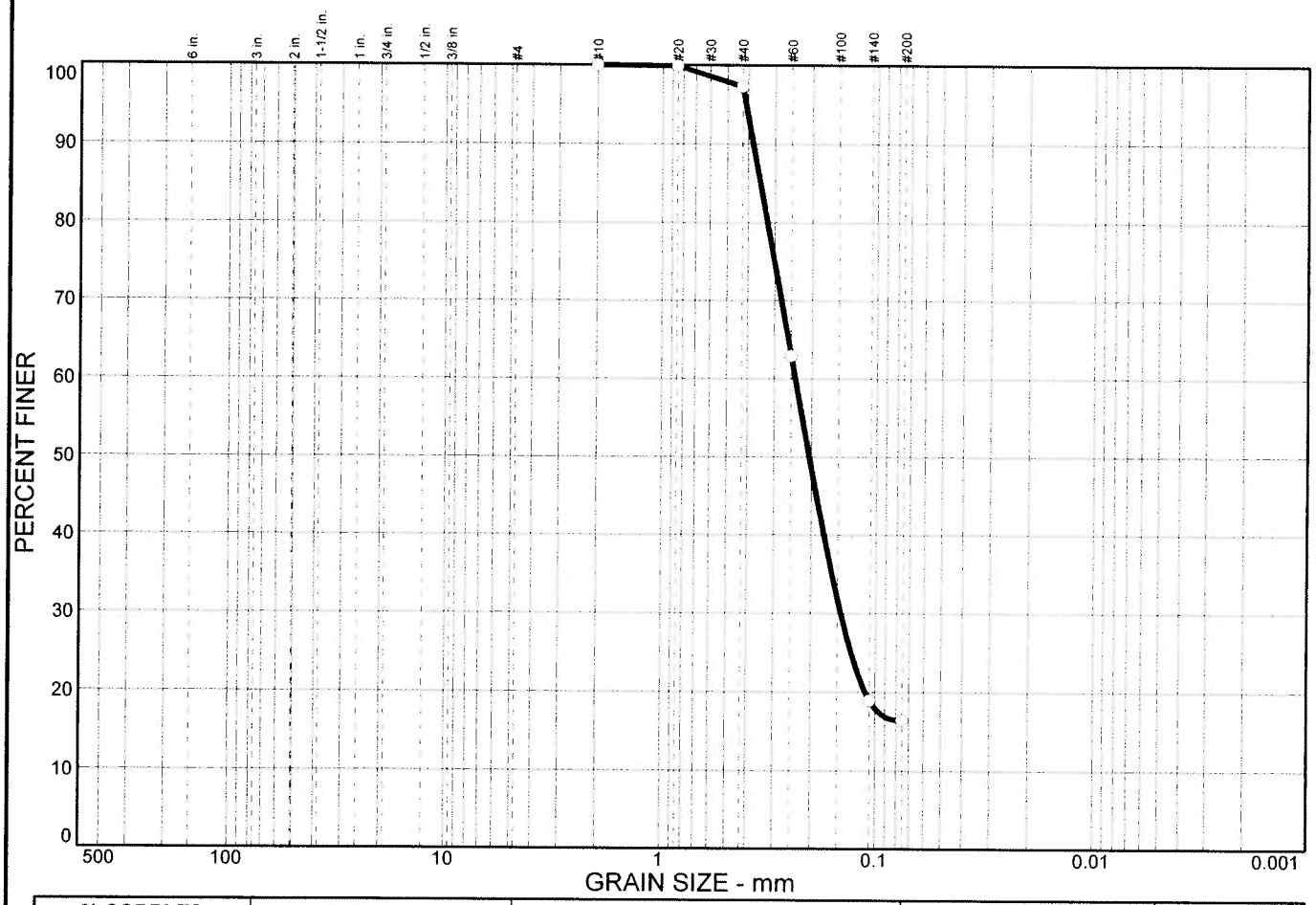
Remarks

Sample No.: 3 **Source of Sample:** RW6-R2A **Date:**
Location: **Elev./Depth:** 7.8-8.3

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	83.6	16.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	97.3		
#60	62.9		
#140	18.9		
#200	16.4		

* (no specification provided)

Soil Description

Reddish brown Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.351 D_{60}= 0.239 D_{50}= 0.205
D_{30}= 0.145 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

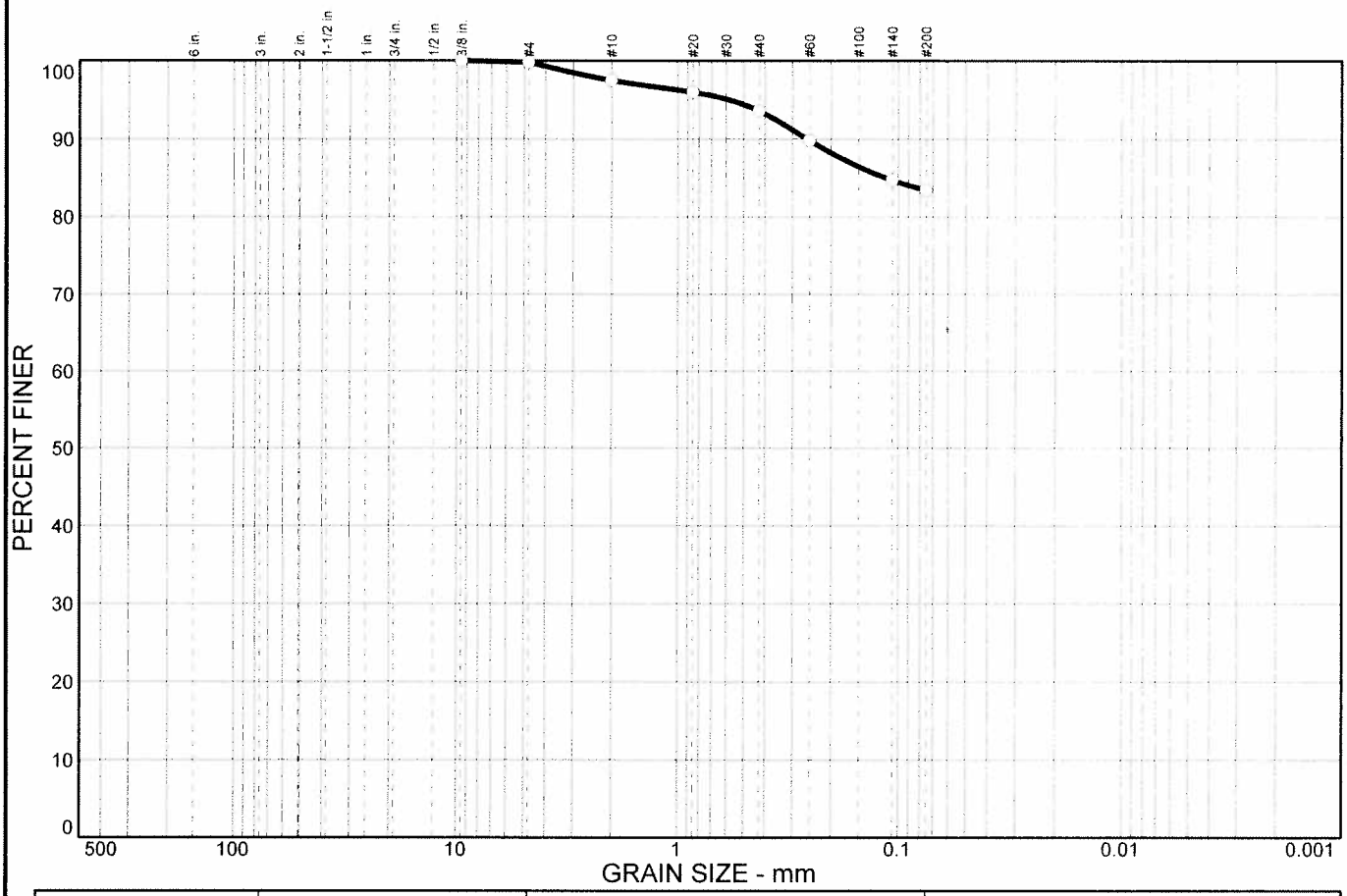
Remarks

Sample No.: 7B **Source of Sample:** RW6-R2A **Date:**
Location: **Elev./Depth:** 18.3-18.8

SIGNET Testing Labs

Client: Arup
Project: Doyle Dr. Replacement Project
Project No: 131558 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	2.3	3.9	10.2	83.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	97.5		
#20	96.0		
#40	93.6		
#60	89.8		
#140	84.7		
#200	83.4		

* (no specification provided)

Soil Description

Very dark brown Silty clay with sand

Atterberg Limits

PL= 17 LL= 24 PI= 7

Coefficients

D_{85}= 0.113 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO=

Remarks

Sample No.: 5A **Source of Sample:** RW8-R1 **Date:** 1-22-09
Location: **Elev./Depth:** 13-13.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project

Project No: EA04-163701 **Figure**

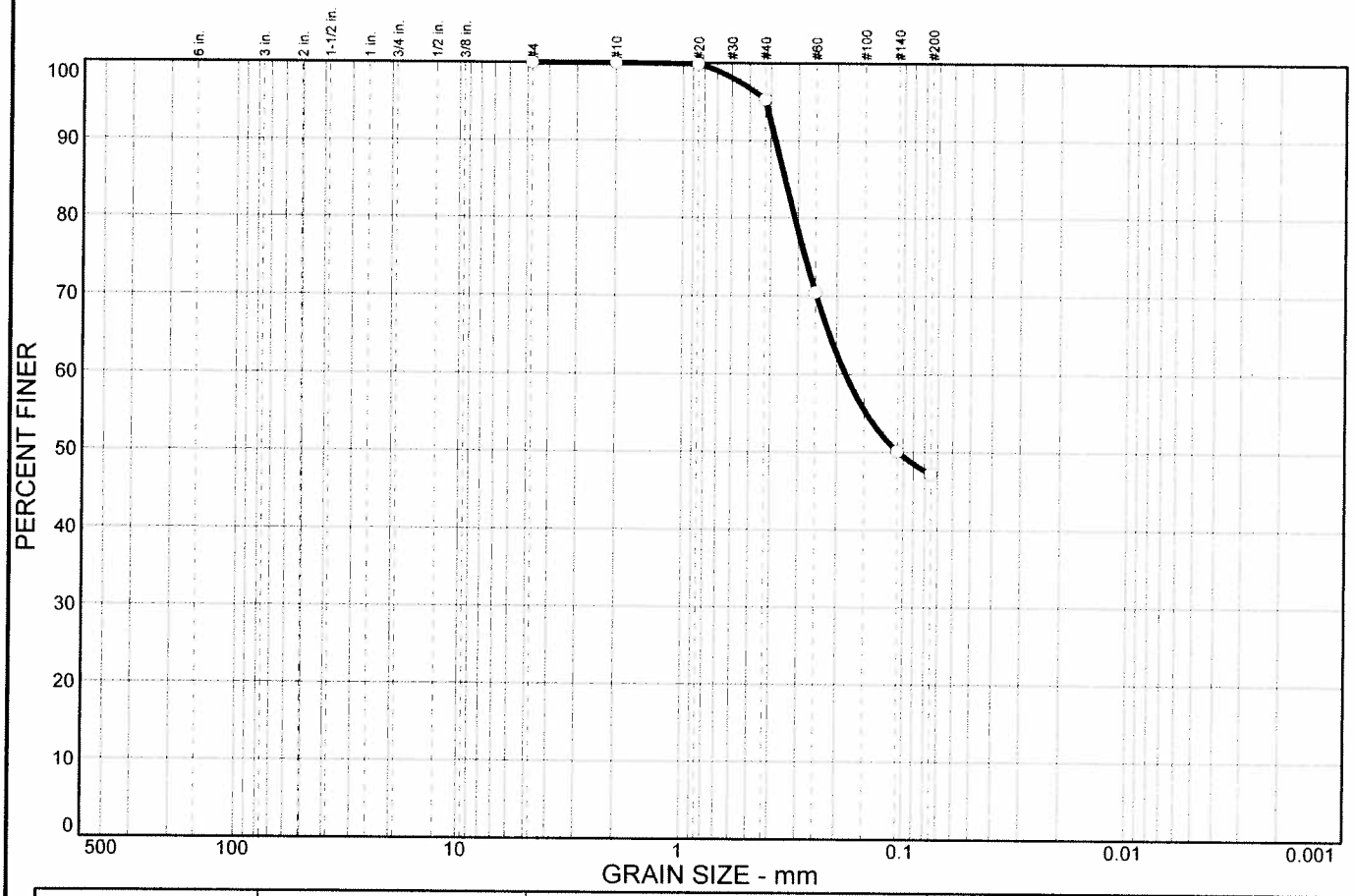
ASTM D-1140
PERCENT PASSING NO. 200 SIEVE REPORT

Method A
Specimens Soaked Overnight without Deflocculating Agent
Dry Mass Determined Directly

Client Name Arup
Project Name Doyle Drive Replacement Project-Retaining Wall #8
Project Number EA04-163701

Boring Number	RW8-R1	RW8-R5			
Sample Number	9	37			
Depth (ft)	22.5-25	146-147.5			
Percent of Soil Finer than No. 200 Sieve	60.1	51.5			
Visual Classification	Brown sandy clay	Dark greenish gray sandy silt			
Date	01/27/09	01/22/09			
Weight of Dry Soil + Pan (before wash)	577.5	550.0			
Weight of Dry Soil + Pan (after wash)	330.2	413.6			
Weight of Pan	166.1	285.0			

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	4.7	48.1	47.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	95.3		
#60	70.4		
#140	50.1		
#200	47.2		

* (no specification provided)

Soil Description

Brown Silty, clayey sand

Atterberg Limits

PL= 16 LL= 23 PI= 7

Coefficients

D_{85}= 0.345 D_{60}= 0.183 D_{50}= 0.105
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

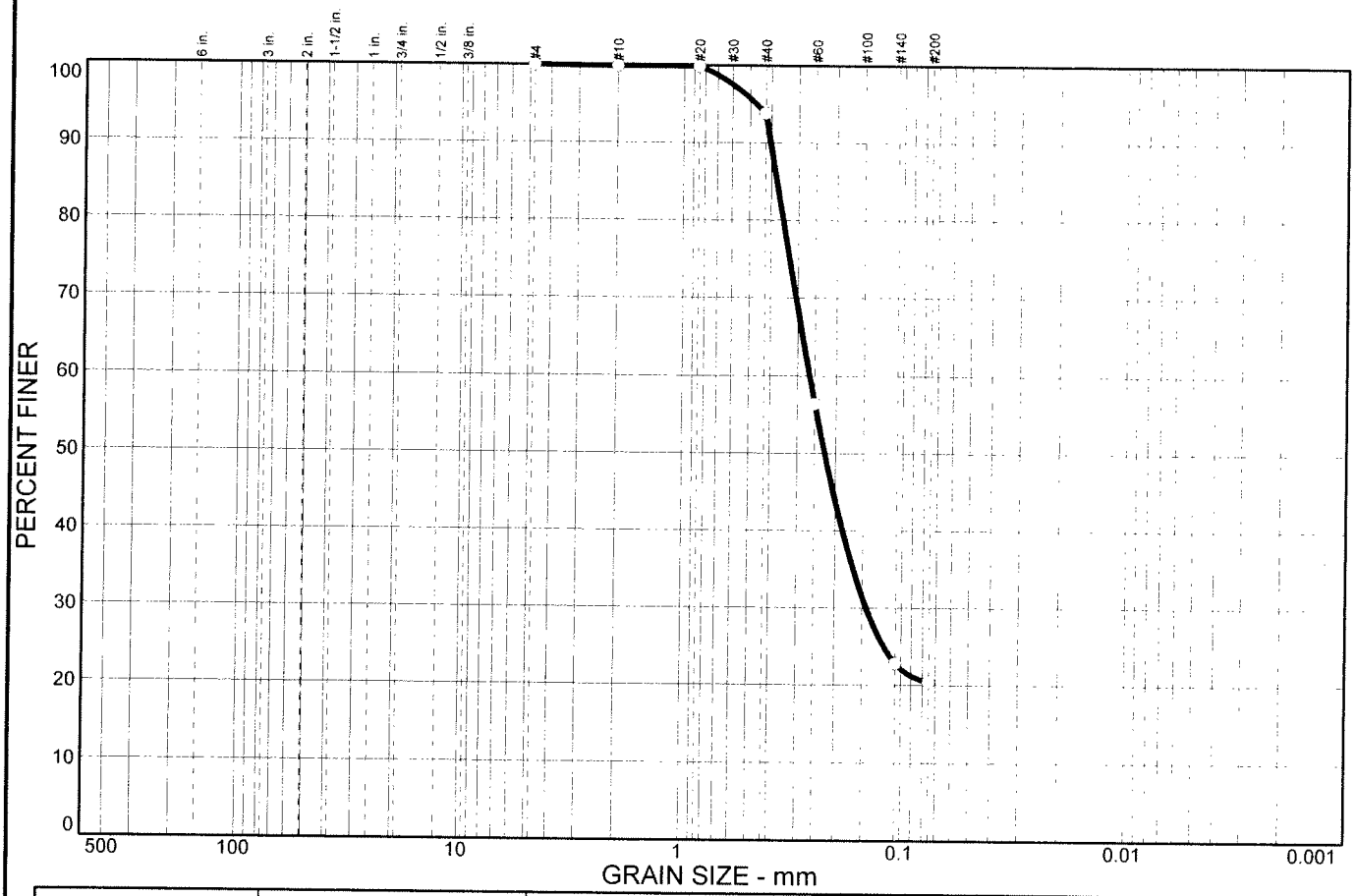
Remarks

Sample No.: 9 Bottom **Source of Sample:** RW8-R1 **Date:**
Location: **Elev./Depth:** 22.5-25

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	6.1	73.4	20.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	93.8		
#60	56.4		
#140	22.8		
#200	20.4		

* (no specification provided)

Soil Description

Dark yellowish brown silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.377 D_{60}= 0.264 D_{50}= 0.225
D_{30}= 0.144 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

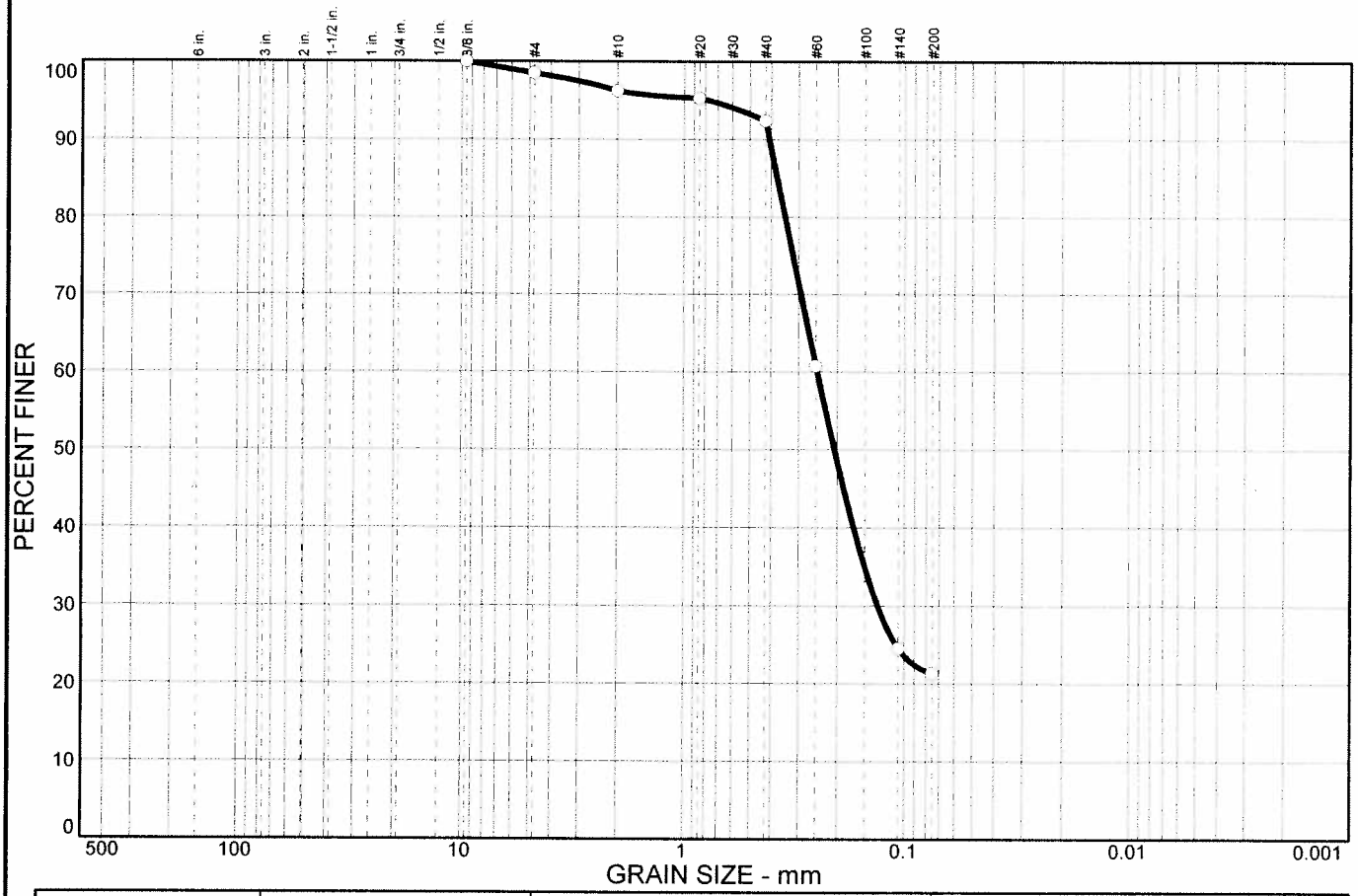
Remarks

Sample No.: 11 **Source of Sample:** RW8-R1 **Date:** 1-29-09
Location: **Elev./Depth:** 29-30.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project
Project No: EA04-163701 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	1.5	2.3	3.8	71.1	21.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.5		
#10	96.2		
#20	95.3		
#40	92.4		
#60	60.7		
#140	24.5		
#200	21.3		

* (no specification provided)

Soil Description

Brown clayey sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.376 D_{60}= 0.247 D_{50}= 0.206
D_{30}= 0.131 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

Remarks

Sample No.: 12A **Source of Sample:** RW8-R1 **Date:**
Location: **Elev./Depth:** 33-33.5

SIGNET Testing Labs

Client: Arup
Project: Doyle Drive Replacement Project

Project No: EA04-163701 **Figure**

BTSB-
RZ
5A
12.8-
13.3

BTSB-R2

15A

37.8 - 38.3

BT3B-12
7A
17.2-18.3

BTSB-
RZ
5A
12.8-
13.3

BTSB-
R3A
9A
12.8-13.3

BTSB-R2

15A

37.8-38.3

BTSB-R2
15B
38.3–
38.8

BTNB-R6
5
13-13.5

BTSB-R2
17
42.8-43.3

BTSB-
R3A
9A
12.8-13.3

BTNB-R7
3B
13.3-
13.8

BTSB-R2

15B

38.3

38.8

BTNB-26

5

13-13.5

M-9/RW7-AH
A

13B

30.5-31

MQ/RW7-
A1A

118

25.4-26.3

BTNB-R6A
11B
283-288

BT38-B3A

11

17.8-18.3

M9/
RW7-A1A

15

35–35.5

BTNB-R7
3B
13.3-
13.8

BTNB-R7A

7B

18.3 - 18.8

M9/RW7-
A1A

11B

25.Y-26.3

M9/RW7-
A1A

17

40.8–
41.3

BTNB-86A

11B

283-285

M-9/RW7-A1
A

13B

30.5-31

BTNB-B7A

7B

18.3 - 18.8

M9/
RW7-A1A
15
35-35.5

MA/ZW7-
A1A

17

40.8-

41.3

BT3B-R2
13B
333-33.8

BTNB-RL

//

27.3-27.8

BTNB-27A
13A
33-33.5

BT9B-R2
13B
333-33.8

BTNB-27A

13A

33 – 33.5

BTNB-RL
11
27.3–27.8

BTNB-R6
90.4-91.0

BTNB-R5
54.0-55.0
Before

BTNB-A1

51.5-52.3

BTNB-R7
86.1-86.7

BTNB-R4
59.9-60.75

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

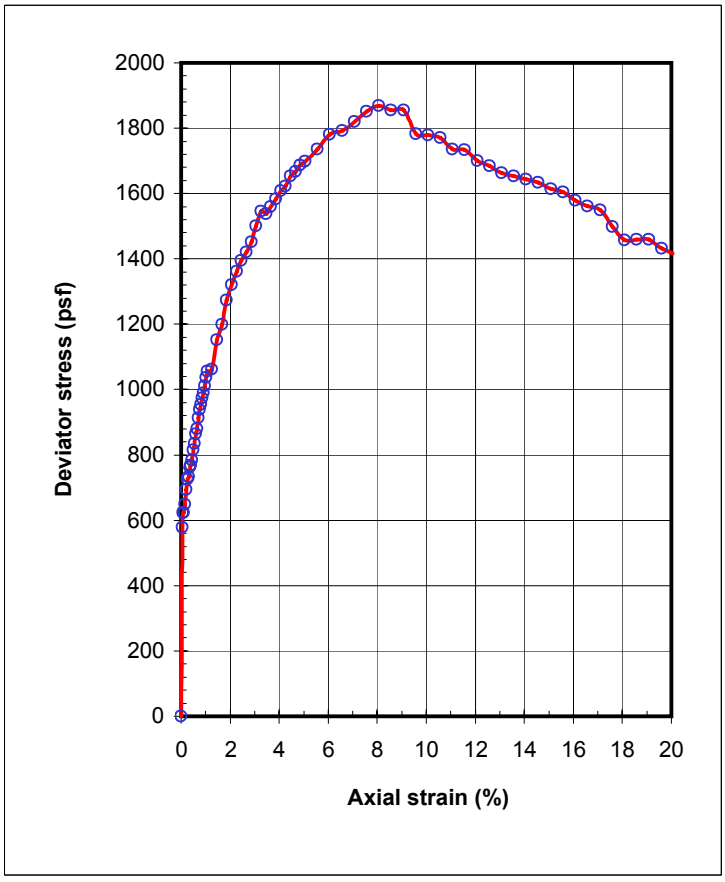
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # BTNB-R1
Sample # :
Depth (ft) : 51.5-52.3
Date tested : 07/01/08
Soil : Very dark gray silty clayey gravel

