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GEOTECHNICAL REPORT

Geotechnical Design Report Line “A” Storm Drain Dated
December 18, 2008

FINAL
GEOTECHNICAL DESIGN REPORT
(THIRD REVISION)
PROPOSED DUNCAN CANYON
LINE "A" STORM DRAIN
CITY OF FONTANA
SAN BERNARDINO COUNTY, CALIFORNIA
08-SBD-15-PM 11.0/11.4
CALTRANS EA NO. 0K 05201

Prepared for:

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December 18, 2008

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December 18, 2008
Project No. 55633

Mr. William Nascimento, PE, SE
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Subject: **Final Geotechnical Design Report (Third Revision)**
Proposed Duncan Canyon "Line A" Storm Drain
City of Fontana, San Bernardino County, California
08-SBd-15-PM 11.0/11.4
Caltrans EA No. 0K 05201

Dear Mr. Nascimento:

Kleinfelder West, Inc. (Kleinfelder) is pleased to present this *Final Geotechnical Design Report* summarizing the results of our geotechnical investigation for the proposed storm drain located northerly and adjacent to Duncan Canyon Road at the I-15 freeway, in the City of Fontana, California. The purpose of our investigation was to evaluate the subsurface conditions at the site and develop geotechnical recommendations for project design and construction. This report incorporates our response to Caltrans review comments dated November 24, 2008 (see Appendix D). We have also included previous Caltrans comments in Appendix D, for reference. Recommendations for pavement design and materials are addressed in a separate *Materials Report* for this project.

It is our opinion, from a geotechnical engineering perspective, that the site is suitable for the proposed project provided the recommendations presented in this report are properly incorporated into design and construction of the project.

We appreciate the opportunity to be of service. If you have any questions or require additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,

KLEINFELDER WEST, INC.

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1.0 INTRODUCTION

1.1 GENERAL

Kleinfelder West, Inc. (Kleinfelder) was retained by Lim & Nascimento Engineering Corporation (LAN Engineering) to conduct a geotechnical investigation along the proposed alignment of a new storm drain northerly and adjacent to Duncan Canyon Road, in Fontana, San Bernardino County, California. The scope of our services was provided in accordance with our proposal entitled, *Proposal for Geotechnical Services, Duncan Canyon Road Box Culvert, Fontana, California,* dated December 13, 2005, and your *Contract Amendment/Notice to Proceed* dated August 30, 2006. Furthermore, additional geotechnical investigation was performed on September 11 and 12, 2007 based on a meeting with our client and Caltrans engineers. The supplemental information from the 2007 geotechnical exploration is incorporated in this report.

This report presents our recommendations relative to the geotechnical aspects of project design and construction. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered at the locations of our field excavations, and the provisions and requirements outlined in the Additional Services and Limitations sections of this report. Recommendations presented in this report should not be extrapolated to other areas or be used for other projects without our prior review.

1.2 SITE AND PROPOSED PROJECT DESCRIPTION

The project will consist of an approximately 2,181-foot long reinforced concrete box (RCB) culvert storm drain planned northerly and adjacent to Duncan Canyon Road between Lytle Creek Road on the east and Hawker Crawford Channel on the west in the City of Fontana, California (see Plate 1, *Site Vicinity Map*, and Plate 2, *Boring Location Map*).

A portion of the storm drain will cross under the Interstate-15 freeway north of the existing Duncan Canyon Overcrossing and future interchange. Based on our discussions with LAN Engineering, the portion of the storm drain crossing under the I-15 freeway will consist of a 237-foot long, 12-foot wide, single-cell, reinforced concrete box (RCB) culvert between Stations 15+23.00 and 17+60.00.

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The invert depth of the storm drain will range from approximately 14 to 47 feet below the existing ground surface with the deepest portion planned at the I-15 crossing. Ground cover over the RCB will generally be on the order of approximately 2 to 33 feet.

The general land use in the vicinity around the alignment is vacant except for the I-15 freeway and Duncan Canyon Road. Topographically, the area is relatively flat with a gentle gradient to the southwest. Elevations vary from approximately 1,704 feet above mean sea level (MSL) at the west end of the alignment to approximately 1,750 feet MSL at the east end. Surface drainage for the study area is via sheet flow runoff toward the southwest. Drainage is locally collected within two drainage swales east and west of the freeway and within Hawker Crawford Channel to the west. The approximate longitude and latitude coordinates of the center of the alignment are 117.4614°W and 34.1653°N, respectively.

1.3 PURPOSE AND SCOPE OF WORK

The purpose of our investigation was to evaluate subsurface conditions at the site and provide geotechnical recommendations for design and construction of the proposed project. A description of the scope of services performed is presented below:

Task 1 – Literature and Background Review

We began our services by reviewing published and unpublished soils and geologic data in our files and from select public agencies (see References). We have completed a computerized search of appropriate seismic and faulting information as it relates to the site.

Task 2 – Field Exploration

Prior to conducting the field exploration, our proposed exploration locations were cleared of known, documented, existing utility lines through Underground Service Alert (USA). We also obtained a temporary encroachment permit from Caltrans to drill within the Caltrans right-of-way. The subsurface exploration program included advancing six exploratory borings along the alignment. Two of the borings (B-1 and B-2) were drilled using a bucket-auger drill rig equipped with a 24-inch diameter bucket. Borings B-3 through B-6 were drilled using a hollow-stem auger drill rig equipped with 8-inch

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diameter augers. The borings were advanced to depths between approximately 6 ½ and 11 ½ feet below ground surface (bgs). Refusal was encountered in all borings due to numerous large cobbles and boulders and caving. Numerous attempts to drill both the bucket-auger and hollow-stem auger borings to greater depths were unsuccessful due to the cobbles and boulders.

Since all the previous borings did not reach the bottom of the proposed storm drain, Kleinfelder performed additional borings after consultation with Caltrans and LAN. Three additional borings (B-7 through B-9) were drilled on September 11 and 12, 2007 along the proposed storm drain alignment at I-15 freeway using mud-rotary drilling method to depths ranging from approximately 25 to 40 feet bgs. Proper traffic control and safety devices were used during drilling operation, including K-Rails and Crash Cushions (Boring B-8) and delineators (Borings B-7 and B-9) in accordance with the requirements of Caltrans Permit Department. All the borings were backfilled with excavated soils after drilling.

Bulk and drive soil samples were obtained from the borings for laboratory testing. A detailed description of the field exploration and the logs of the boring excavations for this study are presented in Appendix A, *Field Exploration*.

Task 3 – Laboratory Soil Testing

Laboratory testing was performed on soil samples collected during our field exploration to substantiate field classifications and to evaluate the physical characteristics of the subsurface soils. Testing consisted of in-situ moisture content and unit weight, grain size distribution, laboratory maximum dry unit weight and optimum moisture content, sand equivalent, shear strength (direct shear test), R-value, and corrosion analyses. The laboratory tests performed for this geotechnical study are described and the test results are presented in Appendix B, *Laboratory Testing*.

Task 4 – Geotechnical Analyses and Report Preparation

Field and laboratory findings were evaluated in conjunction with the proposed project use. This report includes conclusions and recommendations regarding the following:

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- Discussion of the subsurface materials encountered and anticipated excavation characteristics of the materials.

- Regional geologic setting, discussion of geologic features and geologic hazards including the potential for ground rupture due to surface faulting and seismically induced settlement.

- Recommendations for open cut construction.

- Bearing and settlement characteristics of reinforced concrete box (RCB) culvert and street subgrade soils.

- Guidelines for temporary excavation including anticipated excavation characteristics of the subgrade soils.

- Recommendations for trench sidewall slope inclinations and geotechnical parameters for the design of trench shoring.

- Evaluation and recommendations of the use of excavated materials, including suitability of excavated soils for bedding and trench backfill.

1.4 PREVIOUS WORK AND PERTINENT REPORTS

Kleinfelder previously performed a preliminary study and prepared a Preliminary Geotechnical/Structures Design Report for the proposed I-15/Duncan Canyon Road Interchange (report dated January 10, 2006). The purpose of the study was to provide preliminary geological and geotechnical engineering information for use by the design engineer for further planning, design and economic evaluations of a proposed interchange at Duncan Canyon and the I-15 freeway. Kleinfelder also prepared a Preliminary Materials Report for the I-15/Duncan Canyon Road Interchange project (report dated May 15, 2007). Both of these reports were reviewed as part of the current storm drain investigation.

Kleinfelder also prepared a Risk Assessment report for the project (dated November 6, 2007). The purpose of the report was to provide an assessment of the risks and costs associated with various alternative construction methods considered for the section of storm drain planned beneath the I-15 freeway. The Risk Assessment report was performed in association with Lyman Henn, Inc., Geotechnical and Tunneling and Construction Services, Denver, Colorado.