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 801.9 gms
Ht. = 5.160 in
Ave dia. = 2.243 in
Area = 3.954 sq.in
Volume = 334.4 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.242
Ht/Dia ratio = 2.30
Moisture = 10.3 %
Total density = 149.7 pcf
Dry density = 135.6 pcf
Saturation = 115.3 %
Chamber pressure = 9500 psf
Max. deviator stress = 1869 psf
Strain @ failure = 8.07 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	15.9	0.06	577.6
0.003	17.1	0.08	622.5
0.004	17.1	0.11	622.1
0.007	17.8	0.16	647.7
0.009	19.1	0.22	693.4
0.012	20.0	0.27	725.6
0.015	20.2	0.32	733.3
0.017	21.0	0.37	762.4
0.019	21.1	0.40	767.0
0.021	21.6	0.45	784.3
0.024	22.5	0.50	814.2
0.027	23.0	0.55	834.0
0.029	23.9	0.60	863.9
0.032	24.3	0.66	878.6
0.034	25.2	0.70	912.2
0.037	26.0	0.76	938.7
0.040	26.4	0.81	954.4
0.042	26.9	0.86	973.0
0.045	27.4	0.91	990.0
0.048	28.0	0.96	1010.3
0.050	28.8	1.01	1036.5
0.053	29.3	1.06	1056.2
0.063	29.5	1.26	1062.3
0.074	32.1	1.46	1151.9
0.084	33.5	1.66	1198.5
0.094	35.6	1.86	1273.0
0.105	37.0	2.06	1321.2
0.115	38.2	2.26	1360.9
0.125	39.3	2.46	1394.8
0.136	40.1	2.66	1421.1
0.146	41.0	2.86	1451.9
0.156	42.5	3.06	1500.8
0.166	43.9	3.26	1545.4
0.177	43.7	3.46	1537.5
0.187	44.4	3.66	1558.7
0.197	45.2	3.86	1583.1
0.208	46.0	4.06	1608.1
0.218	46.5	4.26	1622.0
0.228	47.5	4.46	1653.2
0.239	48.0	4.66	1667.2
0.249	48.7	4.86	1687.0
0.259	49.1	5.06	1698.6
0.285	50.5	5.56	1735.9
0.311	52.0	6.07	1780.2
0.337	52.7	6.57	1792.8
0.363	53.8	7.07	1819.8
0.389	55.0	7.57	1851.7
0.415	55.8	8.07	1868.7

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

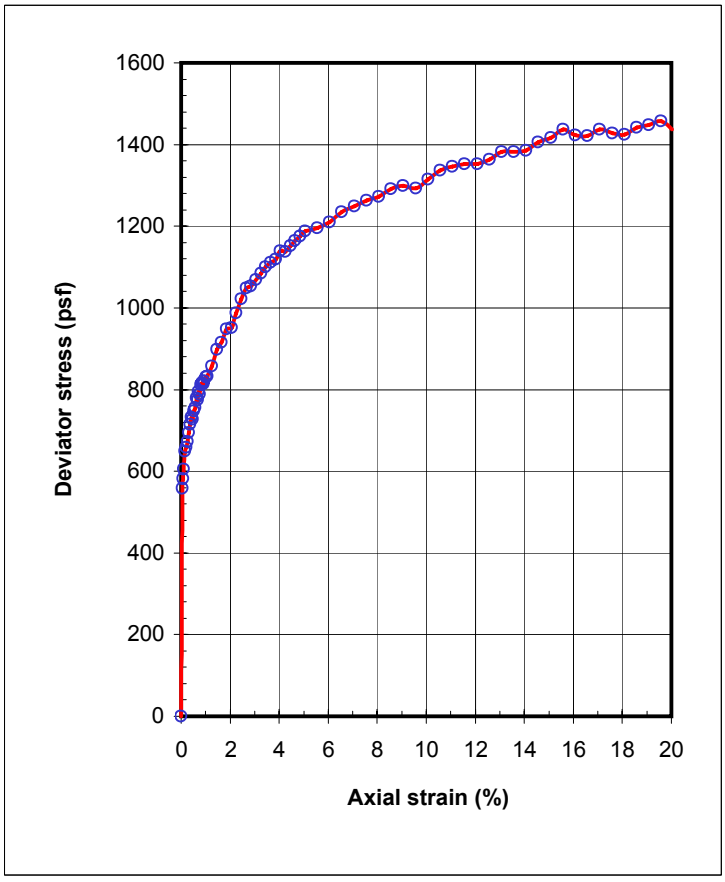
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # BTNB-R4
Sample # :
Depth (ft) : 59.9-60.75
Date tested : 07/01/08
Soil : Bluish gray clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 909.6 gms
Ht. = 5.660 in
Ave dia. = 2.363 in
Area = 4.388 sq.in
Volume = 407.0 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.408
Ht/Dia ratio = 2.39
Moisture = 16.5 %
Total density = 139.4 pcf
Dry density = 119.7 pcf
Saturation = 109.4 %
Chamber pressure = 10500 psf
Max. deviator stress = 1458 psf
Strain @ failure = 19.59 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	17.0	0.05	557.2
0.003	17.7	0.08	581.7
0.004	18.4	0.11	604.3
0.007	19.8	0.16	649.1
0.010	20.1	0.21	658.4
0.013	20.5	0.26	671.6
0.016	21.2	0.31	694.9
0.019	21.9	0.36	715.3
0.022	22.4	0.42	732.1
0.025	22.2	0.46	726.7
0.028	22.9	0.52	747.8
0.030	23.1	0.56	755.1
0.034	23.9	0.62	779.6
0.036	23.7	0.67	773.6
0.039	24.4	0.72	793.9
0.041	24.2	0.75	787.9
0.044	25.0	0.80	812.3
0.047	25.1	0.85	815.7
0.050	25.0	0.90	814.1
0.052	25.3	0.95	820.9
0.055	25.6	1.01	830.1
0.058	25.6	1.06	832.7
0.070	26.4	1.26	856.5
0.081	27.8	1.46	897.6
0.092	28.4	1.66	915.1
0.104	29.4	1.86	947.9
0.115	29.6	2.06	951.7
0.126	30.8	2.26	987.4
0.137	31.9	2.46	1022.1
0.149	32.8	2.66	1049.1
0.160	33.1	2.86	1053.7
0.171	33.6	3.06	1068.2
0.183	34.2	3.26	1084.6
0.194	34.7	3.46	1100.6
0.205	35.1	3.66	1111.0
0.217	35.5	3.86	1119.6
0.228	36.2	4.06	1139.3
0.239	36.2	4.26	1136.9
0.251	36.7	4.46	1152.0
0.262	37.2	4.66	1163.9
0.273	37.7	4.86	1175.6
0.285	38.1	5.06	1187.1
0.313	38.6	5.56	1195.3
0.341	39.2	6.06	1209.0
0.370	40.3	6.56	1235.0
0.398	41.0	7.06	1249.3
0.427	41.6	7.57	1263.1
0.455	42.2	8.07	1273.2

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

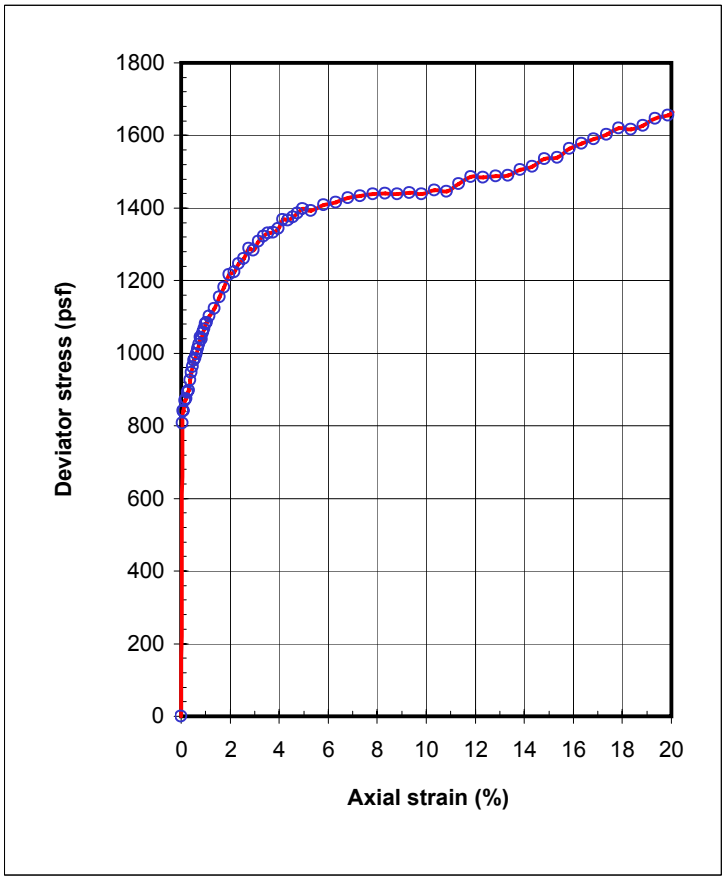
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # BTNB-R4
Sample # :
Depth (ft) : 87.1-88.1
Date tested : 07/02/08
Soil : Bluish gray clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 937.3 gms
Ht. = 5.630 in
Ave dia. = 2.413 in
Area = 4.576 sq.in
Volume = 422.2 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.420
Ht/Dia ratio = 2.33
Moisture = 16.8 %
Total density = 138.5 pcf
Dry density = 118.6 pcf
Saturation = 107.8 %
Chamber pressure = 16000 psf
Max. deviator stress = 1664 psf
Strain @ failure = 20.04 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	25.7	0.05	808.1
0.003	26.7	0.08	840.8
0.004	26.7	0.11	840.6
0.007	27.6	0.16	868.3
0.010	27.8	0.21	873.6
0.013	28.4	0.26	891.7
0.016	28.6	0.31	896.9
0.019	29.5	0.36	924.9
0.021	30.2	0.41	945.9
0.024	30.7	0.46	962.8
0.027	31.3	0.51	979.4
0.030	31.5	0.57	985.2
0.033	31.9	0.62	997.1
0.036	32.4	0.67	1012.5
0.039	32.8	0.72	1024.2
0.042	33.4	0.78	1042.9
0.045	33.3	0.83	1039.1
0.048	33.8	0.88	1055.2
0.051	34.2	0.93	1066.3
0.054	34.7	0.99	1081.5
0.057	34.8	1.03	1084.1
0.064	35.4	1.16	1102.3
0.075	36.2	1.36	1123.2
0.086	37.3	1.56	1154.9
0.097	38.2	1.76	1181.1
0.109	39.4	1.96	1215.6
0.120	39.8	2.16	1224.3
0.131	40.6	2.36	1246.0
0.142	41.1	2.56	1260.5
0.154	42.1	2.76	1288.0
0.165	42.1	2.96	1284.3
0.176	42.9	3.16	1307.7
0.188	43.5	3.36	1323.0
0.199	43.9	3.56	1331.5
0.210	44.0	3.76	1332.3
0.221	44.5	3.96	1343.6
0.233	45.4	4.16	1367.7
0.244	45.4	4.36	1366.5
0.255	45.8	4.56	1375.8
0.266	46.2	4.76	1385.5
0.278	46.7	4.96	1397.7
0.297	46.7	5.31	1392.9
0.326	47.5	5.81	1408.4
0.354	48.0	6.31	1414.8
0.382	48.7	6.82	1428.2
0.410	49.2	7.32	1433.9
0.439	49.6	7.82	1438.4
0.467	49.9	8.32	1439.5

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

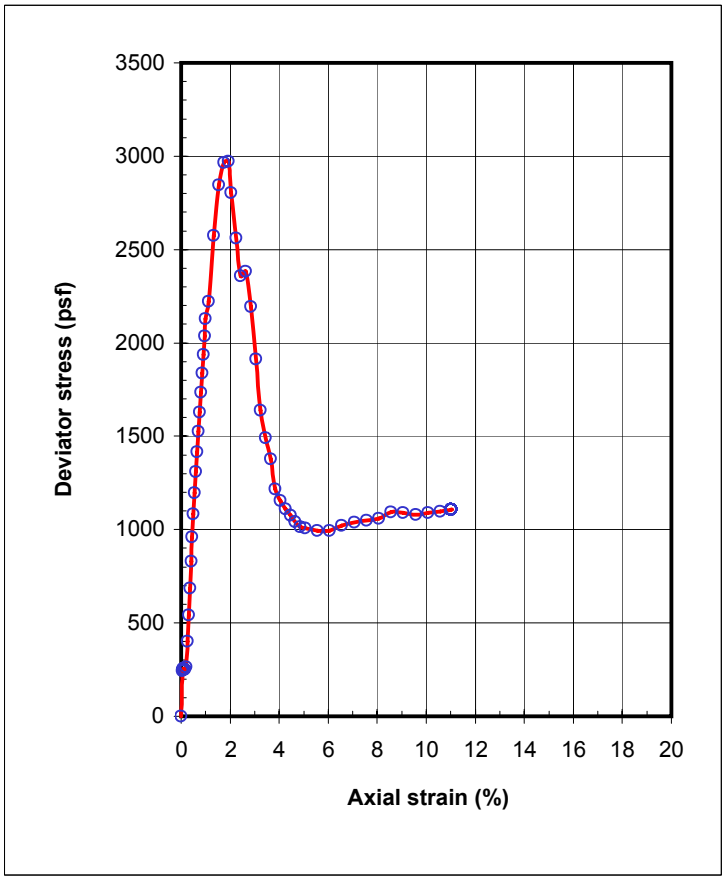
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTNB-R6A
Sample # : 11B
Depth (ft) : 28.3
Date tested : 05/31/08
Soil : Olive brown clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 727.1 gms
Ht. = 5.530 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 417.0 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 1.304
Ht/Dia ratio = 2.29
Moisture = 48.8 %
Total density = 108.8 pcf
Dry density = 73.1 pcf
Saturation = 101.0 %
Chamber pressure = 4850 psf
Max. deviator stress = 2973 psf
Strain @ failure = 1.94 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	7.7	0.05	242.2
0.003	8.1	0.08	253.8
0.004	8.1	0.10	253.2
0.007	8.0	0.15	250.3
0.009	8.5	0.20	265.3
0.012	12.8	0.25	399.8
0.015	17.4	0.30	542.4
0.018	22.0	0.35	686.5
0.021	26.6	0.40	828.7
0.023	30.8	0.45	960.4
0.026	34.8	0.50	1082.2
0.029	38.4	0.55	1196.5
0.032	42.1	0.60	1308.8
0.034	45.6	0.65	1416.8
0.037	49.0	0.70	1524.0
0.040	52.5	0.75	1629.0
0.043	55.9	0.80	1734.3
0.045	59.2	0.85	1835.9
0.048	62.5	0.90	1937.2
0.051	65.7	0.95	2037.5
0.054	68.8	1.00	2130.4
0.061	71.8	1.13	2222.8
0.072	83.4	1.33	2574.7
0.083	92.3	1.53	2845.3
0.094	96.5	1.74	2966.1
0.105	96.9	1.94	2973.1
0.111	91.4	2.03	2802.9
0.122	83.7	2.24	2561.3
0.133	77.3	2.44	2359.7
0.144	78.2	2.64	2383.7
0.155	72.2	2.84	2195.0
0.166	63.0	3.04	1912.2
0.177	54.1	3.24	1637.1
0.188	49.3	3.44	1491.1
0.200	45.7	3.65	1378.0
0.211	40.5	3.85	1218.3
0.222	38.4	4.05	1154.0
0.233	37.1	4.25	1111.1
0.244	36.0	4.45	1077.4
0.255	34.9	4.65	1042.1
0.267	34.1	4.86	1015.5
0.278	33.9	5.06	1006.8
0.306	33.6	5.56	993.8
0.333	33.8	6.06	993.6
0.361	35.0	6.56	1023.0
0.389	35.7	7.06	1039.2
0.416	36.3	7.56	1049.5
0.444	36.8	8.07	1057.6

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

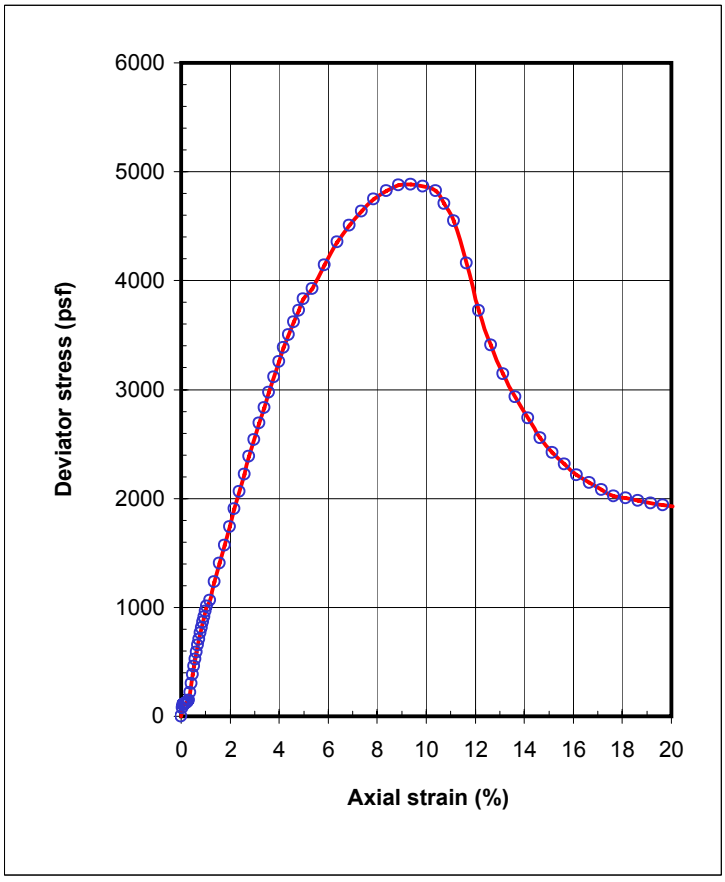
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTNB-R6
Sample # : 5
Depth (ft) : 13
Date tested : 05/30/08
Soil : Brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 891.9 gms
Ht. = 5.710 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 430.6 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.570
Ht/Dia ratio = 2.36
Moisture = 20.5 %
Total density = 129.3 pcf
Dry density = 107.3 pcf
Saturation = 96.9 %
Chamber pressure = 2250 psf
Max. deviator stress = 4883 psf
Strain @ failure = 9.38 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	2.4	0.05	75.5
0.003	3.4	0.07	105.3
0.005	3.5	0.11	110.4
0.007	3.6	0.15	113.2
0.010	3.9	0.20	123.0
0.013	4.1	0.26	127.1
0.016	4.7	0.31	147.7
0.019	7.0	0.37	217.5
0.022	9.7	0.41	302.6
0.025	12.3	0.46	383.9
0.028	14.8	0.52	460.4
0.031	16.9	0.57	525.3
0.034	19.0	0.62	590.0
0.037	21.0	0.68	651.3
0.040	22.8	0.73	707.2
0.043	24.5	0.77	761.1
0.046	26.2	0.83	813.5
0.049	27.9	0.88	864.9
0.052	29.4	0.93	912.9
0.055	31.1	0.99	963.2
0.058	32.7	1.04	1011.6
0.065	34.3	1.17	1061.4
0.077	40.1	1.37	1236.2
0.088	45.6	1.57	1404.5
0.100	51.1	1.77	1570.7
0.111	56.6	1.97	1736.7
0.123	62.1	2.17	1901.3
0.134	67.6	2.38	2065.6
0.146	72.9	2.58	2223.6
0.157	78.4	2.78	2384.6
0.169	83.6	2.98	2537.6
0.180	88.9	3.19	2693.2
0.192	93.7	3.39	2833.9
0.203	98.6	3.59	2975.0
0.215	103.4	3.79	3114.3
0.226	108.3	3.99	3253.4
0.238	112.8	4.19	3383.1
0.249	117.0	4.39	3499.8
0.261	121.1	4.59	3617.2
0.272	125.0	4.79	3723.8
0.284	128.8	5.00	3830.4
0.304	132.5	5.35	3923.9
0.333	140.7	5.86	4145.0
0.362	148.6	6.36	4353.2
0.391	154.6	6.87	4505.5
0.419	159.9	7.36	4635.2
0.448	164.7	7.87	4749.5
0.477	168.3	8.37	4826.5

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

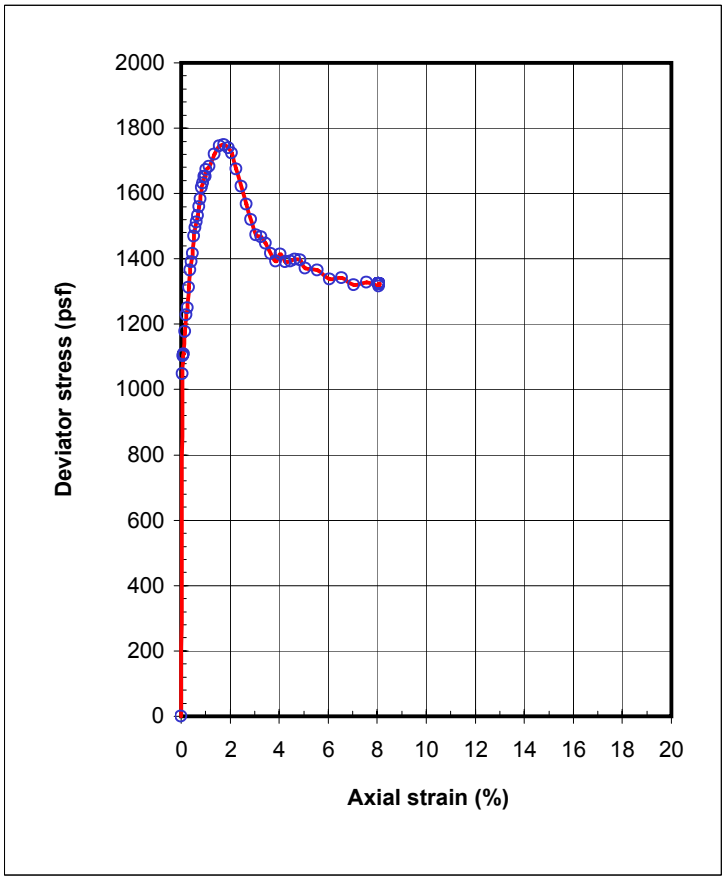
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # BTNB-R6
Sample # :
Depth (ft) : 90.4-91
Date tested : 07/01/08
Soil : Dark bluish gray silt

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 955.8 gms
Ht. = 5.650 in
Ave dia. = 2.417 in
Area = 4.589 sq.in
Volume = 424.9 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.379
Ht/Dia ratio = 2.34
Moisture = 14.9 %
Total density = 140.4 pcf
Dry density = 122.2 pcf
Saturation = 106.0 %
Chamber pressure = 17000 psf
Max. deviator stress = 1750 psf
Strain @ failure = 1.75 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	33.4	0.05	1048.5
0.003	35.2	0.08	1103.1
0.004	35.4	0.11	1108.4
0.007	37.5	0.16	1176.3
0.010	39.2	0.21	1228.0
0.013	39.9	0.26	1250.3
0.016	41.9	0.32	1311.8
0.019	43.7	0.37	1365.4
0.022	44.5	0.42	1391.7
0.025	45.3	0.47	1415.5
0.028	47.1	0.52	1469.9
0.031	47.9	0.57	1494.5
0.034	48.5	0.62	1511.8
0.036	49.2	0.67	1532.3
0.039	50.0	0.73	1558.7
0.042	50.8	0.78	1582.1
0.045	52.0	0.83	1618.8
0.048	52.4	0.88	1631.1
0.051	53.1	0.93	1651.4
0.054	53.1	0.98	1651.5
0.056	53.9	1.03	1673.2
0.064	54.2	1.16	1682.3
0.075	55.5	1.36	1719.1
0.086	56.5	1.55	1744.9
0.098	56.8	1.75	1750.0
0.107	56.5	1.93	1740.2
0.114	56.1	2.05	1723.0
0.126	54.6	2.25	1674.1
0.137	53.0	2.45	1622.4
0.148	51.3	2.65	1566.8
0.160	49.9	2.85	1520.6
0.171	48.4	3.06	1473.2
0.182	48.3	3.25	1467.9
0.194	47.8	3.45	1447.6
0.205	46.8	3.65	1416.2
0.216	46.2	3.86	1393.7
0.227	47.0	4.06	1415.3
0.239	46.3	4.25	1390.6
0.250	46.5	4.45	1392.8
0.261	46.8	4.65	1398.9
0.273	46.8	4.85	1396.6
0.284	46.0	5.05	1371.0
0.312	46.1	5.56	1365.4
0.341	45.4	6.06	1338.8
0.369	45.8	6.56	1341.6
0.397	45.3	7.06	1320.5
0.426	45.8	7.56	1327.7
0.454	45.6	8.06	1315.6