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As-built plans prepared by Caltrans dated August 9, 1976 for Citrus Avenue Overcrossing and Sierra Avenue Undercrossing were also reviewed.

Most of the geologic data compiled and reviewed for this study were obtained from the Geologic Map of the Devore 7½ Minute Quadrangle published by the U.S. Geological Survey (Morton and Matti, 2001). Other maps and publications we reviewed addressing regional geology include the Geologic Map of California, San Bernardino Sheet, compiled by T.H. Rogers (1967), map scale 1:250,000; the Geologic Map of the San Bernardino Quadrangle, California, compiled by E.J. Bortugno and T.E. Spittler (1986), map scale 1:250,000; and Geologic Map of the Cucamonga Fault Zone, (Morton and Matti, 1987). These reports and maps are presented in the references section of this report.

Maps, reports and other studies reviewed addressing faulting and seismicity included "Fault Rupture Hazard Zones in California," Hart, E.W., and Bryant, W.A. (1997); "Fault Activity Map of California and Adjacent Areas, California," Jennings, C.W. (1994); "Seismic Hazards in Southern California: Probable Earthquakes, 1994 to 2024," Working Group on California Earthquake Probabilities (1995); and Map showing Quaternary faults and 1978-84 seismicity of the Los Angeles Region, California, Ziony, J.I., and Jones, L. (1989).

Groundwater information from wells within the study area was researched based on records available through the Cooperative Well Measuring Program (CWMP) covering the Upper Santa Ana River, San Jacinto, and Upper Santa Margarita Watersheds. The CWMP (2006) is compiled by the Western Municipal Water District. Other groundwater records reviewed included groundwater contour maps and records prepared for the Chino and Rialto-Colton Basins (Wildermuth Environmental, 2002), and for Southwestern San Bernardino County (Fife and others, 1976).

Recent and historical aerial photographs available through the U.S. Geological Survey were reviewed as part our study. The aerial photographs were dated 1938, 1953, 1972, 1989, 1994, and 2002.

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2.0 REGIONAL GEOLOGY, FAULTING AND SEISMICITY

2.1 REGIONAL GEOLOGY

The site is situated near the boundary between two prominent geomorphic provinces in California, namely, the Transverse Ranges Province on the north and the Peninsular Ranges Province on the south. The Transverse Ranges Province is an elongate geomorphic and structural unit that extends from Point Arguello on the west, to the eastern end of the Little San Bernardino Mountains on the east. The province is characterized by east-west trending compressional (folding and faulting) structural features and reverse faults in contrast to the northwest-southeast trend of other provinces in California. The most prominent feature of the Transverse Ranges in the study area is the San Gabriel Mountains located just north of the project site.

The site is located within the northernmost portion of the Peninsular Ranges Province, a well-defined northwest-southeast trending physiographic unit that extends from the Transverse Ranges on the north to the Mexican border and beyond on the south. The Peninsular Ranges Province is characterized by elongate ranges and valleys. Within the study area, the Cucamonga fault zone essentially forms the boundary between the Transverse Ranges Province on the north and the Peninsular Ranges Province on the south.

The east-west trending reverse Cucamonga fault and northwest trending right lateral strike slip San Jacinto (San Bernardino Valley segment) fault zone are the predominant active faults in the region (Plate 3, *General Geologic Map*). These faults are located approximately 0.28 miles and 1.8 miles from the project site, respectively. Other significant faults in the area include the San Andreas Fault zone located approximately 6.8 miles to the northeast. However, based on the California Seismic Hazard Map (Mualchin, 1996), the Red Hill-Etiwanda Avenue fault is located approximately 0.5 miles (0.8 km) northwest of the project site.

Locally, the project site is located on a broad alluvial fan that was formed by deposition of fluvial sediments and debris flows emanating from Lytle Creek to the northeast. The alluvial fan coalesces with other fans associated with Cajon Canyon further to the northeast and fans formed along the southern front of the San Gabriel Mountains. The

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thickness of alluvial fan deposits and depth to bedrock beneath the site is estimated to be on the order of 500 to 600 feet.

Adjacent to the mountains, the alluvial deposits are very coarse and crudely bedded, and consist mainly of fine to coarse sand and gravel with numerous cobbles and boulders. The materials encountered during our investigation consist of alluvial fan deposits comprised of a sand and gravel matrix with cobbles and boulders.

2.2 FAULTING AND SEISMICITY

The project alignment is located in the highly seismic Southern California region within the influence of several fault systems that are considered to be active or potentially active. An active fault is defined by the State of California as "a sufficiently active and well defined fault, which has exhibited surface displacement within the Holocene time (the last 11,000 years)." A potentially active fault is defined by the State as "a fault with a history of movement within Pleistocene time (between 11,000 and 1.6 million years ago)." These active and potentially active faults are capable of producing potentially damaging seismic shaking along the alignment. It is anticipated that the project area will periodically experience ground acceleration as the result of moderate to large magnitude earthquakes.

Three major active faults namely, the Cucamonga, San Jacinto, and San Andreas fault zones, and the Red Hill-Etiwanda Avenue escarpment are located relatively close to the site. These faults are considered to have the greatest impact to the site due to high peak ground accelerations resulting from a maximum credible earthquake.

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3.0 LOCAL GEOLOGIC CONDITIONS

3.1 SUBSURFACE SOIL CONDITIONS

The soils encountered during this investigation include artificial fill and alluvial fan deposits as described below. The locations of our exploratory borings are shown on Plate 2, *Boring Location Map*. Detailed descriptions of the subsurface conditions encountered during our field investigation are presented on the Logs of Borings provided in Appendix A, *Field Exploration*. We recommend that all individuals utilizing this report review these boring logs for greater detail.

Artificial Fill

Up to approximately three feet of fill was observed in Borings B-1, and B-3 through B-9 drilled during our field investigation. The fill was likely generated during past roadway and freeway construction. The fill consists of a silty sand matrix with various amounts of fine to coarse gravel. The fill materials were likely derived from the native alluvial fan deposits. The distinction between fill and alluvial fan deposits is poorly defined due to the similarity in composition.

Alluvial Fan Deposits

Quaternary-age alluvial fan deposits are present along the entire length of the alignment. In general, the alluvial fan deposits consist of sand, silt and gravel matrix with numerous cobbles and boulders. These soils are similar to those described in the as-built Log of Test Borings for the Citrus Avenue Overcrossing (renamed as Duncan Canyon Road Overcrossing). The sand-gravel-cobble-boulder materials have very low cohesion and are subject to sloughing and caving upon excavation. Severe caving was noted below a depth of approximately 5 feet in both of the bucket auger borings.

Boulders up to 18 inches in diameter were observed in the bucket auger borings and were also observed locally at the ground surface and within Hawker Crawford Channel. Although not encountered in the borings, larger size boulders may exist and may be encountered during construction and should be anticipated.

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The alluvial fan deposits are considered suitable for support of the proposed RCB storm drain and are also considered suitable as backfill after processing, moisture conditioning and compaction, as detailed in further sections of this report.

3.2 GROUNDWATER

Groundwater was not encountered within the borings drilled for this investigation. Estimates on the depth to groundwater beneath the site are based on information available through local agencies and other available groundwater records.

The project study area is located within the Rialto-Colton Groundwater Basin, a deep water bearing aquifer that underlies a portion of the Upper Santa Ana River Valley. The Rialto-Colton Groundwater Basin is bounded by the San Gabriel Mountains on the north, the Rialto-Colton fault on the west, and the San Jacinto fault on the east. Available information for the area suggests groundwater is at depths greater than 200 feet beneath the ground surface.

Groundwater contour maps presented in the Chino Basin Optimum Basin Management Program (Wildermuth, 2002) indicate groundwater elevations beneath the site are on the order of approximately 1,300 feet above mean sea level, which correlates to depths of approximately 385 to 500 feet beneath the site. Other groundwater contour maps for the area produced in the 1970s indicate groundwater depths on the order of 200 to 250 feet beneath the site (Fife and others, 1976).

More recent groundwater records available through the Western Municipal Cooperative Well Measuring Program (Spring 2006) indicate groundwater depths on the order of 300 to 400 feet beneath the ground surface at well sites located approximately 1.5 to 2.5 miles southeast and southwest of the site. The shallowest groundwater depths in the area are recorded in a series of wells located approximately 2 miles east of the study area near Lytle Creek. Groundwater levels for these wells were measured as shallow as 35 to 38 feet in 1994 and 1995. More recent groundwater depths in these wells are on the order of 68 to 85 feet. The shallow groundwater depths in these wells is likely attributed to groundwater anomalies associated with the San Jacinto fault zone.