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

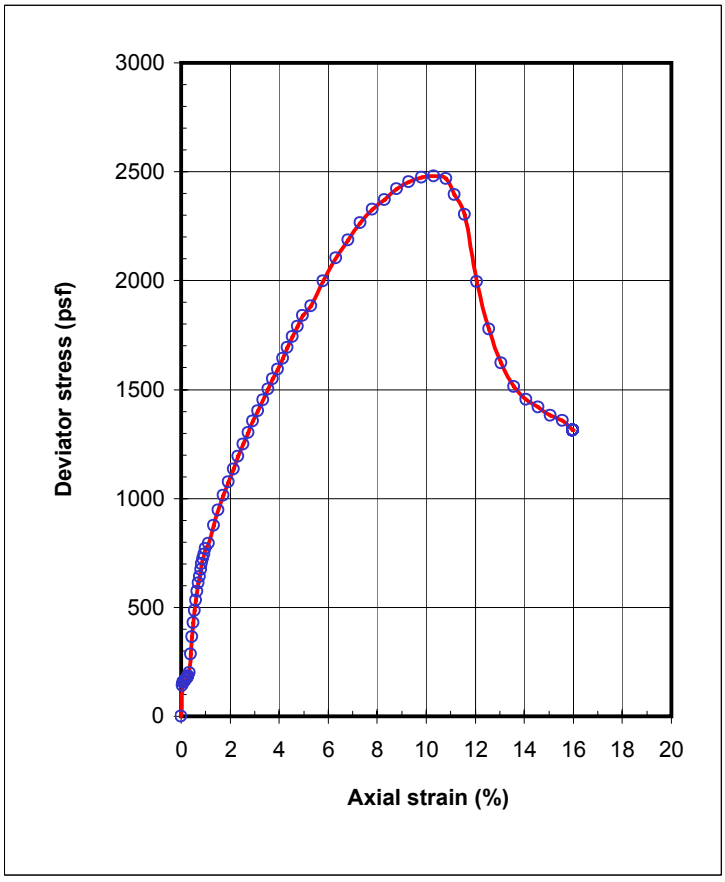
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTNB-R7A
Sample # : 7B
Depth (ft) : 18.3
Date tested : 05/31/08
Soil : Reddish brown sandy clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 901.3 gms
Ht. = 5.750 in
Ave dia. = 2.417 in
Area = 4.589 sq.in
Volume = 432.4 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.565
Ht/Dia ratio = 2.38
Moisture = 20.8 %
Total density = 130.1 pcf
Dry density = 107.7 pcf
Saturation = 99.5 %
Chamber pressure = 3100 psf
Max. deviator stress = 2480 psf
Strain @ failure = 10.31 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	4.5	0.05	139.8
0.003	5.0	0.08	156.5
0.004	5.0	0.10	156.2
0.007	5.1	0.15	161.1
0.010	5.4	0.20	169.5
0.013	5.6	0.25	176.1
0.016	5.9	0.30	185.0
0.019	6.4	0.35	200.0
0.022	9.1	0.40	285.7
0.024	11.6	0.45	363.9
0.027	13.7	0.50	428.5
0.030	15.5	0.55	485.0
0.033	17.0	0.60	531.8
0.036	18.4	0.65	573.0
0.039	19.6	0.70	611.1
0.042	20.6	0.75	641.5
0.045	21.6	0.80	672.2
0.047	22.4	0.85	698.1
0.050	23.2	0.90	721.7
0.053	24.0	0.95	744.6
0.056	24.8	1.00	770.7
0.063	25.5	1.13	792.4
0.075	28.2	1.32	874.4
0.086	30.6	1.52	945.9
0.098	32.8	1.72	1012.5
0.110	34.9	1.93	1075.1
0.121	36.9	2.13	1133.3
0.132	38.9	2.33	1192.7
0.144	40.8	2.53	1248.3
0.156	42.6	2.73	1300.2
0.167	44.5	2.94	1354.0
0.179	46.1	3.13	1401.6
0.191	47.9	3.34	1451.7
0.202	49.6	3.54	1502.7
0.214	51.2	3.74	1547.4
0.225	52.8	3.94	1593.0
0.237	54.6	4.14	1641.2
0.248	56.4	4.34	1693.7
0.260	58.2	4.55	1741.9
0.272	59.9	4.75	1790.1
0.283	61.6	4.95	1838.5
0.304	63.3	5.30	1882.0
0.332	67.6	5.80	1998.2
0.361	71.5	6.31	2103.2
0.390	74.7	6.81	2185.3
0.419	77.9	7.31	2265.8
0.448	80.5	7.81	2327.8
0.476	82.4	8.31	2370.5

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

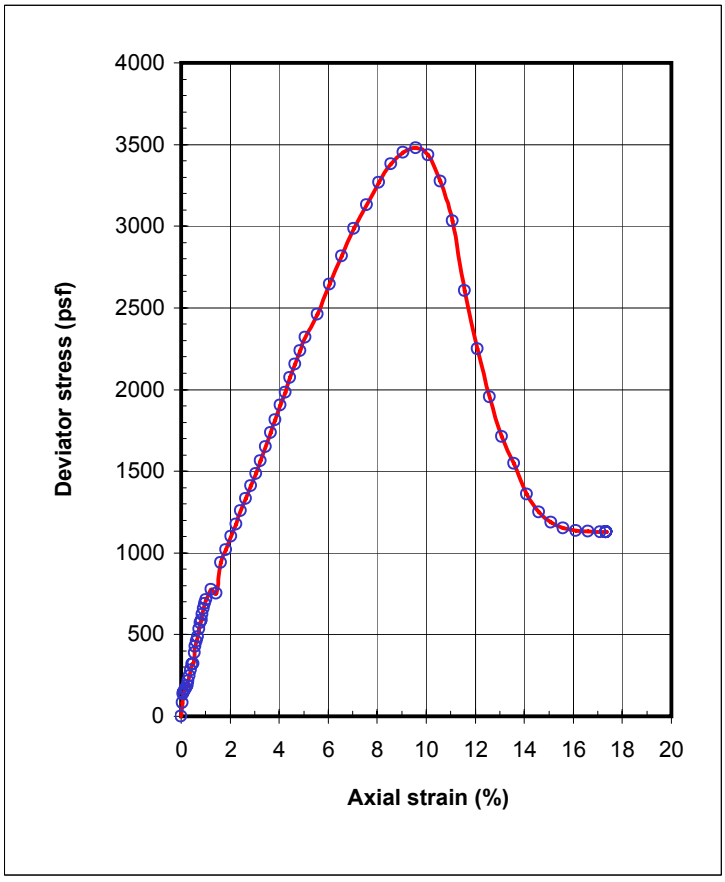
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTNB-R7
Sample # : 3B
Depth (ft) : 13.3
Date tested : 05/31/08
Soil : Brown sandy clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 916.1 gms
Ht. = 5.620 in
Ave dia. = 2.423 in
Area = 4.614 sq.in
Volume = 424.9 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.463
Ht/Dia ratio = 2.32
Moisture = 16.8 %
Total density = 134.5 pcf
Dry density = 115.1 pcf
Saturation = 98.1 %
Chamber pressure = 2250 psf
Max. deviator stress = 3480 psf
Strain @ failure = 9.57 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	2.7	0.05	82.9
0.003	4.4	0.08	135.9
0.004	4.6	0.10	143.8
0.007	5.2	0.15	161.7
0.010	5.6	0.20	173.8
0.013	6.1	0.25	189.2
0.015	7.0	0.30	217.1
0.018	7.9	0.35	245.9
0.021	9.1	0.40	283.8
0.024	10.2	0.45	317.8
0.027	10.3	0.50	320.4
0.029	12.4	0.55	386.1
0.031	13.8	0.57	427.4
0.034	14.8	0.63	460.0
0.036	15.6	0.67	483.9
0.039	17.2	0.72	534.1
0.042	18.4	0.77	570.4
0.045	19.0	0.82	587.5
0.048	20.2	0.87	624.0
0.051	21.3	0.92	658.3
0.053	22.3	0.97	689.8
0.056	23.1	1.02	713.3
0.067	25.2	1.22	777.4
0.079	24.5	1.43	752.2
0.090	30.7	1.63	942.0
0.101	33.3	1.83	1019.8
0.113	36.0	2.03	1101.1
0.124	38.6	2.24	1176.6
0.136	41.2	2.44	1255.9
0.147	43.9	2.64	1333.2
0.158	46.5	2.84	1409.3
0.170	49.1	3.04	1485.8
0.181	51.8	3.24	1564.9
0.192	54.7	3.44	1647.6
0.203	57.7	3.65	1735.4
0.215	60.4	3.85	1813.3
0.226	63.6	4.04	1903.7
0.237	66.4	4.25	1983.6
0.249	69.5	4.45	2071.6
0.260	72.4	4.66	2155.3
0.271	75.4	4.85	2237.6
0.283	78.3	5.06	2320.7
0.311	83.5	5.56	2461.1
0.339	90.2	6.06	2644.9
0.367	96.6	6.56	2817.3
0.395	102.9	7.06	2983.9
0.424	108.5	7.56	3130.7
0.452	113.8	8.07	3266.3

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

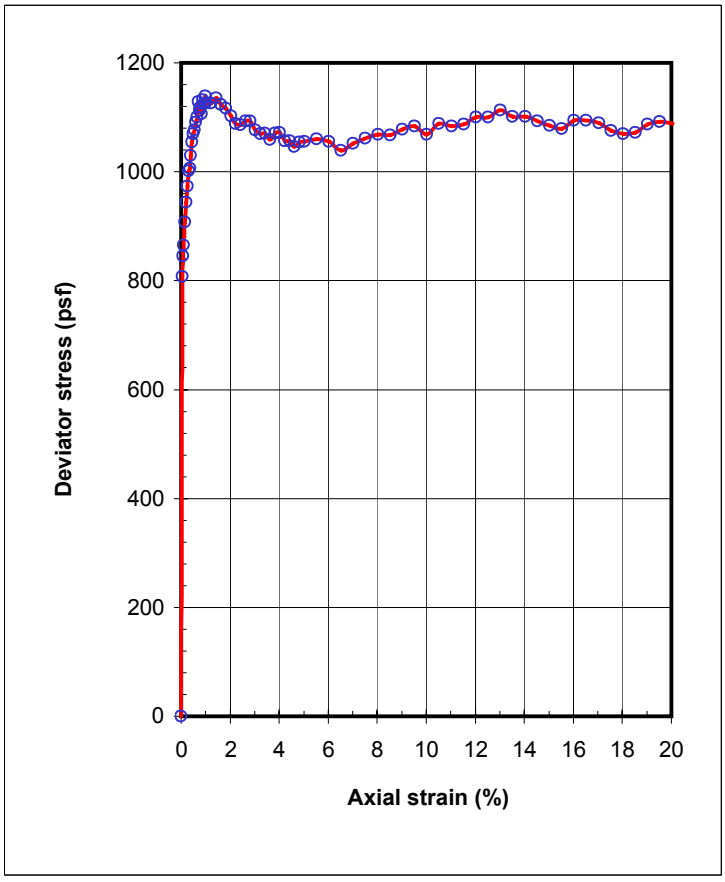
Client : Arup
Project : Doyle Dr. Replacement Project
Job # : 131558
Boring # BTNB-R7
Sample # :
Depth (ft) : 86.1-86.7
Date tested : 07/01/08
Soil : Bluish gray gravelly silt

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 954.2 gms
Ht. = 5.660 in
Ave dia. = 2.413 in
Area = 4.576 sq.in
Volume = 424.4 c.c.
Shearing rate = 0.01 inch/min
Shearing rate = 0.25 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.378
Ht/Dia ratio = 2.35
Moisture = 14.8 %
Total density = 140.3 pcf
Dry density = 122.2 pcf
Saturation = 105.4 %
Chamber pressure = 16000 psf
Max. deviator stress = 1139 psf
Strain @ failure = 0.98 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	25.7	0.05	807.6
0.003	26.9	0.08	844.6
0.005	27.5	0.10	865.6
0.007	28.9	0.15	907.4
0.010	30.0	0.20	943.6
0.013	31.0	0.25	973.5
0.016	31.9	0.30	1001.1
0.019	32.1	0.35	1006.3
0.022	32.8	0.40	1029.5
0.024	33.6	0.45	1054.0
0.027	34.2	0.50	1069.9
0.030	34.4	0.55	1076.0
0.033	34.9	0.60	1090.5
0.036	35.2	0.65	1100.6
0.039	36.1	0.70	1128.7
0.041	35.6	0.75	1112.2
0.043	35.8	0.78	1117.7
0.046	35.4	0.83	1105.6
0.048	36.3	0.88	1131.7
0.051	36.1	0.93	1124.7
0.054	36.6	0.98	1139.3
0.057	36.2	1.03	1126.2
0.068	36.2	1.23	1125.7
0.080	36.6	1.43	1135.1
0.091	36.3	1.63	1124.1
0.102	36.1	1.83	1116.4
0.114	35.8	2.03	1102.9
0.125	35.4	2.23	1088.1
0.136	35.4	2.43	1086.6
0.148	35.7	2.63	1093.0
0.159	35.8	2.83	1093.5
0.170	35.3	3.03	1076.1
0.182	35.1	3.23	1069.4
0.193	35.2	3.43	1070.3
0.204	34.9	3.63	1058.4
0.215	35.4	3.83	1070.5
0.227	35.5	4.03	1072.3
0.238	35.1	4.23	1057.0
0.249	35.1	4.43	1056.1
0.261	34.9	4.63	1046.3
0.272	35.2	4.83	1054.3
0.283	35.3	5.03	1055.2
0.312	35.7	5.53	1060.0
0.340	35.7	6.03	1055.5
0.368	35.3	6.53	1038.8
0.397	35.9	7.03	1051.5
0.425	36.5	7.53	1061.6
0.453	36.9	8.03	1068.3

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

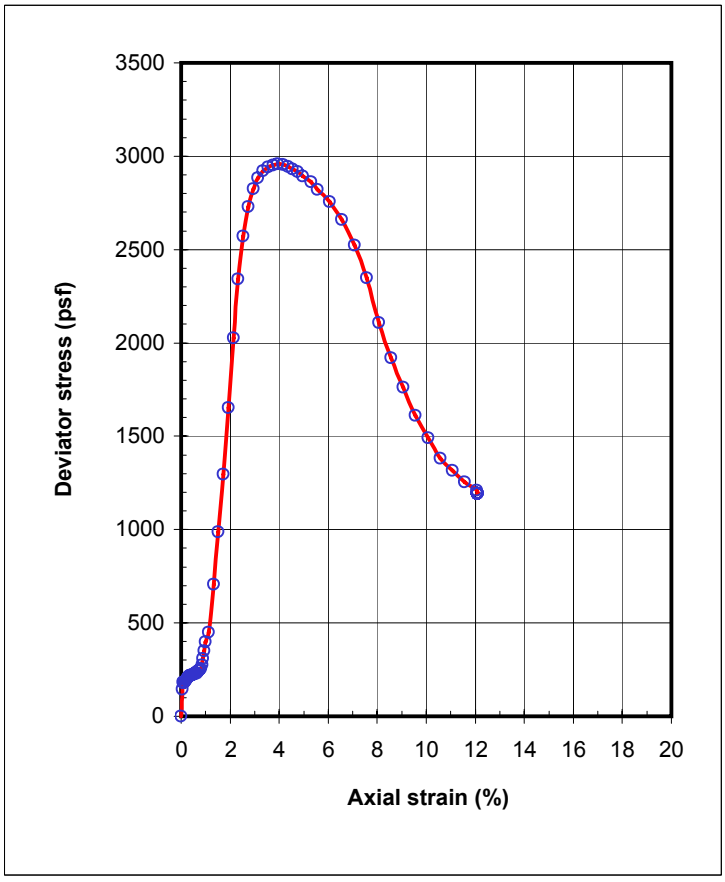
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R1
Sample # : 11 BOTTOM
Depth (ft) : 27.5
Date tested : 05/29/08
Soil : Olive brown clay with sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 1324.0 gms
Ht. = 6.040 in
Ave dia. = 2.860 in
Area = 6.427 sq.in
Volume = 636.1 c.c.
Shearing rate = 0.05 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.582
Ht/Dia ratio = 2.11
Moisture = 22.0 %
Total density = 129.9 pcf
Dry density = 106.5 pcf
Saturation = 101.9 %
Chamber pressure = 5200 psf
Max. deviator stress = 2960 psf
Strain @ failure = 3.95 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	6.4	0.05	143.9
0.003	8.1	0.07	180.3
0.004	8.0	0.10	178.6
0.007	8.2	0.15	182.8
0.010	8.5	0.20	190.9
0.013	9.0	0.25	201.9
0.016	9.4	0.30	209.4
0.019	9.6	0.35	214.6
0.022	9.8	0.40	217.8
0.025	9.9	0.45	220.8
0.028	10.1	0.50	224.4
0.031	10.2	0.55	227.5
0.035	10.4	0.60	232.5
0.038	10.4	0.65	230.8
0.041	10.9	0.70	242.6
0.044	11.1	0.75	247.1
0.047	11.3	0.80	252.3
0.050	12.3	0.85	273.1
0.053	14.0	0.90	309.9
0.056	15.8	0.95	350.2
0.059	17.9	1.00	397.2
0.066	20.3	1.13	449.0
0.079	32.0	1.33	707.4
0.090	44.8	1.53	988.1
0.102	58.9	1.72	1297.3
0.115	75.3	1.93	1653.8
0.127	92.4	2.14	2026.7
0.139	106.9	2.34	2340.1
0.151	117.7	2.53	2571.3
0.164	125.2	2.74	2727.5
0.176	129.8	2.94	2823.2
0.188	132.9	3.14	2884.2
0.200	134.8	3.34	2919.7
0.213	136.1	3.55	2942.3
0.225	136.9	3.75	2952.5
0.237	137.5	3.95	2959.7
0.249	137.5	4.15	2953.5
0.261	137.3	4.35	2943.2
0.273	137.0	4.55	2930.3
0.286	136.6	4.76	2915.6
0.298	135.8	4.96	2892.6
0.319	135.0	5.31	2863.9
0.334	133.3	5.56	2819.9
0.364	131.0	6.06	2757.6
0.395	127.1	6.57	2660.4
0.425	121.2	7.06	2524.6
0.455	113.4	7.56	2347.9
0.486	102.3	8.07	2106.6

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

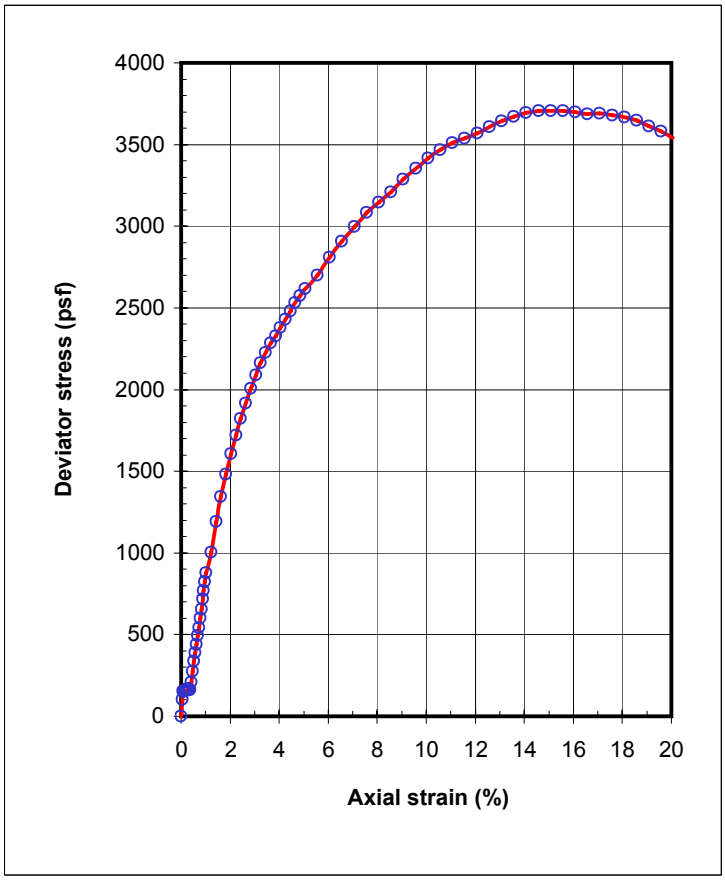
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 5A
Depth (ft) : 12.8
Date tested : 05/30/08
Soil : Reddish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 929.4 gms
Ht. = 6.000 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 452.4 c.c.
Shearing rate = 0.05 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.610
Ht/Dia ratio = 2.48
Moisture = 22.5 %
Total density = 128.2 pcf
Dry density = 104.6 pcf
Saturation = 99.6 %
Chamber pressure = 2250 psf
Max. deviator stress = 3707 psf
Strain @ failure = 15.08 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	3.2	0.05	100.5
0.003	4.9	0.07	154.1
0.004	4.8	0.10	151.5
0.007	4.8	0.15	151.1
0.010	5.0	0.20	155.3
0.013	5.2	0.25	161.5
0.016	5.4	0.30	167.3
0.018	5.3	0.33	165.7
0.021	5.1	0.37	159.8
0.024	6.6	0.43	205.9
0.027	8.9	0.47	275.7
0.030	10.8	0.52	337.5
0.033	12.5	0.57	387.5
0.036	14.1	0.62	437.9
0.039	15.8	0.67	492.5
0.042	17.4	0.72	540.5
0.045	19.3	0.77	599.3
0.048	21.1	0.82	655.2
0.051	23.1	0.88	716.5
0.054	24.8	0.92	768.1
0.057	26.5	0.97	821.6
0.060	28.3	1.02	876.4
0.072	32.5	1.23	1004.3
0.084	38.6	1.43	1190.3
0.096	43.7	1.63	1344.2
0.108	48.2	1.83	1482.2
0.120	52.4	2.03	1605.6
0.133	56.2	2.24	1719.5
0.145	59.7	2.44	1823.1
0.156	62.9	2.63	1917.0
0.169	65.9	2.84	2004.8
0.181	68.9	3.05	2089.4
0.193	71.4	3.24	2162.8
0.205	73.7	3.44	2226.5
0.217	75.7	3.65	2282.2
0.230	77.4	3.85	2328.7
0.241	79.2	4.05	2379.2
0.253	81.1	4.25	2430.6
0.266	83.0	4.46	2481.2
0.278	84.8	4.66	2529.7
0.290	86.5	4.86	2574.5
0.302	88.1	5.06	2618.3
0.332	91.3	5.56	2698.0
0.362	95.6	6.06	2810.0
0.392	99.4	6.56	2906.1
0.422	103.1	7.07	2998.1
0.452	106.6	7.57	3085.0
0.482	109.4	8.07	3146.9

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

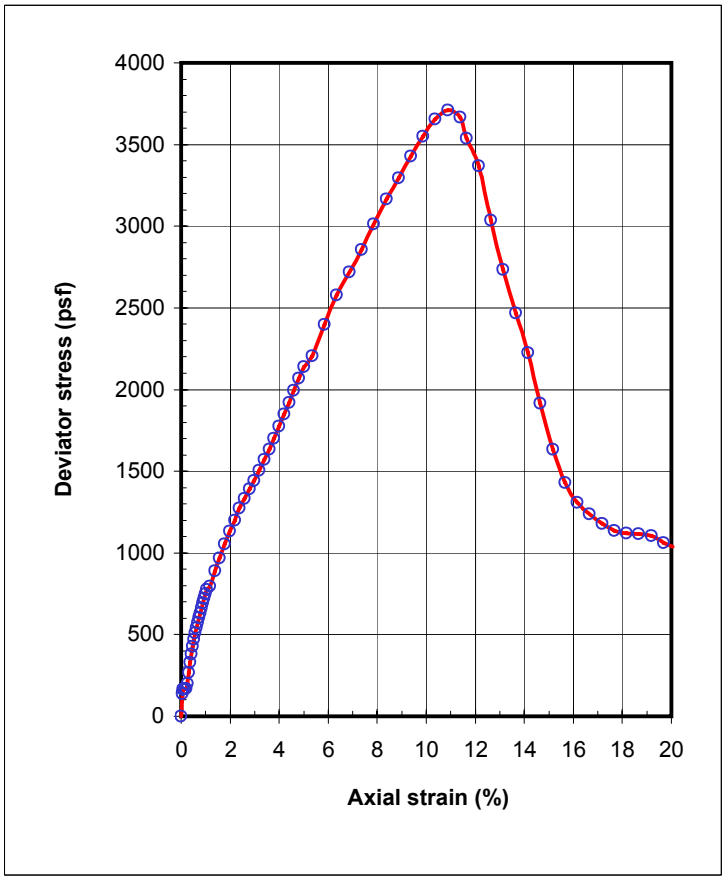
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 7A
Depth (ft) : 17.8
Date tested : 05/30/08
Soil : Reddish brown clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 976.6 gms
Ht. = 5.950 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 448.7 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.478
Ht/Dia ratio = 2.46
Moisture = 19.1 %
Total density = 135.8 pcf
Dry density = 114.0 pcf
Saturation = 108.2 %
Chamber pressure = 3100 psf
Max. deviator stress = 3708 psf
Strain @ failure = 10.88 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	4.4	0.05	136.6
0.003	5.3	0.07	166.3
0.005	5.3	0.10	165.7
0.007	5.4	0.14	167.9
0.011	5.4	0.20	169.1
0.014	6.4	0.25	201.2
0.017	8.6	0.31	268.3
0.020	10.6	0.36	329.1
0.023	12.2	0.41	379.2
0.026	13.7	0.47	426.1
0.029	15.1	0.52	469.8
0.033	16.3	0.57	508.1
0.036	17.4	0.62	542.1
0.039	18.4	0.68	573.0
0.042	19.5	0.73	604.7
0.045	20.3	0.79	631.5
0.049	21.4	0.84	663.2
0.052	22.3	0.89	692.1
0.054	23.3	0.93	721.5
0.058	24.1	0.99	748.1
0.061	25.0	1.05	774.0
0.068	25.7	1.17	794.0
0.080	28.8	1.37	890.2
0.092	31.5	1.58	968.8
0.104	34.3	1.78	1055.1
0.116	36.9	1.98	1133.1
0.128	39.2	2.18	1199.9
0.140	41.7	2.38	1272.8
0.152	43.6	2.58	1330.3
0.164	45.7	2.79	1391.0
0.176	47.5	2.99	1443.1
0.188	49.6	3.19	1502.6
0.200	52.0	3.39	1572.9
0.212	54.2	3.59	1635.6
0.224	56.5	3.79	1700.9
0.236	59.0	4.00	1773.0
0.248	61.7	4.20	1850.0
0.260	64.1	4.40	1919.2
0.272	66.7	4.60	1992.3
0.284	69.4	4.80	2066.6
0.296	72.0	5.00	2139.6
0.317	74.4	5.35	2204.5
0.347	81.4	5.86	2399.6
0.377	87.9	6.35	2576.7
0.407	93.3	6.86	2719.3
0.437	98.5	7.37	2855.5
0.466	104.4	7.86	3011.3
0.497	110.4	8.37	3164.5

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

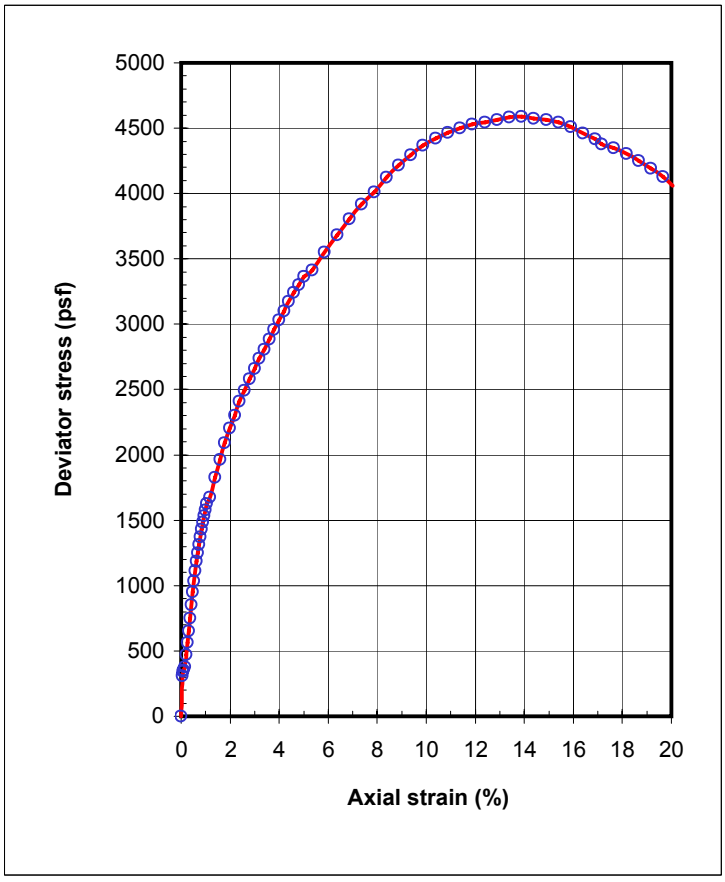
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 15A
Depth (ft) : 37.8
Date tested : 05/30/08
Soil : Reddish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 944.1 gms
Ht. = 5.990 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 451.7 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.559
Ht/Dia ratio = 2.48
Moisture = 20.7 %
Total density = 130.4 pcf
Dry density = 108.1 pcf
Saturation = 99.9 %
Chamber pressure = 6550 psf
Max. deviator stress = 4591 psf
Strain @ failure = 13.89 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	9.9	0.05	310.8
0.003	11.0	0.07	343.1
0.004	11.3	0.09	351.9
0.007	12.1	0.15	379.0
0.011	15.1	0.20	471.4
0.014	18.0	0.25	561.7
0.017	20.8	0.31	649.1
0.020	24.0	0.36	748.9
0.023	27.3	0.41	851.5
0.027	30.4	0.47	948.4
0.030	33.2	0.52	1033.0
0.033	35.8	0.57	1112.4
0.036	38.0	0.63	1183.2
0.039	40.2	0.68	1248.8
0.042	42.3	0.73	1314.0
0.046	44.2	0.78	1371.3
0.049	46.0	0.84	1428.0
0.052	47.8	0.89	1482.8
0.055	49.4	0.94	1532.1
0.058	51.0	1.00	1579.2
0.062	52.6	1.05	1627.5
0.069	54.1	1.18	1672.8
0.081	59.2	1.38	1827.7
0.093	63.7	1.58	1961.9
0.105	68.0	1.78	2088.9
0.118	71.8	1.99	2202.5
0.129	75.2	2.19	2302.0
0.142	78.8	2.39	2407.6
0.154	81.8	2.59	2494.7
0.166	84.8	2.79	2579.7
0.178	87.6	2.99	2658.0
0.190	90.3	3.19	2736.4
0.202	92.9	3.39	2807.2
0.214	95.6	3.59	2884.2
0.226	98.2	3.79	2957.2
0.238	100.9	4.00	3032.9
0.250	103.5	4.20	3101.8
0.262	106.0	4.40	3171.6
0.274	108.6	4.60	3240.9
0.286	110.7	4.80	3299.4
0.298	113.1	5.00	3362.4
0.319	115.3	5.35	3415.7
0.350	120.5	5.86	3551.2
0.380	125.7	6.36	3682.4
0.410	130.5	6.87	3804.4
0.440	135.1	7.37	3915.8
0.470	139.2	7.88	4012.1
0.501	143.8	8.38	4123.6

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

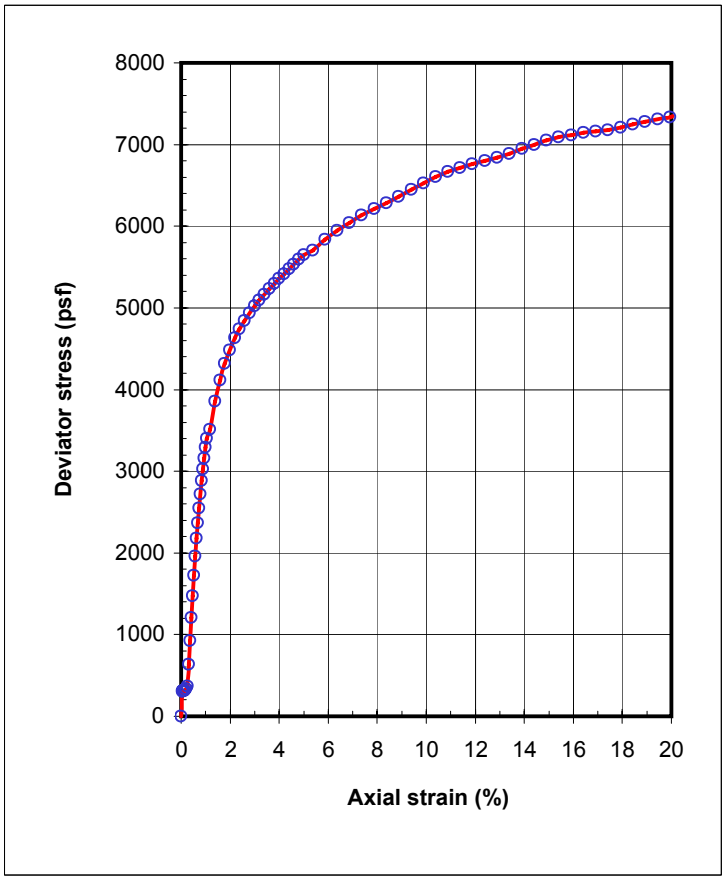
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 15B
Depth (ft) : 38.3
Date tested : 05/30/08
Soil : Yellowish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 845.2 gms
Ht. = 5.510 in
Ave dia. = 2.413 in
Area = 4.576 sq.in
Volume = 413.2 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.615
Ht/Dia ratio = 2.28
Moisture = 22.3 %
Total density = 127.6 pcf
Dry density = 104.3 pcf
Saturation = 98.1 %
Chamber pressure = 6550 psf
Max. deviator stress = 7350 psf
Strain @ failure = 20.04 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	9.6	0.05	302.6
0.003	9.8	0.08	308.9
0.004	9.9	0.11	309.8
0.007	10.1	0.16	316.8
0.010	10.7	0.21	334.5
0.013	11.7	0.27	366.7
0.016	20.2	0.31	634.6
0.019	29.5	0.37	926.1
0.022	38.5	0.42	1206.7
0.025	47.0	0.47	1473.2
0.027	55.0	0.53	1722.2
0.030	62.6	0.58	1958.8
0.033	69.6	0.63	2176.6
0.036	75.8	0.69	2369.1
0.039	81.6	0.74	2547.5
0.042	87.2	0.79	2722.7
0.045	92.5	0.85	2887.1
0.047	97.1	0.89	3026.9
0.051	101.3	0.94	3159.0
0.053	105.5	1.00	3287.5
0.056	109.3	1.05	3404.2
0.063	113.0	1.18	3513.7
0.075	124.2	1.38	3855.0
0.086	132.9	1.58	4117.4
0.097	139.8	1.78	4319.3
0.108	145.4	1.98	4484.1
0.119	150.3	2.19	4627.3
0.130	154.5	2.39	4744.3
0.141	158.0	2.59	4844.7
0.152	161.4	2.79	4938.0
0.163	164.5	2.99	5022.3
0.174	167.2	3.19	5092.7
0.186	169.9	3.40	5165.4
0.197	172.6	3.60	5234.8
0.208	174.9	3.80	5293.6
0.219	177.5	4.00	5361.0
0.230	179.7	4.20	5417.4
0.241	182.0	4.40	5474.3
0.252	184.3	4.61	5533.2
0.263	186.8	4.81	5594.4
0.274	189.1	5.01	5652.1
0.294	191.5	5.37	5702.1
0.322	197.1	5.87	5837.4
0.350	201.8	6.37	5946.4
0.377	206.2	6.87	6043.7
0.404	210.5	7.37	6136.9
0.432	214.3	7.88	6213.7
0.460	217.9	8.38	6283.2

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

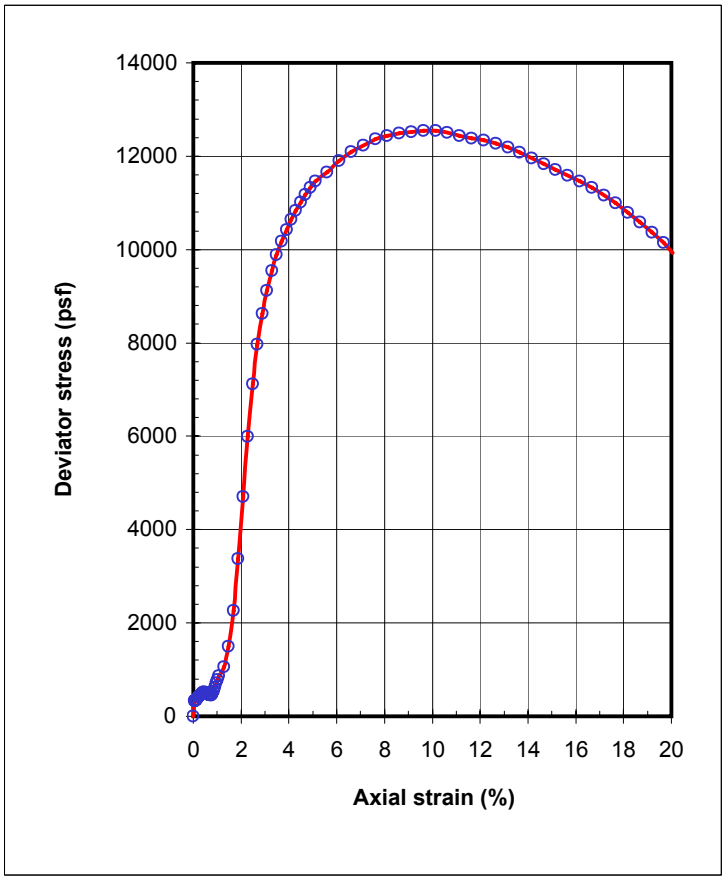
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R2
Sample # : 17
Depth (ft) : 42.8
Date tested : 05/30/08
Soil : Yellowish brown clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 905.4 gms
Ht. = 5.660 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 426.8 c.c.
Shearing rate = 0.06 inch/min
Shearing rate = 1 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.519
Ht/Dia ratio = 2.34
Moisture = 19.4 %
Total density = 132.4 pcf
Dry density = 110.9 pcf
Saturation = 100.7 %
Chamber pressure = 7400 psf
Max. deviator stress = 12547 psf
Strain @ failure = 9.63 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	10.5	0.05	328.0
0.003	10.5	0.07	327.3
0.004	10.4	0.11	325.9
0.007	11.4	0.16	356.4
0.010	13.1	0.21	409.4
0.014	14.0	0.27	436.5
0.017	14.7	0.32	457.6
0.019	15.7	0.37	488.1
0.022	16.1	0.42	500.7
0.024	16.8	0.44	524.1
0.027	16.1	0.50	500.4
0.030	16.3	0.56	506.0
0.033	15.2	0.61	472.3
0.036	14.9	0.66	464.6
0.039	14.4	0.71	447.9
0.042	14.5	0.77	448.9
0.044	15.5	0.81	480.2
0.047	17.3	0.86	536.0
0.050	20.1	0.92	623.1
0.053	23.0	0.97	712.0
0.056	25.2	1.02	781.1
0.059	27.7	1.08	858.7
0.071	34.1	1.28	1053.2
0.082	48.4	1.48	1491.3
0.094	73.3	1.68	2256.4
0.105	109.8	1.88	3371.8
0.116	153.6	2.08	4707.6
0.128	195.7	2.28	5985.5
0.139	233.3	2.49	7119.5
0.151	261.5	2.69	7962.3
0.162	283.8	2.89	8623.8
0.173	300.8	3.09	9122.8
0.185	315.1	3.29	9537.5
0.196	327.4	3.49	9886.5
0.208	337.6	3.70	10176.0
0.219	346.7	3.90	10426.0
0.230	354.7	4.10	10645.6
0.242	361.9	4.30	10837.5
0.253	368.3	4.50	11008.1
0.264	374.8	4.70	11177.0
0.276	380.5	4.90	11323.6
0.287	385.9	5.10	11459.6
0.316	394.5	5.61	11653.4
0.344	404.9	6.11	11895.9
0.373	413.7	6.61	12089.9
0.401	420.8	7.11	12232.4
0.430	427.7	7.62	12363.7
0.458	432.7	8.12	12439.8

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

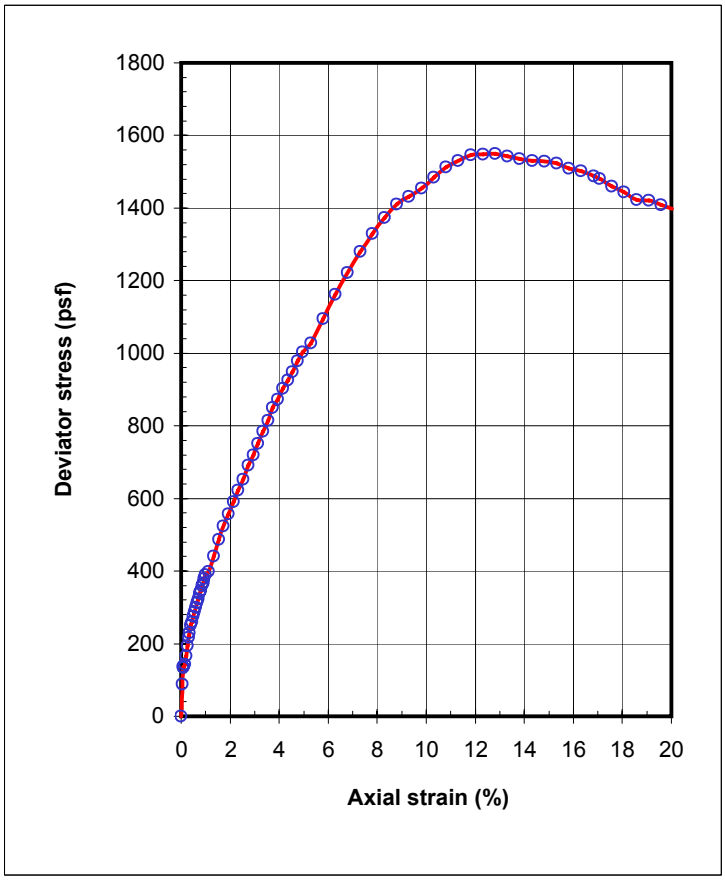
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R3A
Sample # : 9A
Depth (ft) : 12.8
Date tested : 05/30/08
Soil : Dark brown sandy clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 921.7 gms
Ht. = 5.850 in
Ave dia. = 2.407 in
Area = 4.551 sq.in
Volume = 436.3 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.516
Ht/Dia ratio = 2.43
Moisture = 18.6 %
Total density = 131.8 pcf
Dry density = 111.2 pcf
Saturation = 97.4 %
Chamber pressure = 2250 psf
Max. deviator stress = 1549 psf
Strain @ failure = 12.81 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	2.8	0.05	88.4
0.003	4.3	0.08	135.0
0.004	4.2	0.10	134.1
0.007	4.5	0.15	143.2
0.010	5.3	0.20	166.0
0.013	6.2	0.25	194.4
0.016	6.9	0.30	216.1
0.019	7.3	0.35	230.0
0.022	7.9	0.40	249.5
0.025	8.2	0.45	259.2
0.028	8.8	0.50	275.6
0.031	9.1	0.55	286.6
0.033	9.5	0.60	299.3
0.036	9.9	0.65	312.0
0.039	10.3	0.70	323.0
0.042	10.8	0.75	338.2
0.045	11.0	0.80	346.3
0.048	11.4	0.85	359.0
0.051	11.7	0.90	367.1
0.054	12.1	0.95	379.3
0.057	12.5	1.00	390.3
0.064	12.7	1.13	398.8
0.076	14.1	1.33	440.5
0.088	15.6	1.53	485.7
0.099	16.8	1.73	523.3
0.111	18.0	1.93	557.9
0.123	19.0	2.13	589.9
0.135	20.1	2.33	622.5
0.147	21.2	2.54	652.5
0.158	22.4	2.74	690.2
0.170	23.4	2.94	719.9
0.182	24.5	3.14	751.4
0.194	25.7	3.34	784.6
0.205	26.7	3.54	814.9
0.217	27.9	3.74	849.0
0.229	28.7	3.94	872.2
0.240	29.7	4.14	901.8
0.253	30.6	4.35	925.5
0.264	31.4	4.54	947.7
0.276	32.5	4.74	978.6
0.288	33.4	4.95	1003.9
0.308	34.3	5.30	1027.4
0.338	36.7	5.80	1094.9
0.367	39.2	6.30	1162.0
0.396	41.4	6.80	1220.9
0.426	43.7	7.31	1280.4
0.455	45.5	7.80	1328.7
0.484	47.3	8.30	1373.8

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

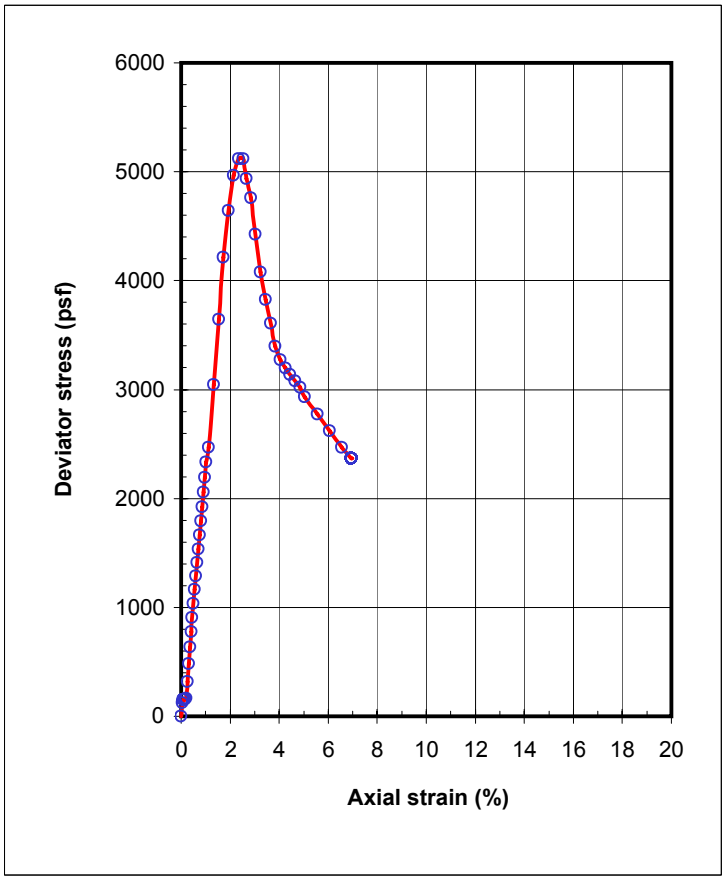
Client : Arup
Project : Doyle Drive Replacement Project
Job # : 131558
Boring # BTSB-R3A
Sample # : 11
Depth (ft) : 17.8
Date tested : 05/31/08
Soil : Yellowish brown clayey sand

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 936.5 gms
Ht. = 5.450 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 411.0 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.309
Ht/Dia ratio = 2.25
Moisture = 10.5 %
Total density = 142.2 pcf
Dry density = 128.7 pcf
Saturation = 91.7 %
Chamber pressure = 3100 psf
Max. deviator stress = 5121 psf
Strain @ failure = 2.34 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	3.9	0.06	123.0
0.003	4.8	0.08	151.1
0.004	4.8	0.11	150.7
0.007	4.9	0.16	151.6
0.009	5.3	0.21	166.9
0.012	10.3	0.26	320.0
0.015	15.4	0.31	481.2
0.018	20.4	0.36	635.2
0.020	24.9	0.41	774.8
0.023	29.1	0.46	906.3
0.026	33.2	0.51	1034.6
0.028	37.4	0.56	1162.5
0.031	41.3	0.61	1285.2
0.034	45.3	0.66	1409.9
0.037	49.4	0.71	1535.4
0.039	53.5	0.76	1660.2
0.042	57.7	0.81	1790.9
0.045	61.9	0.86	1919.5
0.048	66.3	0.91	2056.2
0.050	70.8	0.96	2192.9
0.053	75.3	1.01	2332.2
0.060	79.8	1.13	2468.3
0.071	98.7	1.33	3046.3
0.082	118.3	1.53	3645.3
0.092	137.0	1.73	4212.7
0.104	151.2	1.94	4639.7
0.114	162.2	2.14	4968.4
0.126	167.6	2.34	5121.3
0.137	167.8	2.54	5118.1
0.143	162.0	2.66	4933.9
0.153	156.6	2.84	4761.5
0.164	145.7	3.04	4422.1
0.175	134.6	3.24	4076.0
0.186	126.6	3.44	3824.6
0.197	119.7	3.65	3608.0
0.208	112.9	3.85	3398.5
0.219	109.0	4.05	3273.8
0.230	106.6	4.25	3194.2
0.240	104.9	4.45	3136.6
0.251	103.2	4.65	3080.7
0.263	101.5	4.85	3021.1
0.273	98.7	5.05	2932.0
0.301	93.9	5.56	2774.1
0.328	89.2	6.05	2621.7
0.356	84.5	6.56	2470.1
0.376	81.3	6.93	2367.7

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

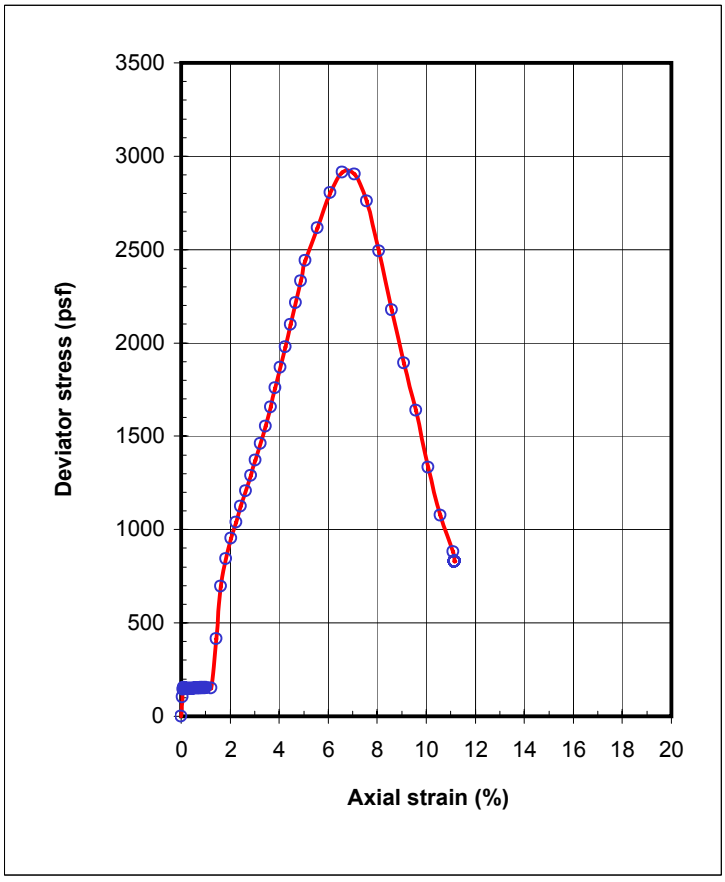
Client : Arup
Project : Doyle Drive Replacement Project - Retaining Wall #8
Job # : EA04-163701
Boring # RW8-R1
Sample # : 9
Depth (ft) : 22.5
Date tested : 01/27/09
Soil : Brown sandy clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 1243.4 gms
Ht. = 5.910 in
Ave dia. = 2.840 in
Area = 6.337 sq.in
Volume = 613.7 c.c.
Shearing rate = 0.04 inch/min
Shearing rate = 0.75 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.594
Ht/Dia ratio = 2.08
Moisture = 19.6 %
Total density = 126.4 pcf
Dry density = 105.7 pcf
Saturation = 89.0 %
Chamber pressure = 4200 psf
Max. deviator stress = 2914 psf
Strain @ failure = 6.57 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	4.5	0.05	103.2
0.003	6.4	0.07	145.5
0.004	6.8	0.10	154.6
0.007	6.6	0.15	150.4
0.010	6.6	0.20	149.3
0.013	6.5	0.25	147.3
0.016	6.6	0.30	148.4
0.018	6.5	0.32	147.9
0.021	6.6	0.37	149.5
0.024	6.6	0.42	148.4
0.027	6.6	0.47	148.8
0.030	6.6	0.52	150.0
0.032	6.6	0.57	149.7
0.035	6.7	0.62	150.6
0.038	6.7	0.67	151.1
0.041	6.7	0.72	151.2
0.044	6.7	0.77	151.6
0.047	6.8	0.82	153.7
0.050	6.8	0.87	152.2
0.053	6.8	0.92	153.1
0.056	6.7	0.97	151.8
0.059	6.8	1.02	153.4
0.071	6.8	1.23	152.0
0.083	18.5	1.43	414.7
0.095	31.1	1.63	695.9
0.107	37.8	1.83	844.3
0.119	42.7	2.03	951.5
0.131	46.7	2.24	1038.2
0.143	50.8	2.44	1125.1
0.155	54.5	2.64	1206.5
0.166	58.3	2.84	1287.3
0.178	62.3	3.04	1372.2
0.190	66.4	3.24	1459.6
0.202	70.8	3.44	1553.5
0.214	75.6	3.65	1654.9
0.226	80.4	3.85	1757.5
0.238	85.6	4.06	1866.9
0.250	90.9	4.26	1977.9
0.263	96.6	4.47	2098.0
0.274	102.2	4.66	2214.6
0.286	107.9	4.87	2332.3
0.298	113.2	5.07	2442.3
0.328	121.9	5.57	2615.9
0.357	131.5	6.07	2805.7
0.387	137.3	6.57	2914.1
0.417	137.5	7.07	2903.3
0.446	131.5	7.58	2761.0
0.476	119.3	8.08	2491.8