The site is not located within a Federal Emergency Management Agency (FEMA) designated flood hazard zone. Fluctuations of the groundwater level, localized zones of perched water, and soil moisture content should be anticipated during and following the

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rainy season. Pumping or irrigation of landscaped areas can also cause local groundwater levels to fluctuate.

3.3 EXPANSIVE SOILS

Expansive soils generally contain clay particles that swell considerably when wetted and shrink when dried. Foundations constructed on these soils are subjected to uplifting forces caused by the swelling.

Based on our observation of soil samples obtained from the excavations, soil materials along the project alignment appear to have a “very low” expansion potential. Testing of the final subgrade soils after completion of backfilling should be conducted to evaluate their expansion potential and confirm or modify the recommendations presented herein.

3.4 COLLAPSIBLE SOILS

A collapsible soil is generally defined as a soil that will undergo a sudden decrease in volume after wetting when its internal support structure is lost. The internal support is considered to be a temporary strength and is derived from any number of sources, including capillary tension, cementing agents (e.g. iron oxide and calcium carbonate), clay-welding of grains, silt bonds, clay bonds and clay bridges. Collapse can occur even when there is no increase in vertical stress. Soils found to be most susceptible to collapse include loess deposits (fine-grained wind-deposited soils), valley alluvium deposited within a semi-arid to arid climate, and residual soil deposits.

Based on the results of our field exploration, the general collapse potential of encountered on-site soils deposits is considered to be “low”.

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4.0 GEOLOGIC HAZARDS

4.1 SEISMIC SHAKING

The most significant geologic hazard to this project is the potential for moderate to severe seismic shaking that is likely to occur during the design life of the proposed structure. The recommended seismic design parameters for this project are provided in Section 6.1 of this report.

4.2 FAULT RUPTURE

The proposed storm drain alignment is not located within a currently delineated State of California Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 1997). The southeastern boundary of the Alquist-Priolo Earthquake Fault Zone for the Cucamonga fault is located approximately 1,000 feet from the site and the mapped trace of the Cucamonga fault is located approximately 1,500 feet northwest of the site. Since no known active fault traces project toward or cross the site, the potential for ground surface rupture is considered low. While fault rupture would most likely occur along previously established fault traces, future fault rupture could occur at other locations.

4.3 LIQUEFACTION AND SEISMICALLY INDUCED SETTLEMENT

Liquefaction is the sudden loss of shear strength in a loose, saturated granular soil due to vibratory motions such as those associated with earthquakes. Seismically induced soil liquefaction generally occurs in loose, saturated, cohesionless soil when pore pressures within the soil increase during ground shaking. The increase in pore pressure transforms the soil from a solid to a semi-liquid state. These soils typically lose a portion or all of their shear strength and regain strength sometime after shaking stops.

During a strong seismic event, seismically induced settlements can occur within loose to medium dense, dry or saturated granular soils.

Due to the relatively dense soils at the site and the depth to groundwater, it is our opinion that the potential for liquefaction and seismically induced settlement along the proposed storm drain alignment is very low.

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4.4 LANDSLIDES

The site is relatively flat and level and is considered to have a low potential for hazards due to landslides. Potentials for debris flow hazards within or adjacent to the site are considered nil as no defined drainage courses exist within the project area.

4.5 FLOODING

Flood plain data reviewed for the area indicates that the site is not currently within a designated Federal Emergency Management Agency (FEMA) 100- or 500-year floodplain.

4.6 SECONDARY SEISMIC HAZARDS

Secondary seismic hazards related to ground shaking include ground deformation, areal subsidence, tsunamis, and seiches.

Non-tectonic ground deformation consists of surface cracking of the ground with little to no displacement. This type of deformation is not caused by fault rupture. Rather it is generally associated with differential shaking of two or more geologic units with differing physical characteristics. The site possesses relatively consistent geologic materials. The potential for ground deformation is considered “low” under current conditions and proposed grades.

Due to the inland location of the site, its elevation, and lack of a large body of open water the hazards from tsunamis and seiches are considered nil. Due to the relatively dense alluvial soils underlying the site and the depth to groundwater the potential for areal subsidence is considered to be “low”.

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5.0 GEOTECHNICAL FEASIBILITY

Based on our current understanding of the project, the results of our field exploration, laboratory testing, and geotechnical analyses conducted, it is our professional opinion that it is geotechnically feasible to construct the proposed project, provided the recommendations presented in this report are incorporated into the project design and construction.

Based on discussions with you, Lyman Henn, Inc., and Caltrans regarding options for construction, we anticipate the storm drain will be constructed using open cut construction methods. For the portion of RCB culvert crossing the freeway, we understand that driven steel HP piles will be installed on both sides of the freeway to temporarily support the concrete deck cover and serve as temporary shoring during construction of the RCB culvert side walls. The proposed box culvert deck will be supported by the box culvert walls and the invert slab. Foundation recommendations for the portion of RCB culvert crossing the freeway will be provided in a separate Structure Foundation Report..

Alluvial fan deposits comprised of a sand-silt-gravel matrix with numerous cobbles and boulders are anticipated to be encountered beneath the site, based on the findings of our geotechnical investigation. Groundwater is not anticipated to be encountered during excavation of the open cut or tunneling sections of the project.

The cobble-boulder nature of the alluvial soils should be anticipated and considered as part of the open cut and backfill operations for the RCB culvert trenches. Cobbles and boulders should also be anticipated during trench excavations and pile driving operations.

Geotechnical recommendations for open cut construction are presented in this report as well as other detailed geotechnical recommendations for design and construction of the proposed project.

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6.0 ANALYSES AND RECOMMENDATIONS

6.1 SEISMIC DESIGN PARAMETERS

Based on information available from our field exploration, the as-built Logs of Test Borings for the existing bridge crossing the I-15 freeway at Duncan Canyon Road, and in accordance with Table B.1 of Caltrans *Seismic Design Criteria* (SDC) Version 1.4 (dated June 2006), the site can be classified as Soil Profile Type C.

Caltrans *Guidelines for Structures Foundation Reports* (Version 2.0, dated March 2006) requires active faults that have the potential to affect the project site be identified in accordance with the *1996 California Seismic Hazard Map,* prepared by Caltrans (Mualchin, 1996a,b). The 1996 Seismic Hazard Map indicates a peak bedrock acceleration (PBA) of 0.7g for the site. However, Caltrans requires that the PBA derived from the 1996 Seismic Hazard Map be verified with well-established attenuation relationships, such as Sadigh et al. (1997), for controlling faults. Based on the Sadigh et al. (1997) attenuation relationship, the PBA value for the site is 0.9g. The Caltrans Guidelines for Structures Foundation Reports requires that, if PBA discrepancy exists between the Seismic Hazard Map and the attenuation relationship used, discussion shall be made and the suggested PBA shall be submitted for Caltrans approval. We recommend that a PBA of 0.9g be used for the proposed storm drain, consistent with our recommendation for the proposed I-15/Duncan Canyon Road Interchange (Kleinfelder, 2006). The recommended seismic design parameters are summarized in Table 1, below.

Table 1
Seismic Design Parameters

Seismic Design Parameter	Design Recommendation and Reference
Controlling Fault	Red Hill- Etiwanda Avenue fault (Mualchin, 1996a,b)
Type of Fault	Unknown (assumed Reverse/Thrust)
Site Distance from the Fault	0.8 km (0.5 miles)
Earthquake Magnitude	7.0
Peak Bedrock Acceleration (PBA)	0.9g
Peak Ground Acceleration (PGA)	0.71g
Soil Profile Type	C (Table B.1, 2006 Caltrans Seismic Design Criteria)
Standard ARS Curve	Figure B.5 (2006 Caltrans Seismic Design Criteria); Damping = 5%

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6.2 DESIGN SOIL PARAMETERS

The proposed culvert should be designed to support the weight of the overburden soil and traffic surcharge. The overburden pressure on the culvert can be calculated by multiplying the unit weight of the soil by the thickness of this cover. For design purposes, a soil unit weight of 130 pounds-per-cubic-foot (pcf) may be used for the overburden compacted fill soil.

An allowable net bearing pressure of 4,000 pound-per-square-foot (psf) may be used for design of the proposed RCB culvert bearing on native subgrade soils.

For seismic design of proposed RCB wall, we recommend an additional uniform horizontal pressure of ($0.75\ k_h\ \gamma_t\ H$) = 0.75 x 0.36 x 130 x H = 35H, where H is the wall height in feet, based on the formula developed by Yong (1985) for restrained walls.

Specific soil parameters and coefficients, presented in Table 2, are being provided in this section with the understanding that their practical use for design calculations requires significant experience and familiarity with the laboratory work and field exploration.