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

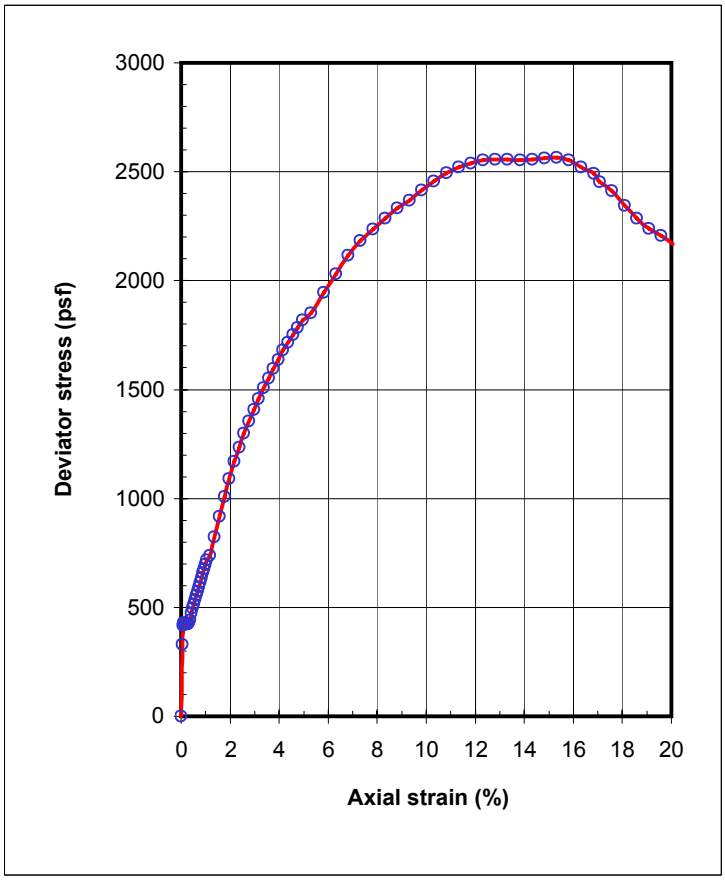
Client : Arup
Project : Doyle Drive Replacement Project - Retaining Wall #8
Job # : EA04-163701
Boring # RW8-R1
Sample # : 16A
Depth (ft) : 43
Date tested : 01/24/09
Soil : Brown clay with gravel

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:
Total wt. = 799.0 gms
Ht. = 5.210 in
Ave dia. = 2.420 in
Area = 4.601 sq.in
Volume = 392.9 c.c.
Shearing rate = 0.03 inch/min
Shearing rate = 0.5 %/min
Gs (assumed) = 2.70

Test Report:
Void ratio = 0.634
Ht/Dia ratio = 2.15
Moisture = 23.1 %
Total density = 126.9 pcf
Dry density = 103.1 pcf
Saturation = 98.4 %
Chamber pressure = 8175 psf
Max. deviator stress = 2564 psf
Strain @ failure = 15.33 %



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	10.5	0.06	328.8
0.003	13.4	0.08	418.7
0.004	13.7	0.11	428.9
0.007	13.6	0.16	424.1
0.009	13.6	0.21	423.7
0.012	13.5	0.27	422.9
0.015	13.7	0.32	427.3
0.018	14.1	0.37	441.1
0.020	15.1	0.43	471.7
0.023	15.9	0.48	495.6
0.026	16.5	0.53	513.9
0.028	17.2	0.58	535.3
0.031	17.8	0.63	554.1
0.034	18.5	0.68	574.4
0.037	19.1	0.73	593.5
0.039	19.8	0.79	615.3
0.042	20.5	0.84	635.1
0.045	21.2	0.89	657.1
0.047	21.8	0.94	675.1
0.050	22.5	0.99	696.0
0.052	23.1	1.04	716.7
0.059	23.8	1.17	737.4
0.069	26.7	1.37	824.0
0.080	29.8	1.57	917.6
0.090	32.8	1.77	1008.8
0.101	35.6	1.97	1091.0
0.111	38.2	2.17	1168.2
0.121	40.4	2.36	1234.6
0.132	42.6	2.57	1298.5
0.142	44.5	2.76	1353.2
0.153	46.4	2.97	1408.9
0.163	48.1	3.16	1458.5
0.174	49.8	3.36	1507.0
0.184	51.4	3.56	1552.2
0.194	53.0	3.76	1596.2
0.205	54.5	3.96	1637.0
0.215	56.1	4.16	1681.9
0.226	57.3	4.36	1715.6
0.236	58.6	4.56	1751.0
0.246	59.8	4.76	1782.7
0.257	61.1	4.97	1818.1
0.275	62.5	5.31	1851.4
0.301	66.0	5.81	1944.9
0.327	69.2	6.31	2030.0
0.353	72.5	6.82	2114.3
0.380	75.2	7.32	2181.8
0.406	77.5	7.82	2235.0
0.432	79.7	8.32	2287.3

Reviewed For Adequacy (RFA)

REC'D JUL 10 2008

By: TC

Date: 7/10/2008

ADVANCED TERRA TESTING, Inc.

833 Parfet Street • Lakewood, Colorado 80215 • (303) 232-8308 • Fax: (303) 232-1579

UNCONFINDED COMPRESSIVE STRENGTH
ASTM D 7012 Method D

UNCONFINED COMPRESSIVE STRENGTH
With Stress / Strain Measurements
ASTM D 7012; Method D (Previously ASTM D 3148)

CLIENT: ARUP PB JOB NO.: 2653-13

LOCATION: Doyle Drive Replacement DATE TESTED: 6/24-27/08 HN

Specimen ID			Diameter (in.)	Length (in.)	Mass (gms)	Wet Density (pcf)	Failure Load (lb)	Failure Type **	Compressive Strength (psi)	Young's Modulus (X10^6 psi)	Poisson's Ratio
Boring	Depth (ft.)	Rock type									
BTSB-R1	36.0-36.5	Sandstone	2.400	5.227	1021.60	164.6	49,050	S/F	10,840	4.23	0.184
BTSB-R1	44.90-45.45	Sandstone	2.399	5.326	1051.40	166.4	57,000	F/S	12,610	6.63	0.202
BTSB-R3	24.80-25.35	Sandstone	2.398	4.850	909.50	158.2	22,000	F	4,870	1.35	0.086
BTSB-R3	30.0-30.4	Sandstone	2.401	3.886	735.50	159.3	15,600	F	*3350	1.78	0.197
BTSB-R3	44.2-44.7	Sandstone	2.395	5.437	1037.00	161.3	42,500	F	9,430	4.96	0.109
BTSB-R3	50.15-50.65	Sandstone	2.408	5.220	1029.00	164.9	76,500	S/F	16,800	5.45	0.136
BTSB-R3	81.4-81.9	Sandstone	2.410	5.053	1005.70	166.2	16,000	F	3,510	3.30	0.193
M-9/RW-7A1A	46.65-47.20	Gabro	2.382	5.499	1047.70	162.9	35,000	F/S	7,850	6.92	0.278
BTNB-R4	96.36-96.90	Serpentinite	2.401	5.036	852.00	142.4	5,800	F/S	1,280	0.72	0.108
BTNB-R5	88.1-88.6	Sandstone	2.389	5.011	965.60	163.8	39,500	F	8,810	1.33	0.089
BTNB-R5A	25.2-25.7	Sandstone	2.405	5.193	1025.70	165.6	44,500	F	9,800	4.92	0.108
BTNB-R6	47.5-47.9	Serpentinite	2.399	5.076	795.40	132.1	1,800	F	400	0.15	0.095
BTNB-R6	83.6-84.0	Gabro	2.398	5.326	954.10	151.1	16,500	F/S	3,650	1.10	0.177
RW6-R1	26.60-27.20	Sandstone	2.403	5.816	1056.60	152.6	14,000	F/S	3,090	0.46	0.131
RW6-R1	45.10-45.55	Sandstone	2.394	3.891	751.40	163.4	67,000	S	*14480	4.17	0.114
RW6-R2	30.7-31.2	Sandstone	2.396	5.330	1012.50	160.5	17,000	F	3,770	1.25	0.121
RW8-R1	121.65-122.15	-	2.398	5.219	931.10	150.5	8,000	F/S	1,770	0.76	0.200

Notes and Comments:

* Indicates regardless of ASTM D 7012 method D, sample with L/D < 2.0.
was tested and correction factor for short sample was applied to the calculation.
C=Ca/[0.88+0.24b/h]
Ca = Failure Load / Surface Area
b = Sample Diameter
h = Sample Length

** Failure Type:
S: Shear Failure, M: Matrix Failure, F/V Fracture, Bedding/Void Collapse, C: Combination

Data Entered By: HN Date: 06/28/2008
Data Checked By: CJ Date: 06/30/08
Filename: ARUCSS13

ADVANCED TERRA TESTING, INC. ATT

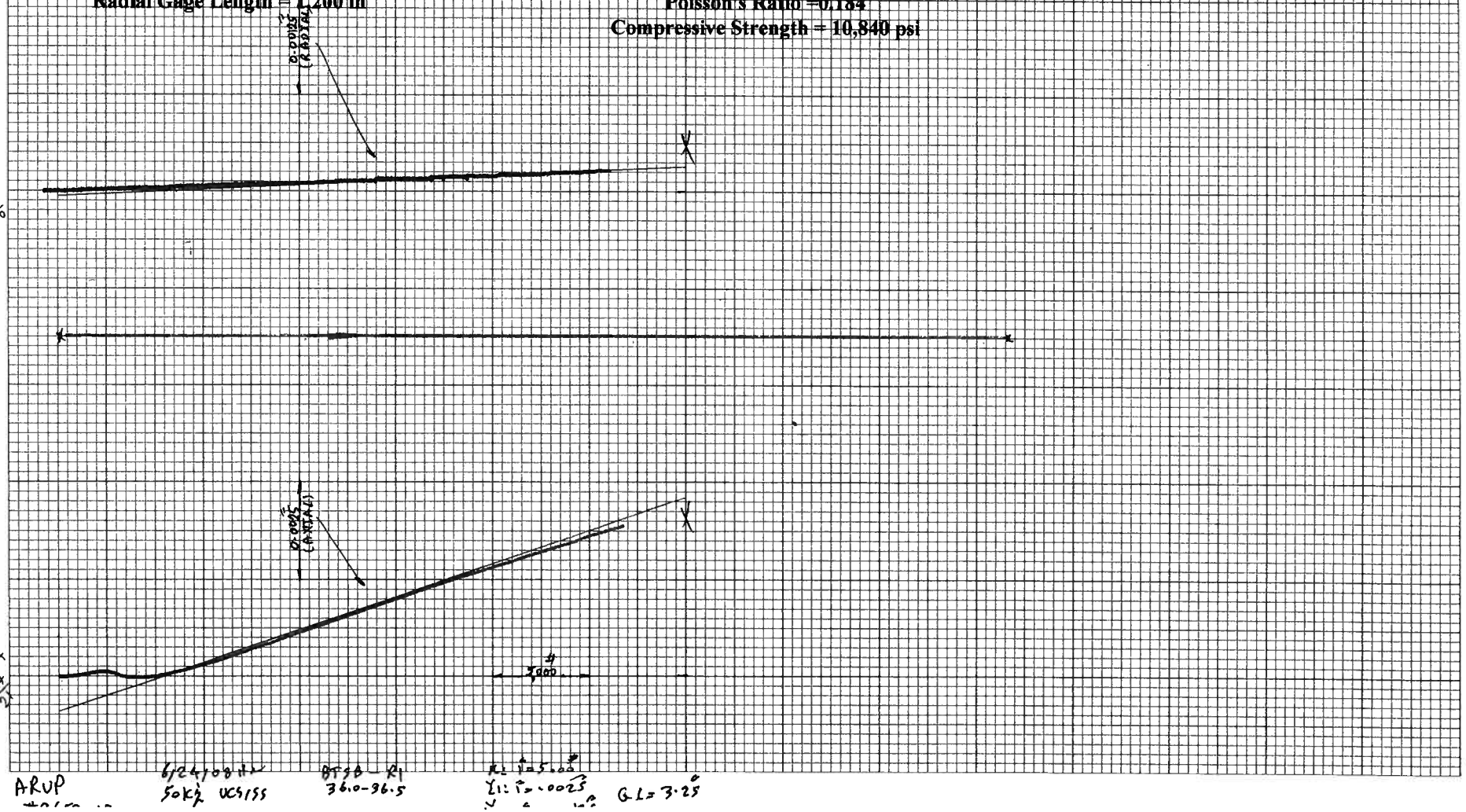
ARUP PB

BTSB-R1, 36.0-36.5
Diameter = 2.400 in
Area = 4.524 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.200 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 4.23 x 10⁶ psi
Poisson's Ratio = 0.184
Compressive Strength = 10,840 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
50 kip Load Cell
Scales: X: 1" = 5,000 #
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.00125



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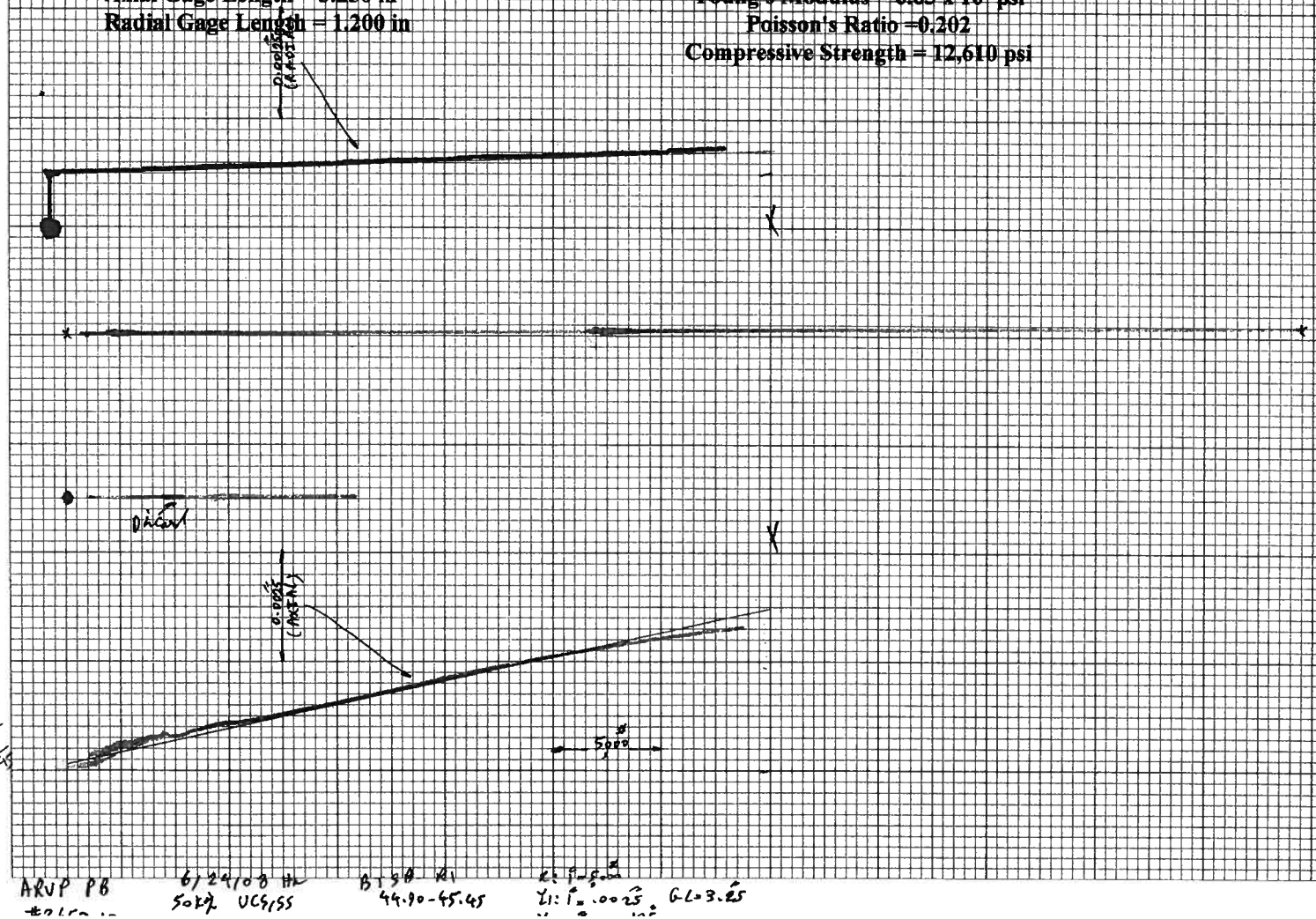
ARUP PB

BTSB-R1, 44.90-45.45
Diameter = 2.399 in
Area = 4.520 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.200 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 6.63 x 10^6 psi
Poisson's Ratio = 0.202
Compressive Strength = 12,610 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
50 kip Load Cell
Scales: X: 1" = 5,000 #
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.00125



ARUP PB 6/24/08 HL B1 SB R1
50kip UCS/SS 44.90-45.45
R: 1"=5,000#
Y1: 1"=.0025" GL=3.25

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ADVANCED TERRA TESTING, INC. ATT

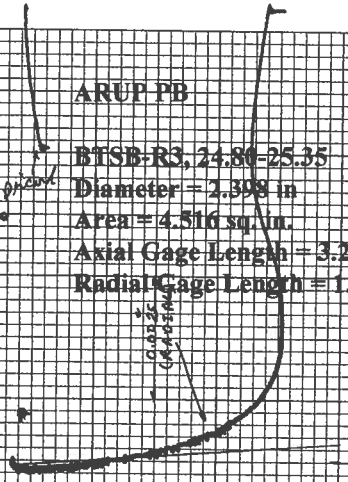
ARUP PB

BTSB-R3, 24.80-25.35
Diameter = 2.398 in
Area = 4.516 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.199 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

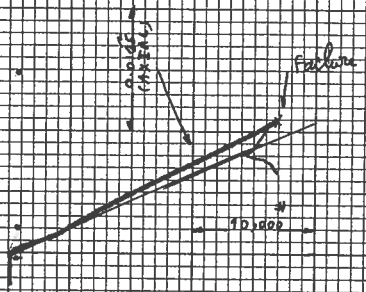
Young's Modulus = 1.35 x 10^6 psi
Poisson's Ratio = 0.086
Compressive Strength = 4,870 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
250 kip Load Cell
Scales: X: 1" = 10,000 #
Y (Axial): 1" = 0.0125"
Y (Radial): 1" = 0.0025



.14
.03
.17

Note: Failure during stress/strain measurements



1.07

ARUP PB
#2653-13
6/24/08 HN
200 kip UC9195
BTSB-R3
24.80-25.35
Gl=3.25

Filename: f:\users\don\tcsstemp.lwp

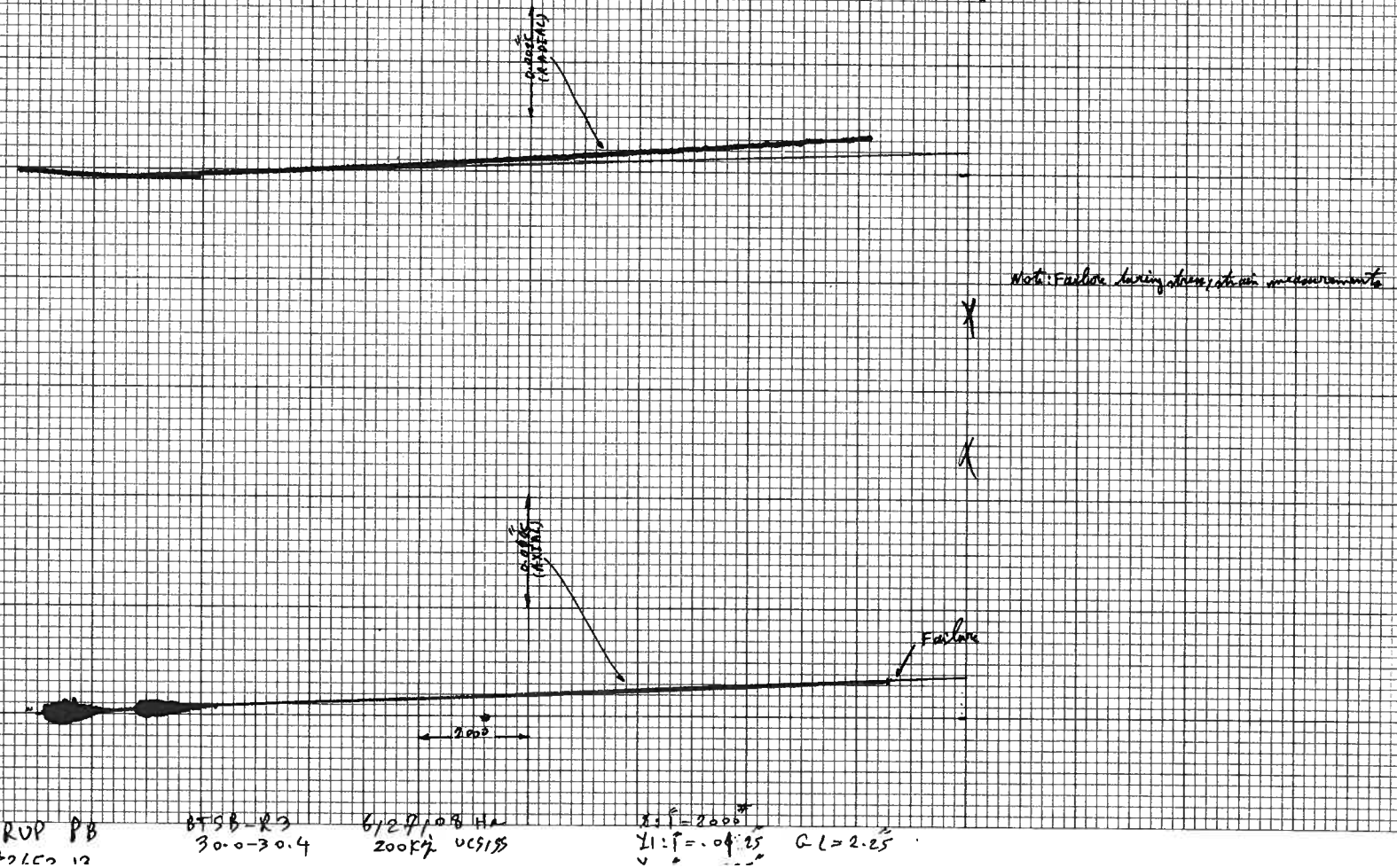
ARUP PB

BTSB-R3, 30.0-30.4
Diameter = 2.401 in
Area = 4.528 sq. in.
Axial Gage Length = 2.250 in
Radial Gage Length = 1.201 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 1.78 x 10⁶ psi
Poisson's Ratio = 0.197
Compressive Strength = 3,350 psi

Job No.: 2653-13
Tested By: HN Date: 6-27-08
250 kip Load Cell
Scales: X: 1" = 2,000 #
Y (Axial): 1" = 0.0125"
Y (Radial): 1" = 0.0025"



ARUP PB
#2653-13
BTSB-R3
30.0-30.4
6/27/08 HN
200K# UCS155
Y1: 1" = .0125" Gl = 2.25"

Filename: f:\users\don\tcsstemp.lwp

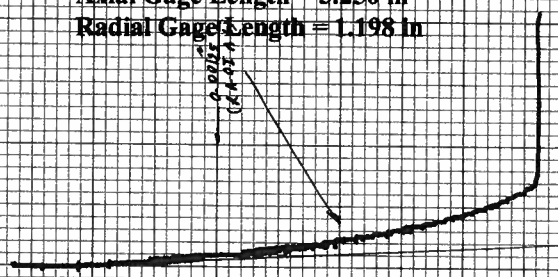
ARUP PB

BTSB-R3, 44.20-44.75
Diameter = 2.395 in
Area = 4.505 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.198 in

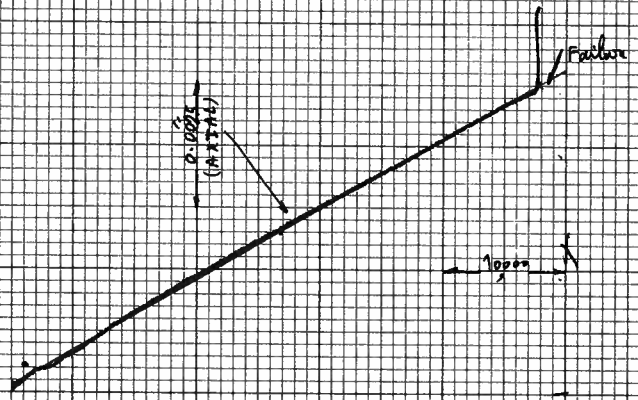
UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 4.96 x 10^6 psi
Poisson's Ratio = 0.109
Compressive Strength = 9,430 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
50 kip Load Cell
Scales: X: 1" = 10,000 #
Y (Axial): 1" = 0.025"
Y (Radial): 1" = 0.00125



Note: Failure during stress/strain measurements



2.62

ARUP PB
#2652-13
6/24/08 HN
50kip UCS/SS
BTSB-R3
44.2-44.75ft
X: 1" = 10,000#
Y: 1" = .025" .00125
GL=3.25"

Filename: f:\users\don\tcsstemp.lwp

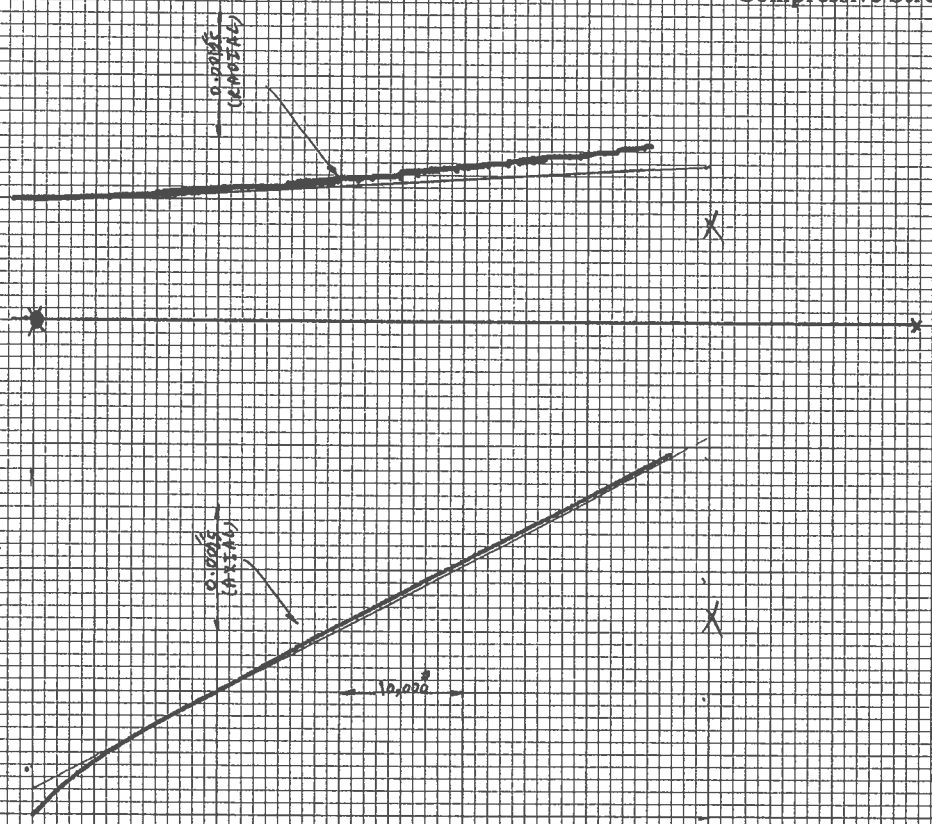
ARUP PB

BTSB-R3, 50.15-50.65
Diameter = 2.408 in
Area = 4.554 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.204 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 5.45 x 10^6 psi
Poisson's Ratio = 0.136
Compressive Strength = 16,800 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
200 kip Load Cell
Scales: X: 1" = 10,000 #
Y (Axial): 1" = 0.025"
Y (Radial): 1" = 0.00125



.29

3.09
.21
2.98

ARUP PB 6/24/08 HN BTSB-R3 X: F = 10,000# Y1: F = .0025" GL = 3.25"
#2653-13 200kip UCS/SS 50.15-50.65 Y2:

Filename: f:\users\don\tcsstemp.lwp

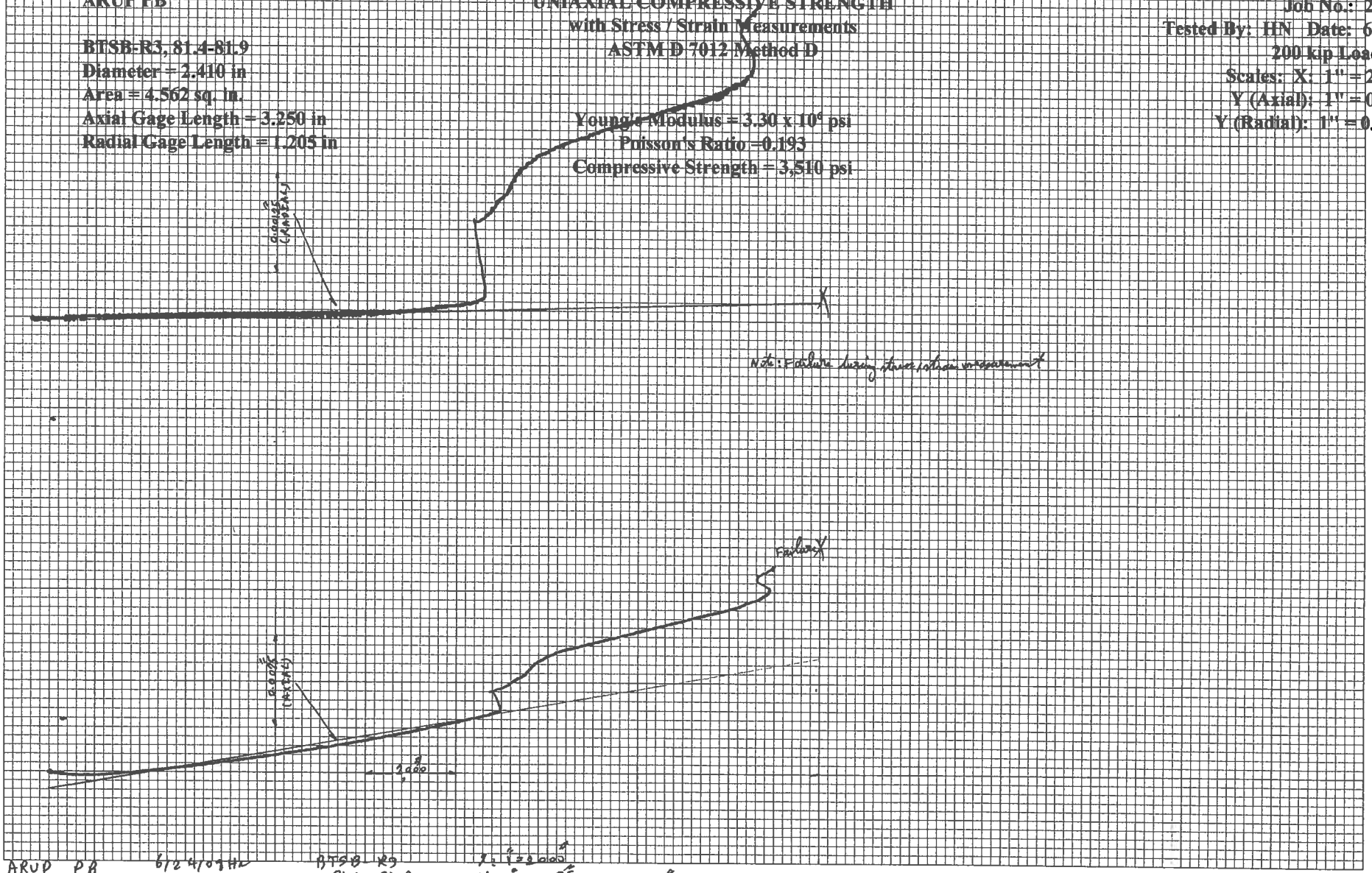
ARUP PB

BTSB-R3, 81.4-81.9
Diameter = 2.410 in
Area = 4.562 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.205 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 3.30 x 10^6 psi
Poisson's Ratio = 0.193
Compressive Strength = 3,510 psi

Job No.: 2653-13
Tested By: HN Date: 6-24-08
200 kip Load Cell
Scales: X: 1" = 2,000 #
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.00125



ARUP PB #2653-13 6/24/08 HN 200 kip UCS/SS BTSB-R3 81.4-81.9 Y1: 1" = 2,000# Y2: 1" = .0025" G.L. = 3.25"

Filename: f:\users\don\tcsstemp.lwp

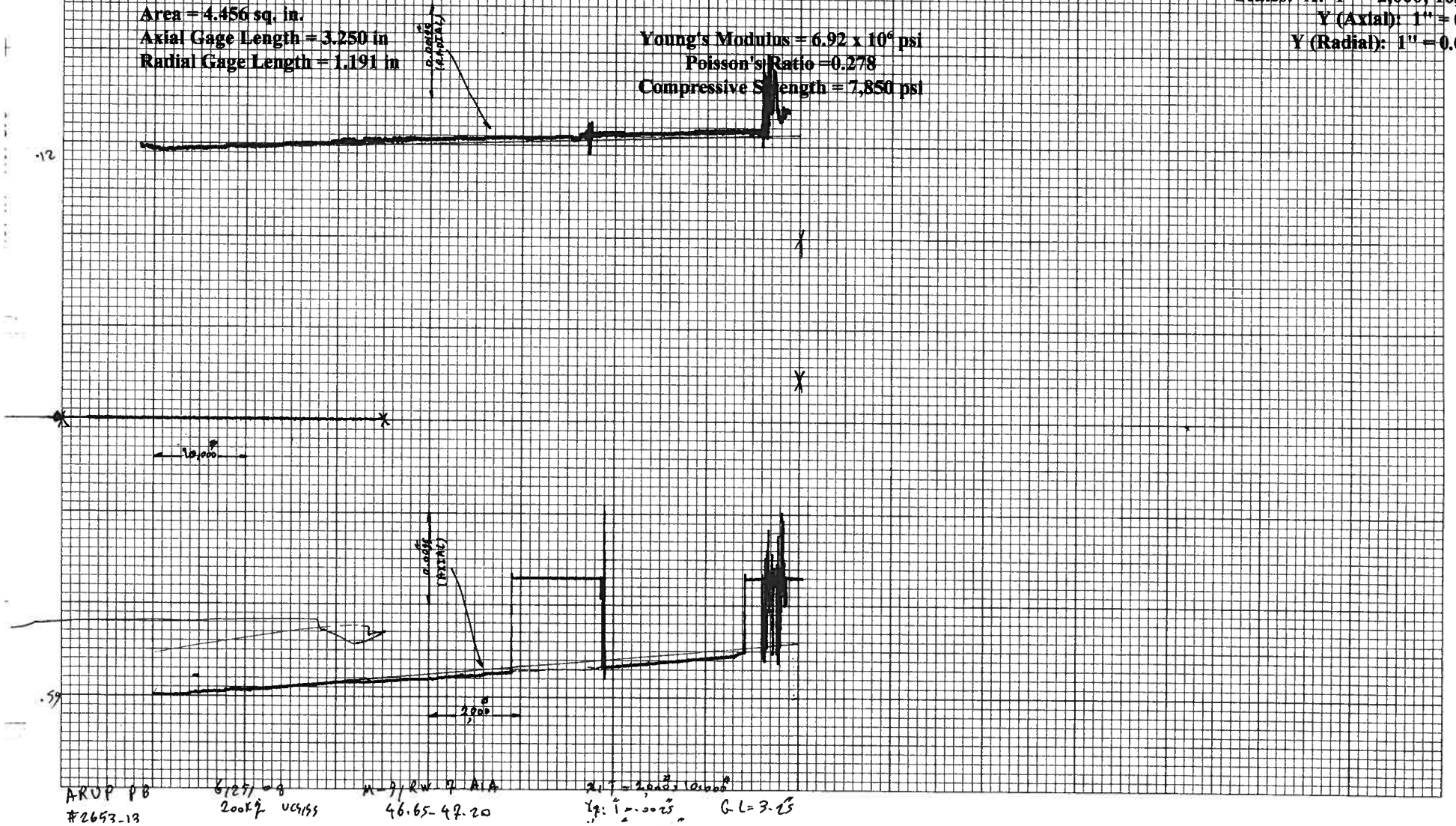
ARUP PB

M-9/RW-7A1A, 46.65-47.20
Diameter = 2.382 in
Area = 4.456 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.191 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 6.92 x 10^6 psi
Poisson's Ratio =0.278
Compressive Strength = 7,850 psi

Job No.: 2653-13
Tested By: HN Date: 6-25-08
200 kip Load Cell
Scales: X: 1" = 2,000; 10,000 #
Y (Axial): 1" = 0.025"
Y (Radial): 1" = 0.00125"



ARUP PB
#2653-13
6/27/08
200kip UCS/SS
M-9/RW-7-A1A
46.65-47.20
X: 1" = 2,000; 10,000#
Y: 1" = .025" G.L = 3.25"

Filename: f:\users\don\tcsstemp.lwp

ADVANCED TERRA TESTING, INC.
ATT

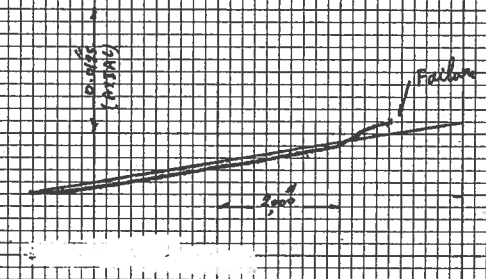
ARUP PB

BTNB-R4, 96.36-96.90
Diameter = 2.401 in
Area = 4.528 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.201 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 0.72 x 10^6 psi
Poisson's Ratio =0.171
Compressive Strength = 1,280 psi

Job No.: 2653-13
Tested By: HN Date: 6-26-08
200 kip Load Cell
Scales: X: 1" = 2,000; #
Y (Axial): 1" = 0.0125'
Y (Radial): 1" = 0.0025



ARUP PB
#2653-13

6/26/08 HN
200 kf UCS/SS

BT NB - R4
96.36-96.9

X: 1" = 2,000#
Y1: 1" = 0.0125"
Y2: 1" = .0025"
GL = 3.25"

Filename: f:\users\don\tcsstemp.lwp

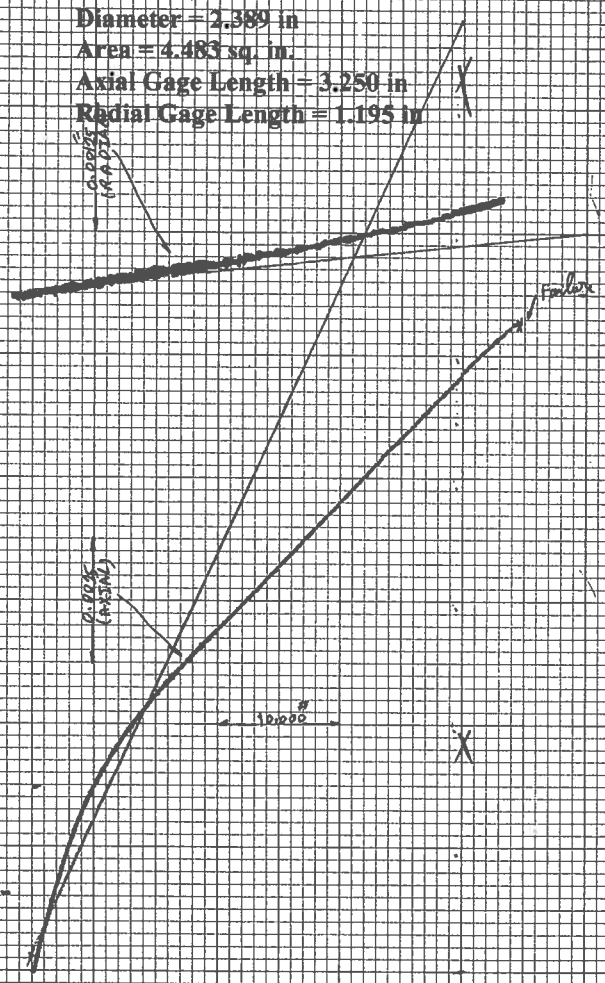
ARUP PB

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Job No.: 2653-13
Tested By: HN Date: 6-26-08
200 kip Load Cell
Scales: X: 1" = 10,000 #
Y (Axial): 1" = 0.0025'
Y (Radial): 1" = 0.00125

BTNB-R5, 88.1-88.6
Diameter = 2.389 in
Area = 4.483 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.195 in

Young's Modulus = 1.33 x 10^6 psi
Poisson's Ratio =0.089
Compressive Strength = 8,810 psi



not failure during stress/strain measurement

ARUP PB 6/26/08 HN
#2653-13 200K2 UCS155
BTNB-R5 88.1-88.6
X: 1"=10,000#
Y: 1"=.0025"

Filename: f:\users\don\tcsstemp.lwp

ADVANCED TERRA TESTING, INC.
ATT

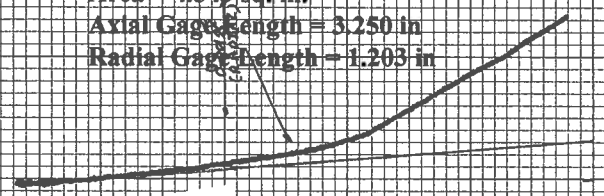
ARUP PB

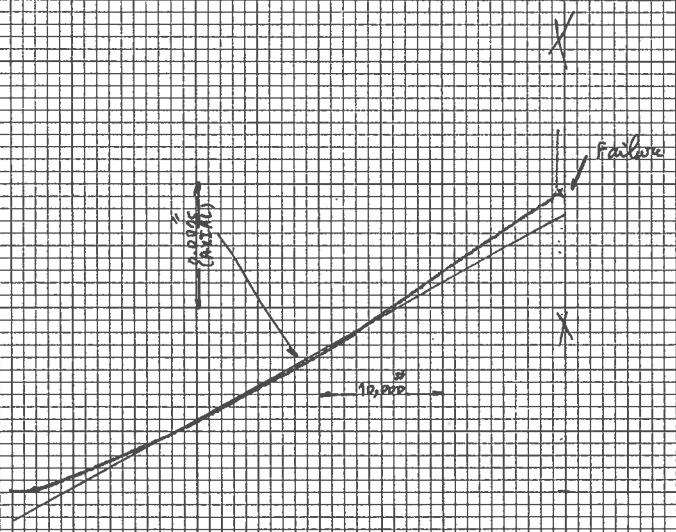
BTNB-RSA, 25.2-25.7
Diameter = 2.405 in
Area = 4.543 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.203 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 4.92 x 10^6 psi
Poisson's Ratio = 0.108
Compressive Strength = 9,800 psi

Job No.: 2653-13
Tested By: HN Date: 6-26-08
200 kip Load Cell
Scales: X: 1" = 10,000 #
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.00125





ARUP PB
#2653-13

6/26/08 HN
200K# UCS/SS

BTNB-RSA
25.2-25.7

Y: 1" = .0025"
X: 1" = 10,000#
RL = 3.95"

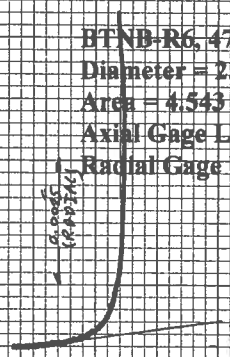
ARUP PB

BTNB-R6, 47.5-47.9
Diameter = 2.399 in
Area = 4.543 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.200 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

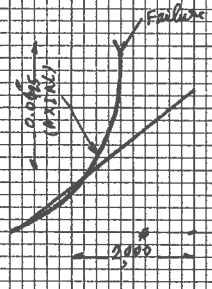
Young's Modulus = 0.15 x 10^6 psi
Poisson's Ratio = 0.095
Compressive Strength = 400 psi

Job No.: 2653-13
Tested By: HN Date: 6-27-08
200 kip Load Cell
Scales: X: 1" = 2,000 #
Y (Axial): 1" = 0.0125"
Y (Radial): 1" = 0.0025"



·2

Note: Failure limits shown with no measurements



1·19

ARUP PB 6/27/08 HN BTNB-R6 X: 1" = 2000#
200K2 UCS/SS 47.5-47.9 Y1: 1" = 0.0125" GL = 3.29"

ADVANCED TERRA TESTING, INC. ATT

Filename: f:\users\don\tcsstemp.lwp

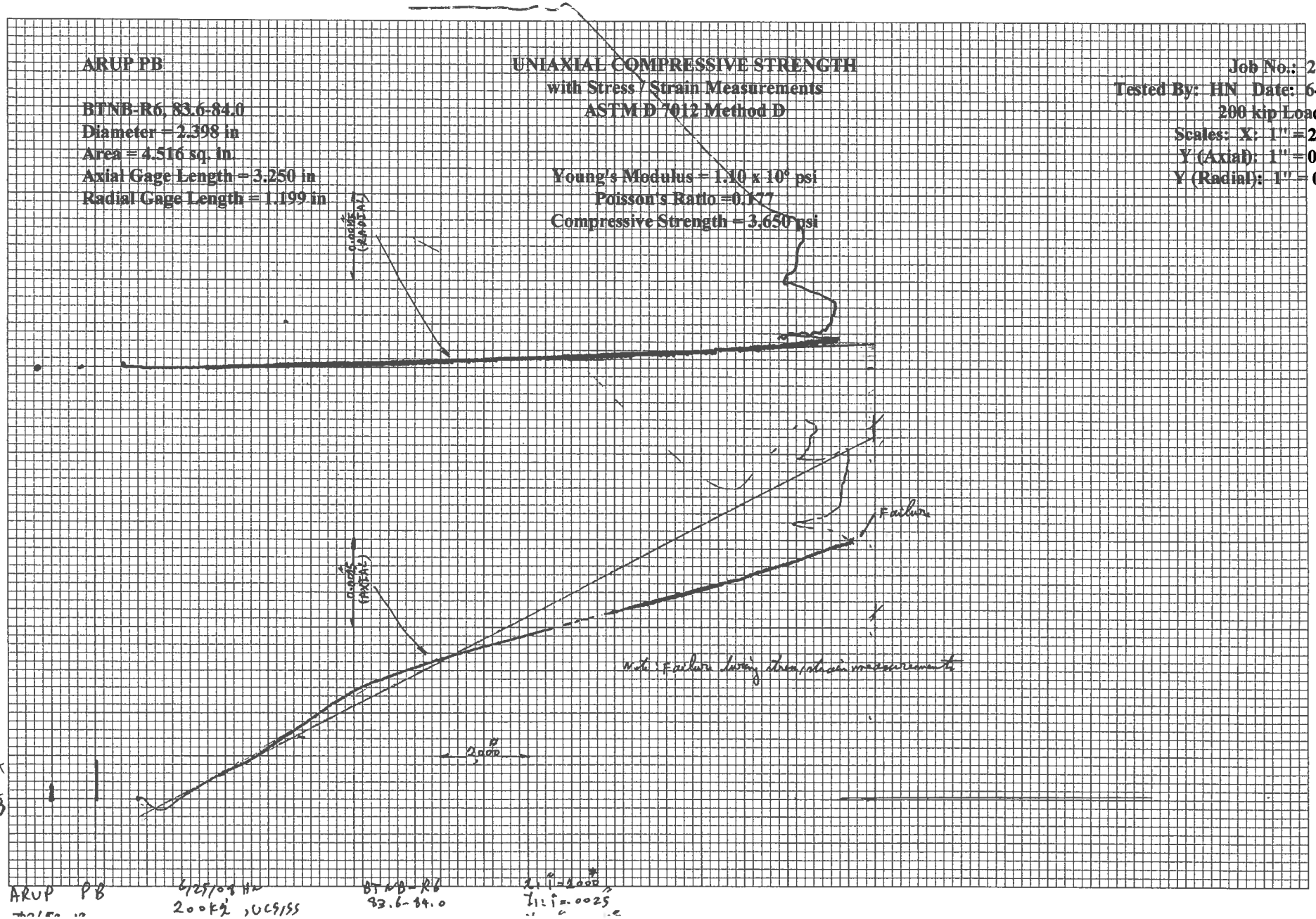
ARUP PB

BTNB-R6, 83.6-84.0
Diameter = 2.398 in
Area = 4.516 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.199 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 1.10 x 10⁶ psi
Poisson's Ratio = 0.177
Compressive Strength = 3,650 psi

Job No.: 2653-13
Tested By: HN Date: 6-25-08
200 kip Load Cell
Scales: X: 1" = 2,000 #
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.0025



ARUP PB 6/25/08 HN 200kip, UCS/SS BTNB-R6 83.6-84.0 1" = 2000 # 1" = .0025"

Filename: f:\users\don\tcsstemp.lwp

ADVANCED TERRA TESTING, INC.
ATT

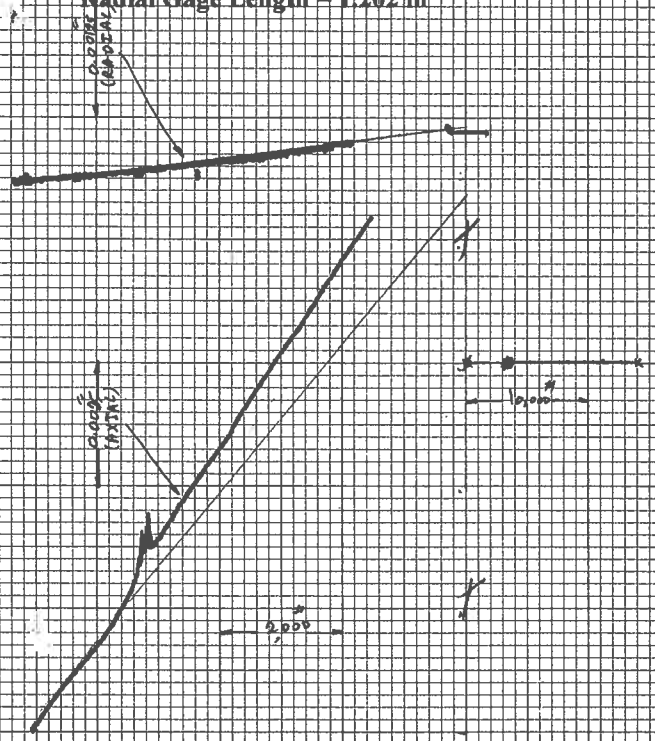
ARUP PB

RW6-R1, 26.60-27.20
Diameter = 2.403 in
Area = 4.535 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.202 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 0.46 x 10^6 psi
Poisson's Ratio = 0.131
Compressive Strength = 3,090 psi

Job No.: 2653-13
Tested By: HN Date: 6-25-08
200 kip Load Cell
Scales: X: 1" = 2,000 ; 10,000#
Y (Axial): 1" = 0.0025'
Y (Radial): 1" = 0.00125



.42

4.35

ARUP PB 6/25/08 HN RW6-R1, 26.6-27.2
200k# UCS/SS
X: F=2,000 / 10,000 #
Y1: ε=.0025", GL=3.25"

Filename: f:\users\don\tcsstemp.lwp

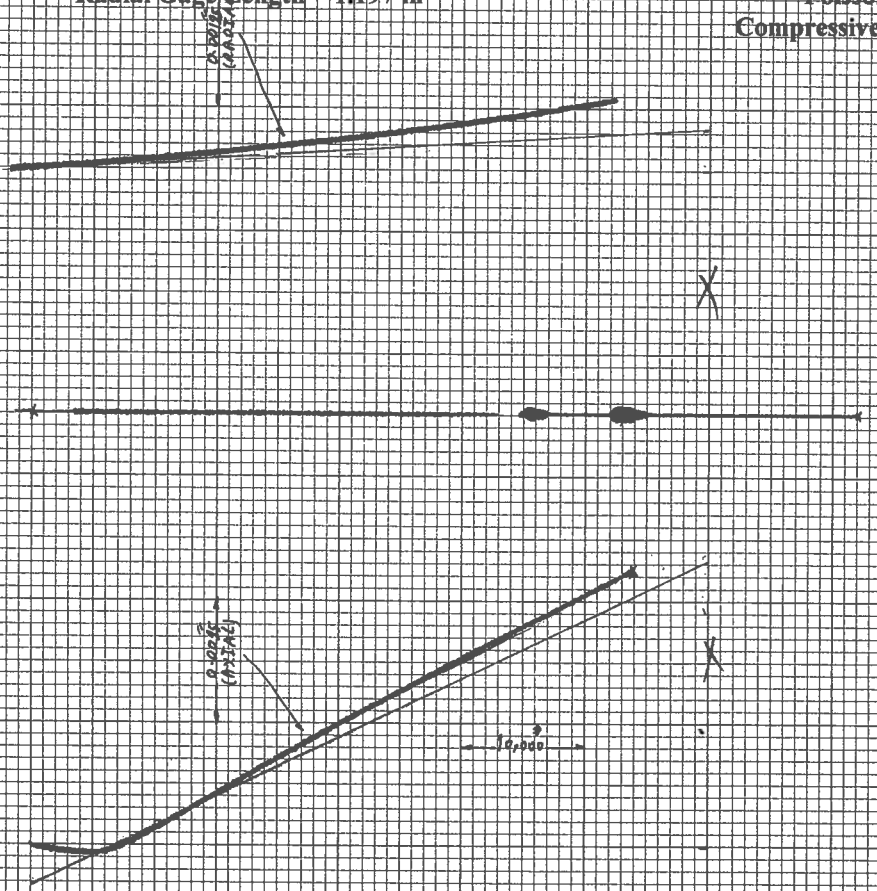
ARUP PB

RW6-R1, 45.10-45.55
Diameter = 2.394 in
Area = 4.501 sq. in.
Axial Gage Length = 2.250 in
Radial Gage Length = 1.197 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 4.17 x 10^6 psi
Poisson's Ratio = 0.114
Compressive Strength = 14,880 psi

Job No.: 2653-13
Tested By: HN Date: 6-27-08
200 kip Load Cell
Scales: X: 1" = 10,000#
Y (Axial): 1" = 0.0025"
Y (Radial): 1" = 0.00125"



ARUP PB
#2653-13
6/29/08 HN
200kip, UCS/SS
RW6-R1
45.1-45.55
X: 1" = 10,000#
Y1: 1" = .0025"
GL = 2.25"

Filename: f:\users\don\tcsstemp.lwp

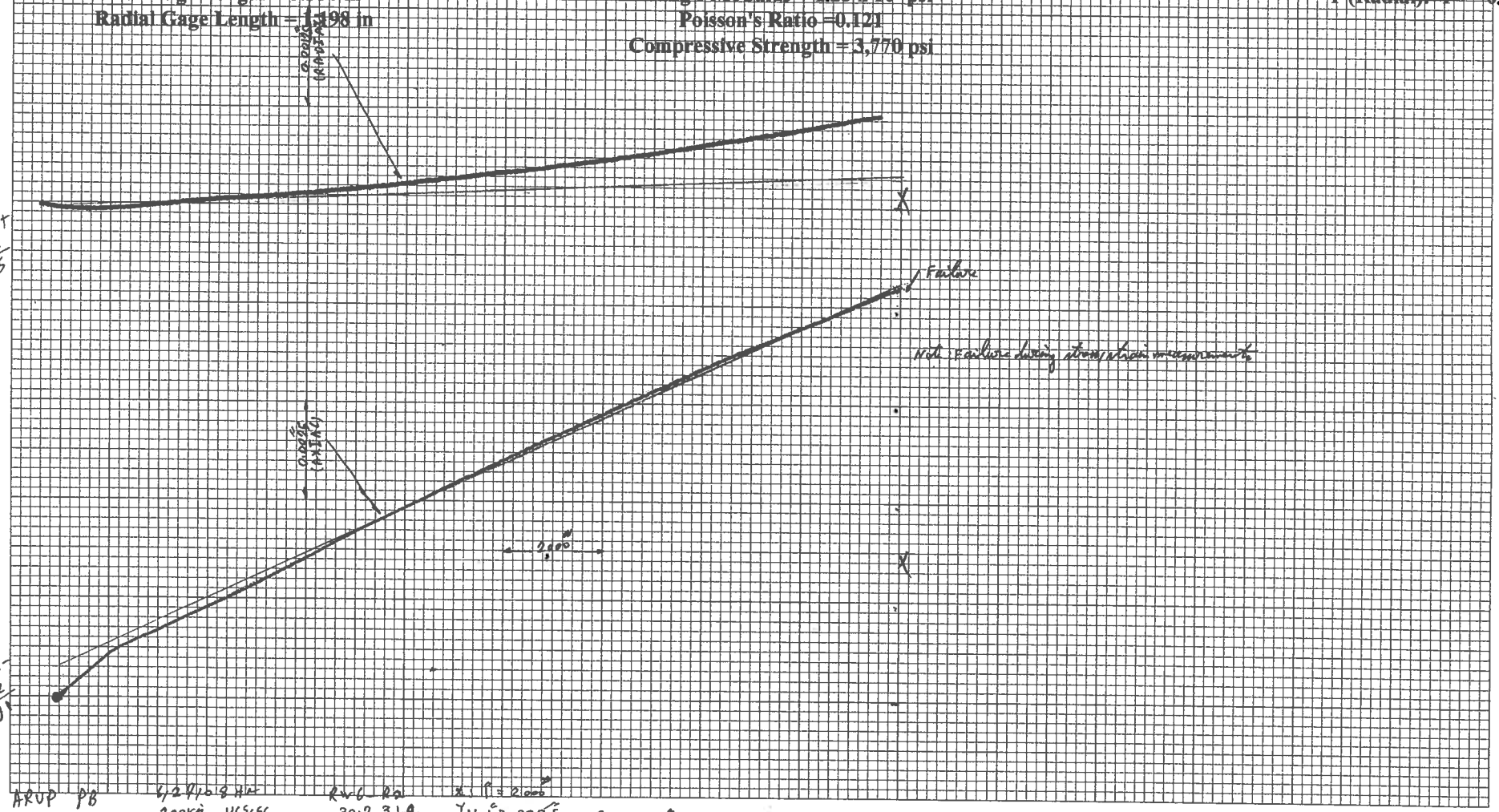
ARUP PB

RW6-R2, 30.70-31.20
Diameter = 2.396 in
Area = 4.509 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.398 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 1.25 x 10^6 psi
Poisson's Ratio =0.121
Compressive Strength = 3,770 psi

Job No.: 2653-13
Tested By: HN Date: 6-27-08
200 kip Load Cell
Scales: X: 1" =2,000#
Y (Axial): 1" = 0.0025'
Y (Radial): 1" = 0.00125



ARUP PB
#2653-13

6/27/08 HN
200kip UCS/SS

RW6 R2
30.7-31.2

Y1: 1" = .0025"
Y2: 1" = .00125"

GL = 3.25"

ADVANCED TERRA TESTING, INC.

Filename: f:\users\don\tcsstemp.lwp

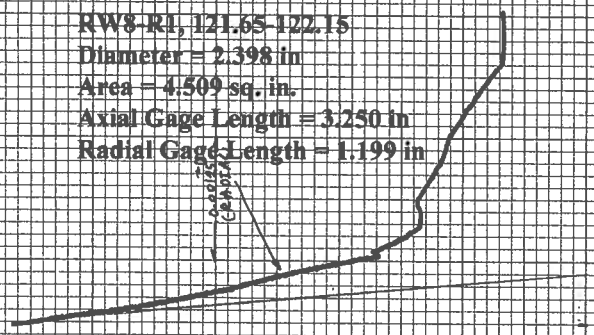
ARUP PB

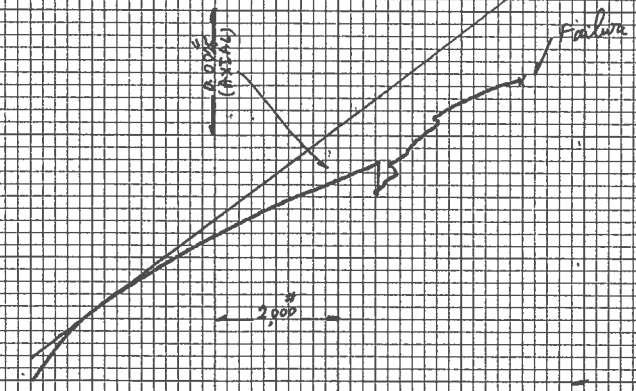
RW8-R1, 121.65-122.15
Diameter = 2.398 in
Area = 4.509 sq. in.
Axial Gage Length = 3.250 in
Radial Gage Length = 1.199 in

UNIAXIAL COMPRESSIVE STRENGTH
with Stress / Strain Measurements
ASTM D 7012 Method D

Young's Modulus = 0.76 x 10^6 psi
Poisson's Ratio =0.200
Compressive Strength = 1,770 psi

Job No.: 2653-13
Tested By: HN Date: 6-27-08
200 kip Load Cell
Scales: X: 1" =2,000#
Y (Axial): 1" = 0.0025'
Y (Radial): 1" = 0.00125



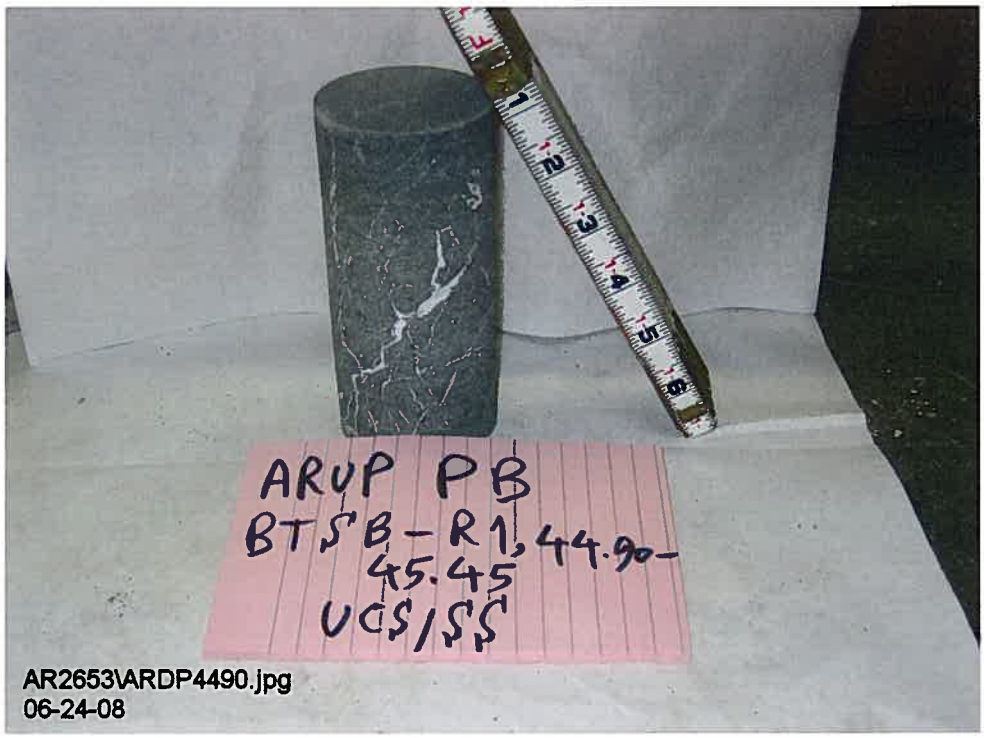


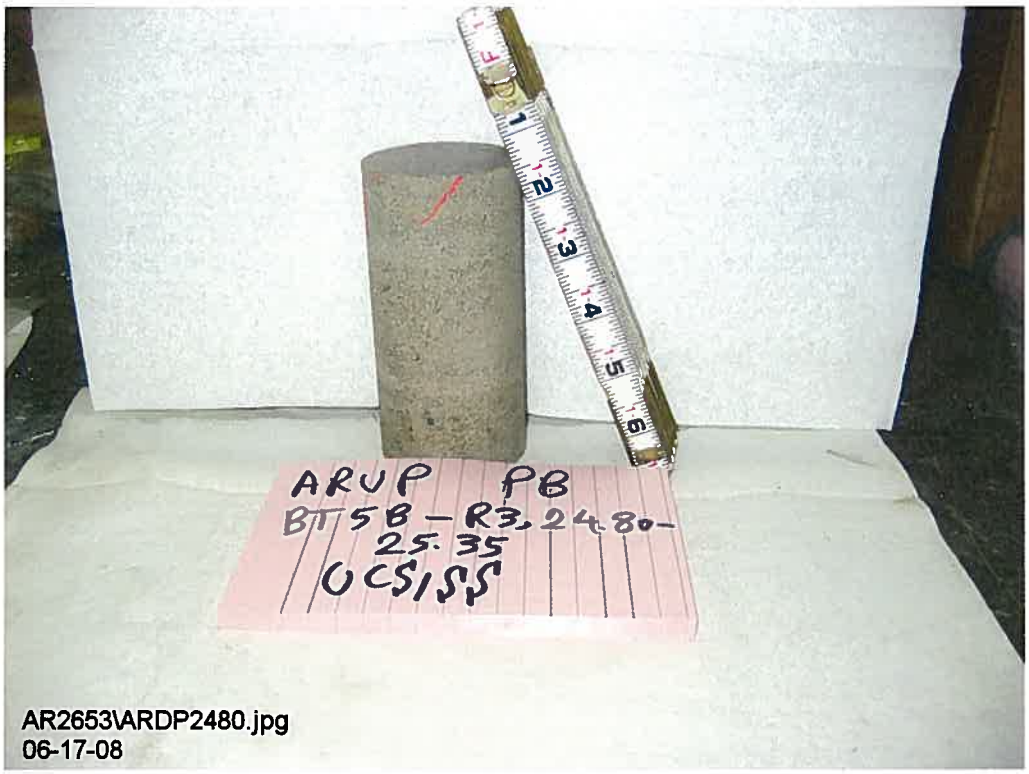
Note: Failure during stress/strain measurements

ARUP PB
#2653-13
6/26/08 HN
200kip
RW8 R1
121.65-122.15
X: 1" = 2000#
Y1: 1" = .0025
Y2: 1" = .00125
GL = 3.25"

Filename: f:\users\don\tcsstemp.lwp

AR2653\ARDP3603.jpg
06-24-08


ARUP PB
BTSB-R1, 44.90-
45.45
UCS/SS
AR2653\ARDP4490.jpg
06-24-08

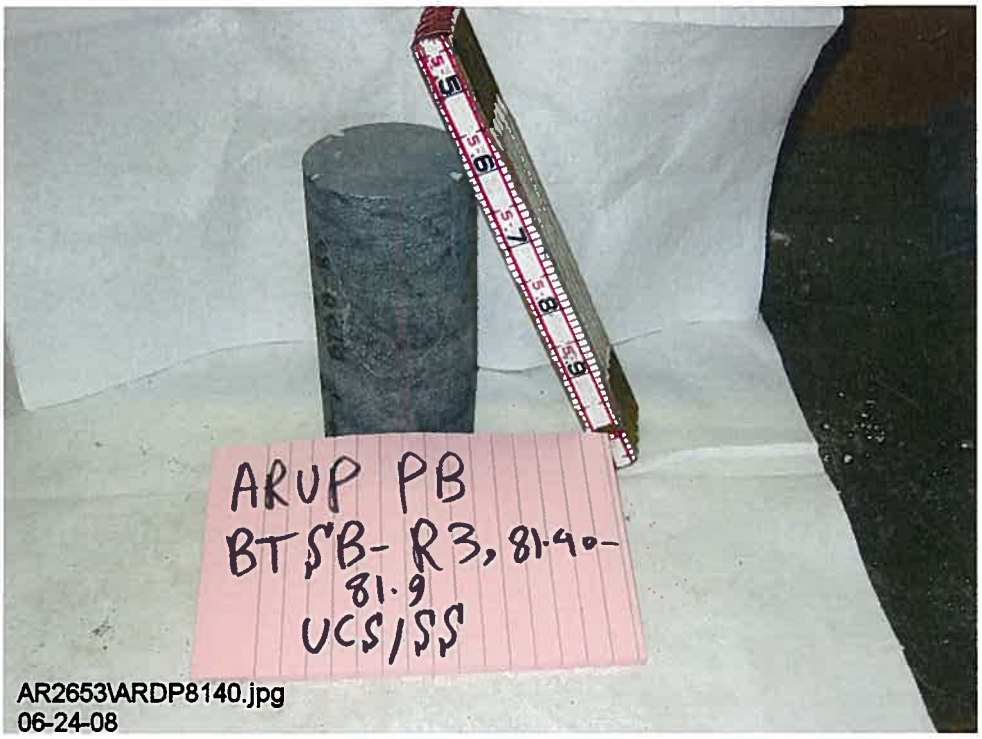


AR2653\ARDP2480.jpg
06-17-08

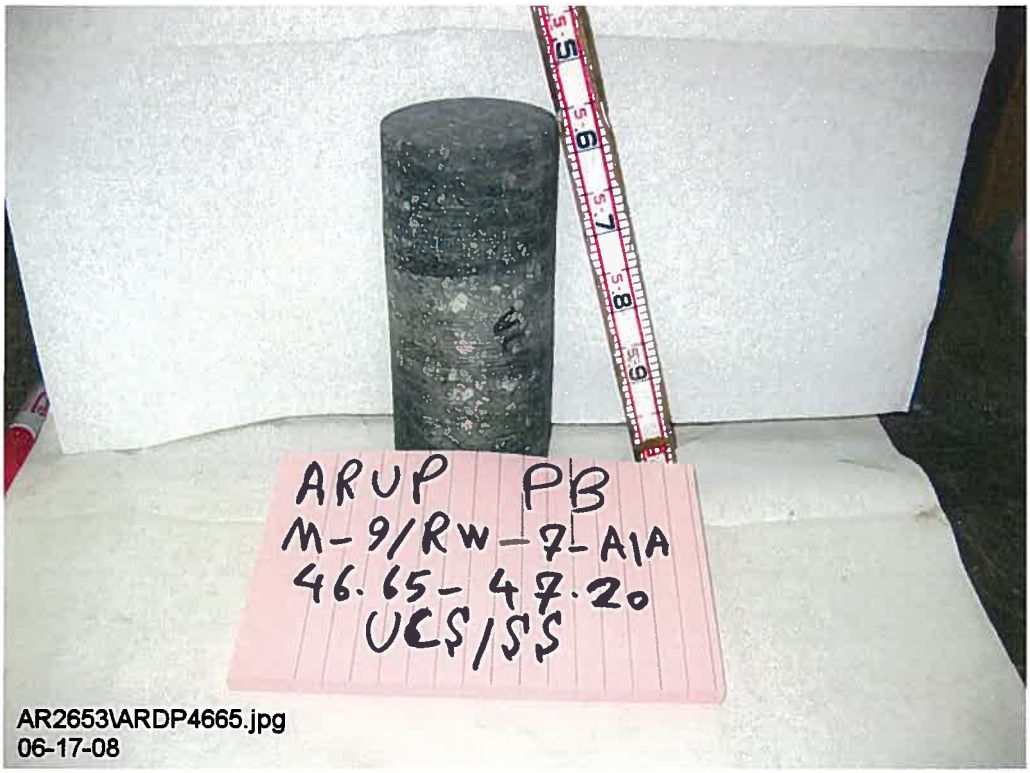
AR2653\ARDP3003.jpg
06-24-08

ARUP PB
BT SB-R3, 44.20-
44.79
UCS/SS
AR2653\ARDP4420.jpg
06-16-08

ARUP PB
BTSB-R3, 50.15-
50.65
UCS/SS
AR2653\ARDP5015.jpg
06-24-08



AR2653\ARDP8140.jpg
06-24-08



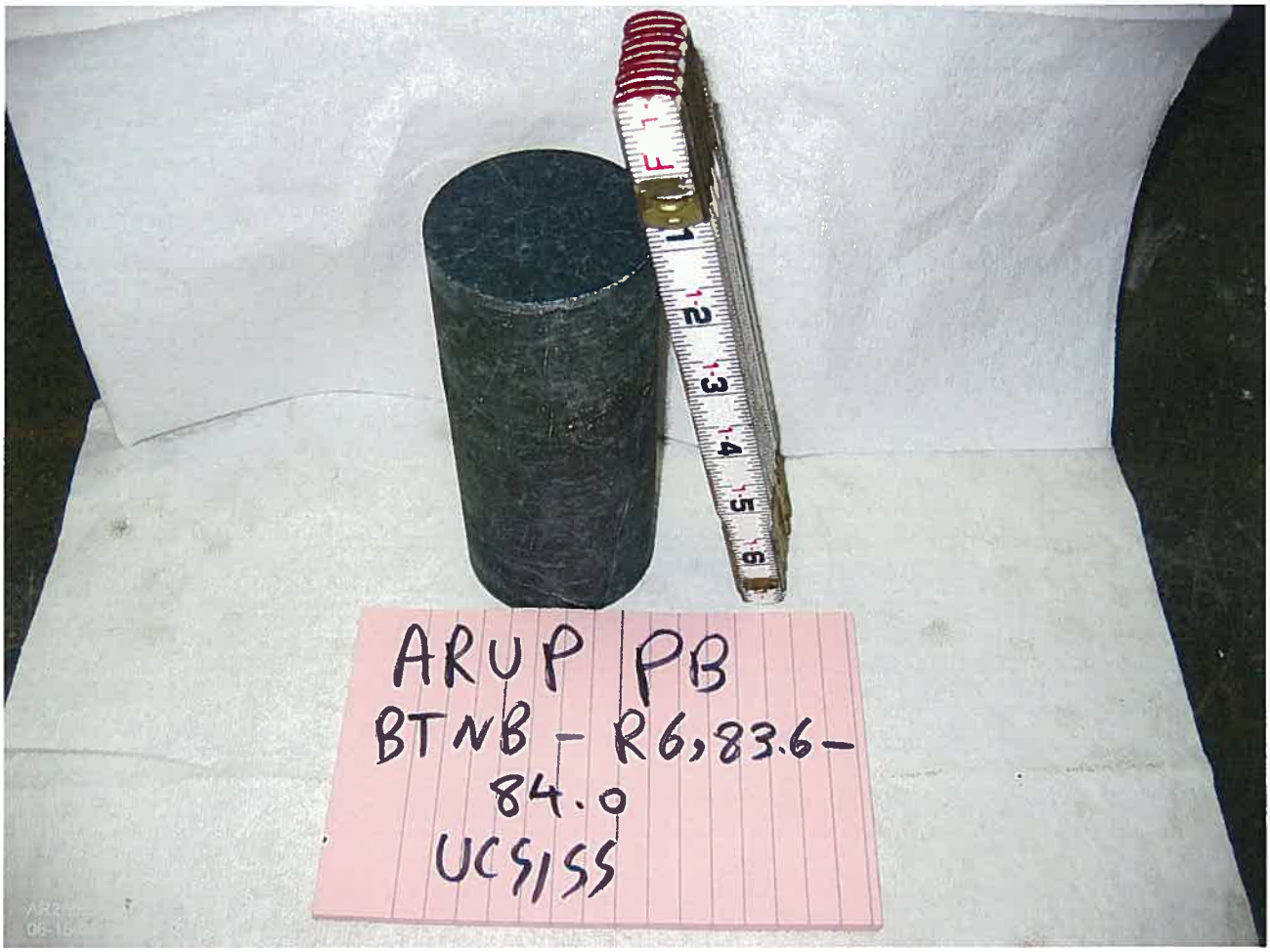
AR2653\ARDP4665.jpg
06-17-08

AR2653\ARDP9636.jpg
06-17-08

AR2653\ARDP8818.jpg
06-17-08

AR2653\ARDP2522.jpg
06-17-08

ARUP PB
BTB-R6, 47.5-47.9
UCS/SS
AR2653\ARDP4754.jpg
06-24-08


ARUP PB
BTNB - R6,83.6-
84.0
UC 91 SS

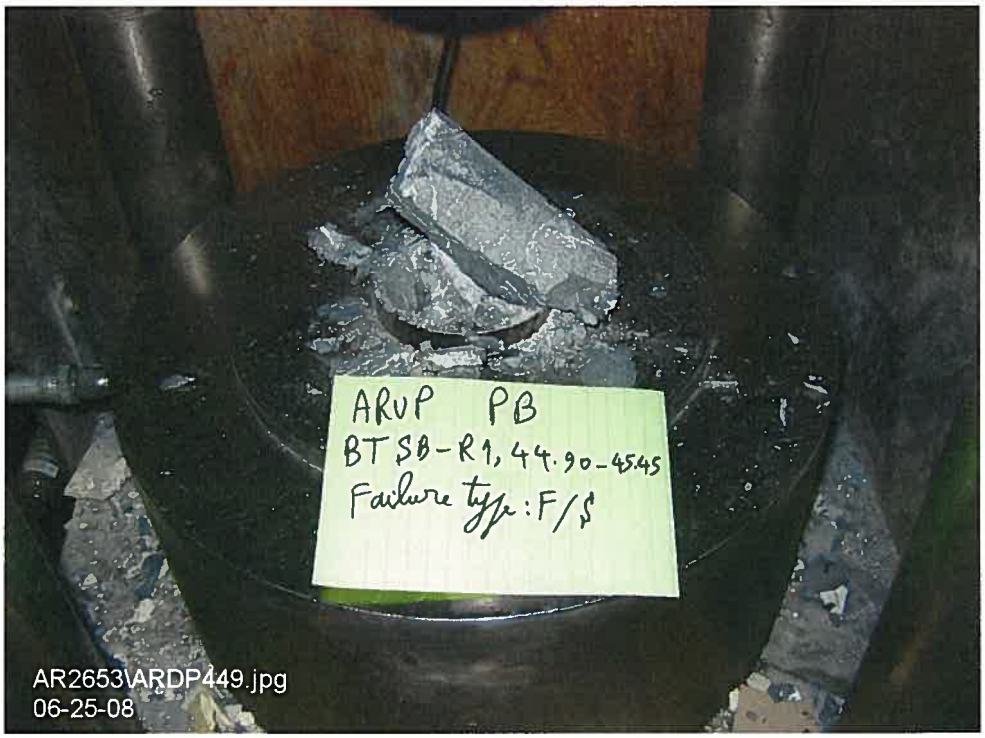
ARUP PB
RWG-R1,26.60-
27.20
UCS/SS
AR2653\ARDP2660.jpg
06-16-08

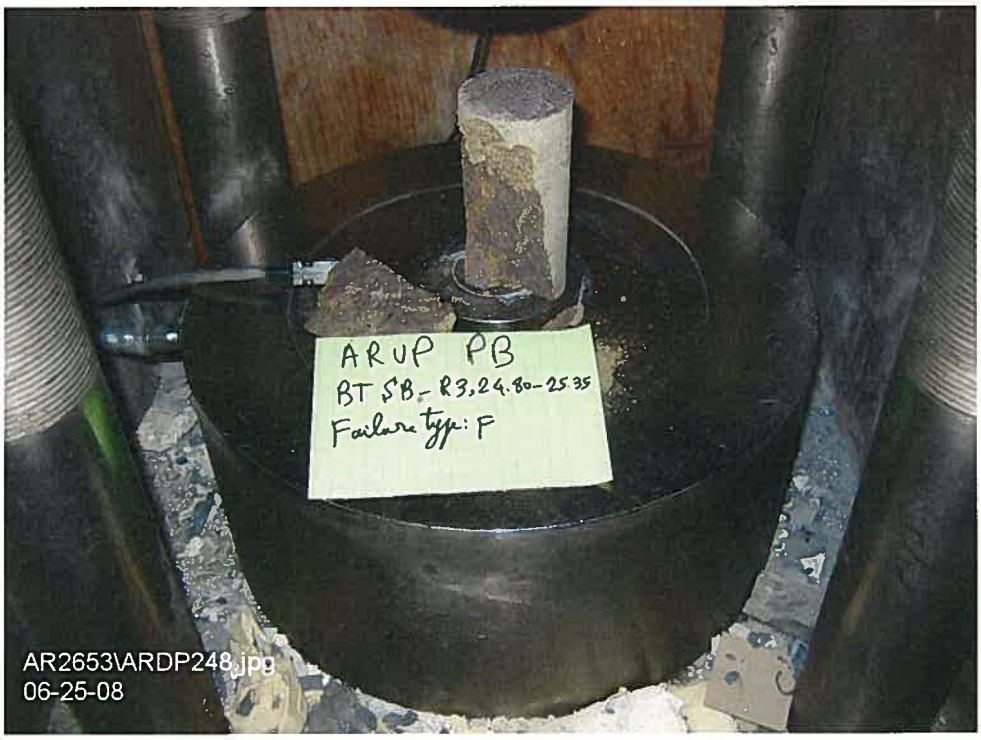
AR2653\ARDP4514.jpg
06-24-08

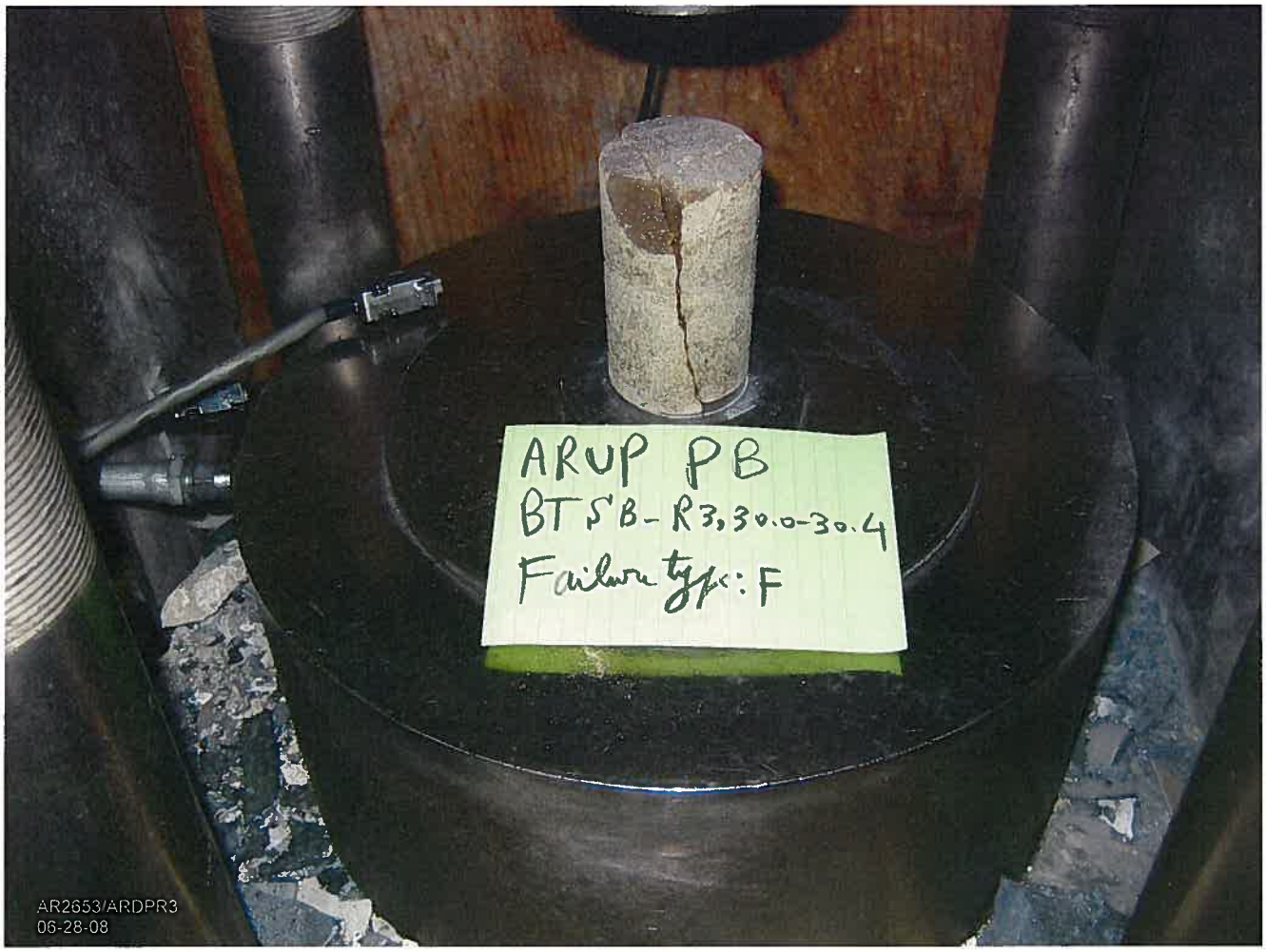
AR2653\ARDP3073.jpg
06-24-08

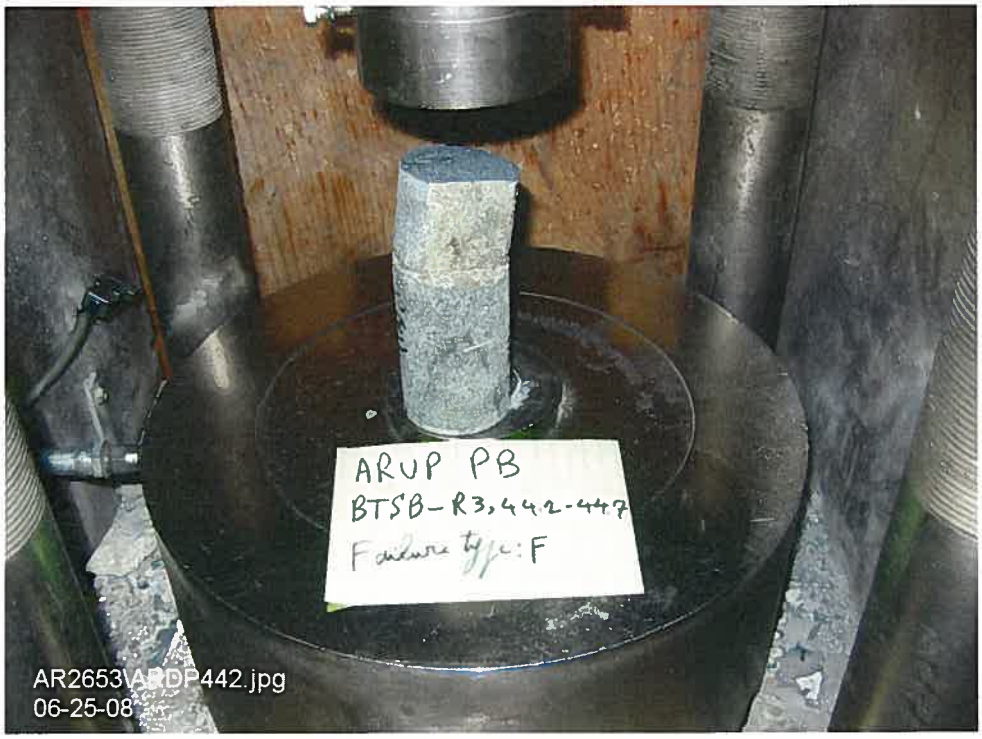
ARUP PB
RW8-R1,121-65-
122.15
UCS/SS
AR2653\ARDP1216.jpg
06-24-08

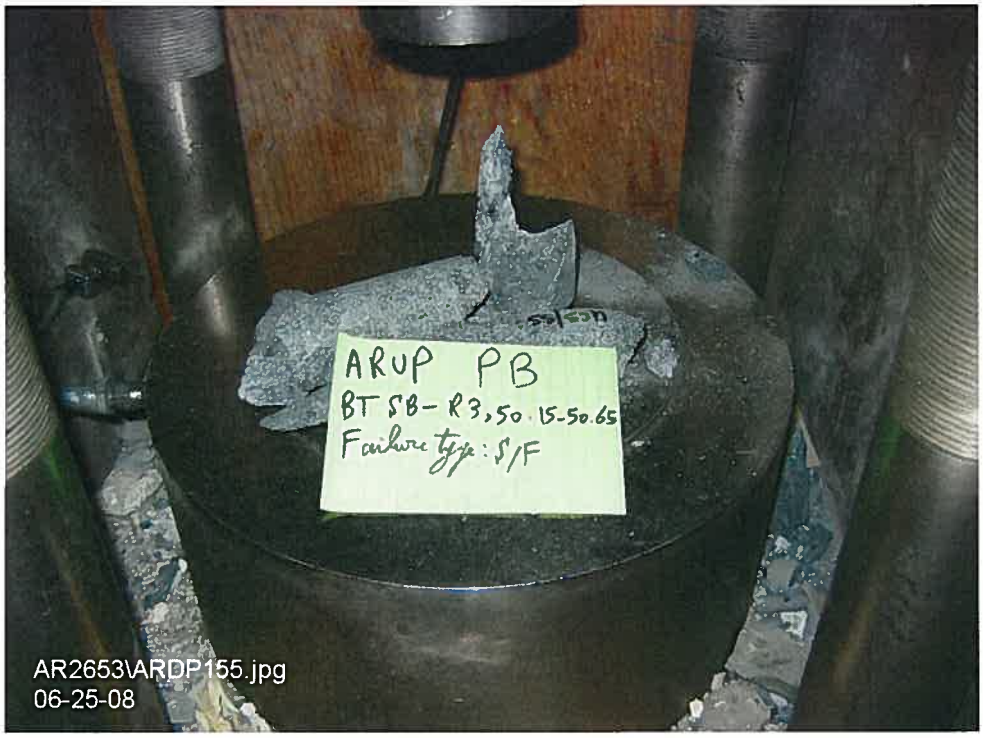
ARUP PB
BT SB-R1,36.0-36.5
Failure type: S/F
AR2653\ARDP360.jpg
06-25-08


ARUP PB
BTSB-R1, 44.90-45.45
Failure type: F/S
AR2653\ARDP449.jpg
06-25-08


ARUP PB
BT SB_R3,24.80-25.35
Failure type: F
AR2653\ARDP248.jpg
06-25-08

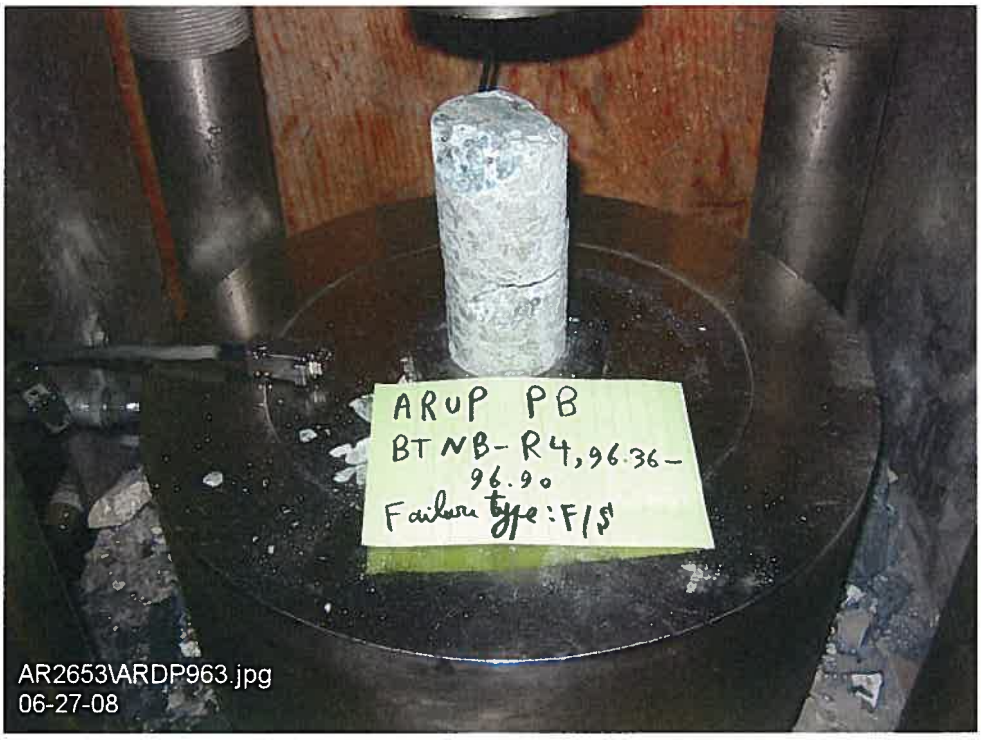

ARUP PB
BTSB-R3,30.0-30.4
Failure type: F
AR2653/ARDPR3
06-28-08


ARUP PB
BTSB-R3,442-447
Failure type: F
AR2653\ARDP442.jpg
06-25-08


ARUP PB
BT SB-R3,50.15-50.65
Failure type: S/F
AR2653\ARDP155.jpg
06-25-08

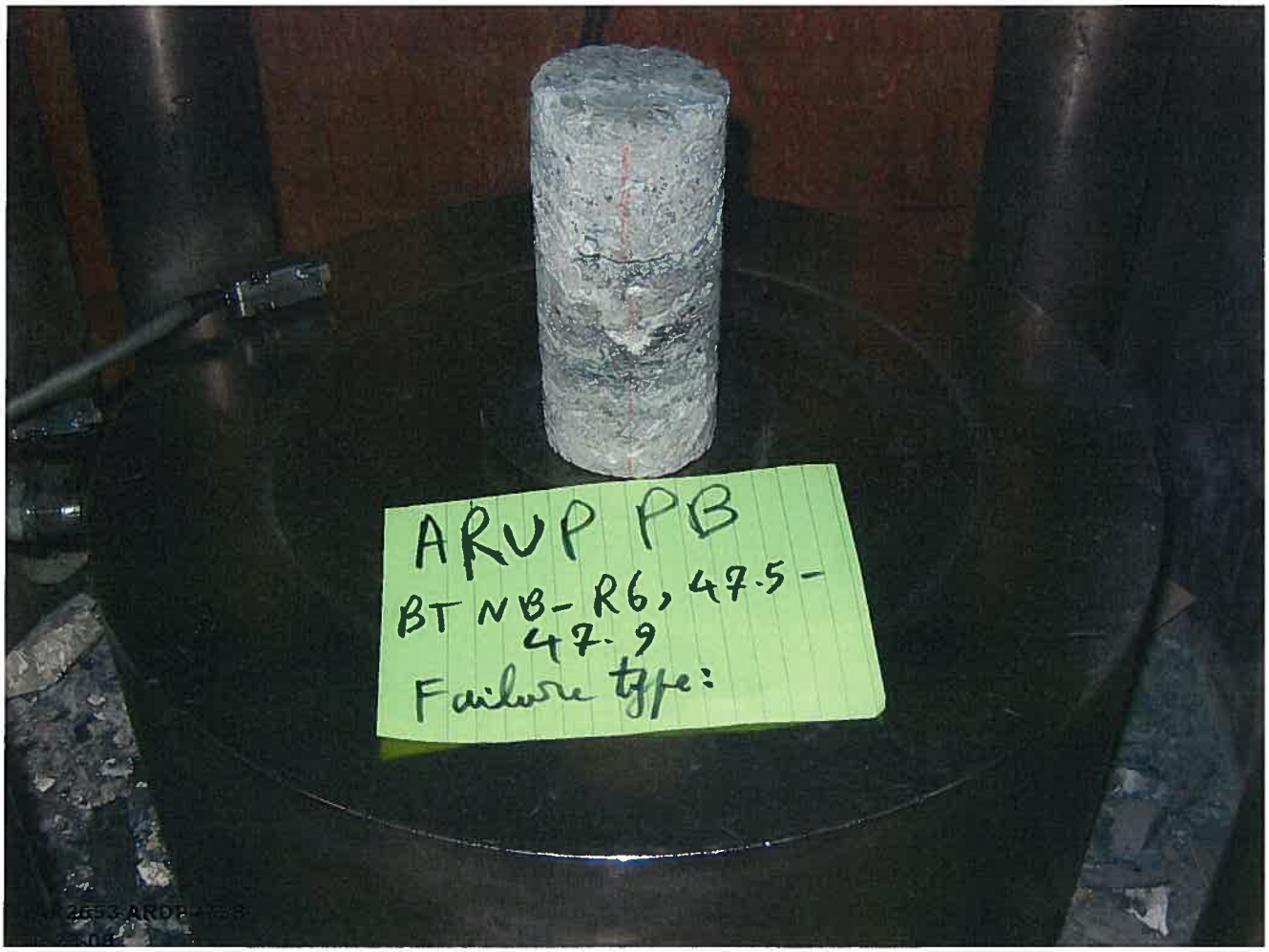
ARUP PB
BT SB-R3, 81.4-81.9
Failure type: F
AR2653\ARDP814.jpg
06-25-08

ARUP PB
M-9/RW-7-A1A.
46.65-47.20
Failure type: F/S
AR2653\ARDP466.jpg
06-26-08


ARUP PB
BT NB-R4, 96.36-96.90
Failure type: F/S
AR2653\ARDP963.jpg
06-27-08

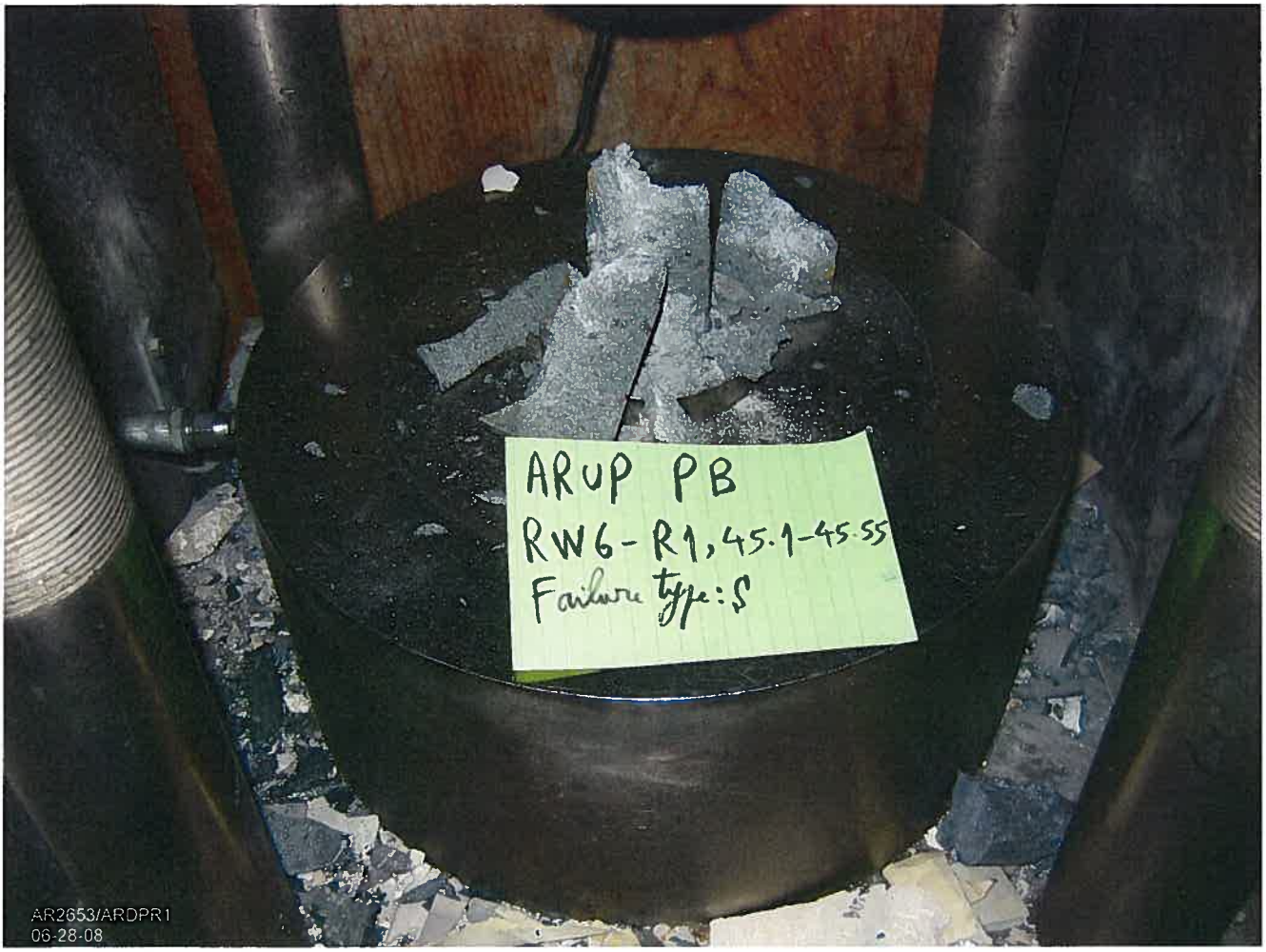
ARUP PB
BTNB-R5, 88.1-
88.6
Failure type: F
AR2653\ARDP881.jpg
06-27-08

BTNB-RSA
ARUP PB
BTNB-RSA
25.2 - 25.7
Failure type: F
AR2653\ARDP252.jpg
06-27-08


ARUP PB
BT NB-R6, 47.5-47.9
Failure type:

ARUP PB
BTNB-R6, 83.6-84.0
Failure type: F/S
AR2653\ARDP836.jpg
06-26-08

ARUP PB
RW6-R1,26.60-
27.2
Failure type: F/S
AR2653\ARDP266.jpg
06-26-08


ARUP PB
RW6-R1, 45.1-45.55
Failure type: S
AR2653/ARDPR1
06-28-08

ARUP PB
RW6 – R2, 30.7 –
31.2
Failure type: F
AR2653/ARDP307
06-28-08

ARUP PB
RW 8 - R1, 121.65 -
122.15
Failure type: F/S
AR2653\ARDP121.jpg
06-27-08