Table 2
Design Soil Parameters

Soil Parameter	Recommended Design Value
Total Soil Unit Weight, γ_t	130 pcf
Soil Friction Angle, Φ	34 degrees
Soil Cohesion, C	0 psf
Coefficient of Active Earth Pressure, K_a	0.28
Coefficient of At-Rest Earth Pressure, K_o	0.44
Coefficient of Passive Earth Pressure, K_p	3.54
Coefficient of Friction Between Culvert and Soil, μ	0.44

6.3 TRENCH EXCAVATION

The trench excavation operations must expose a firm, and unyielding subgrade that is free of significant voids, loose soil, and organics. Additional removals may be required as a result of observation and testing of the exposed subgrade soils.

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6.3.1 Soil Stripping

No excavated materials containing surficial vegetation, roots, organics, oversize material, etc, and deleterious materials shall be used as trench and or structured backfill. Stripped topsoil (less any debris) may be stockpiled and reused for landscape purposes; however, this material should not be incorporated into any engineered backfill. Oversize material is any material with a maximum dimension greater than 1 inch for fills placed in the pipe-zone area, and a maximum dimension of 6 inches for backfill material used above the pipe-zone. “Nesting” of gravel or cobbles that are suitable to remain in backfill material should not be permitted. Gravel and/or cobbles should be uniformly spread throughout any above pipe-zone backfill material.

Voids created by the removal of subsurface obstructions (such as oversize material, underground utilities, etc) should have all, loose soil, organic matter, and other deleterious materials removed, and be backfilled with material placed, and compacted as engineered fill or as directed by the Oversight Engineer. If significant quantities of “oversize” materials are encountered during excavation operations, rock disposal areas should be designated. Oversize material should not be permitted to be disposed of in any utility trench, pavement, flatwork, or any other areas designated for structural use.

6.3.2 Excavation Characteristics

Borings were advanced with moderate to difficult effort within the existing alluvial soils. Refusal was encountered in all but two of the borings drilled due to the gravelly and cobbly nature of the soils. Refusal was encountered at depths of approximately 6.5 to 11.5 feet, bgs in Borings B-1 through B-6, and at 25.5 feet in Boring B-7. Conventional trenching equipment, such as an excavator or backhoe is anticipated, with effort, to be capable of performing the alluvial soil excavations required. However, special handling of oversize material may be required.

Many existing underground facilities, including other pipelines, electrical, sewer, and other infrastructure installations are present along the alignment. Fill soils associated with these improvements may exist that may require special attention during construction to avoid trench wall collapse, undermining, and damage to existing facilities. Shoring of trench walls or alternate methods of trench stability should be incorporated into the project planning. We recommend that all individuals utilizing this

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report review the boring logs presented in Appendix A for greater detail. Soils similar to those encountered during exploration may be encountered during culvert excavation.

6.3.3 Excavation

The soils exposed at the bottom of the trench excavation should be in a firm, and unyielding condition. Voids within the trench subgrade or sidewalls should be filled with material compacted in accordance with the recommendations presented within. A representative from our firm should be present during excavation and fill placement operations to observe the materials uncovered during grading, substantiate the proper use of materials, and verify or modify the recommendations presented herein. To allow for adequate bedding material, trenches should be overexcavated to a depth of at least 6 inches below the bottom of the pipe invert section and into firm, and unyielding material. Additional removals may be required as a result of observation and testing of the exposed subgrade soils.

6.4 TEMPORARY EXCAVATIONS AND SHORING

6.4.1 Temporary Excavations

All work within existing or proposed State Right-of-Way (R/W) shall be in compliance with State Standards dated May 2006. Trenches (either open or backfilled) which parallel structures, pavements, or flatwork, should be planned so that they do not extend below a plane having a downward slope of 1:1 from the bottom edge of footings, pavements, or flatwork. An observation should be made by the civil designer to verify that all trenches comply with the above setback recommendations. If there are special cases where these requirements are not practical, the civil designer should communicate with the project geotechnical engineer on a case-by-case basis.

Based on present safety regulations of the California State Industrial Safety Orders and OSHA, shoring and/or bracing of excavations will be required where personnel are working within excavations deeper than five feet. In our opinion, the near-surface soils encountered during our field investigation can be considered Type ‘C’ soil for the storm drain alignment with regard to the OSHA regulations. For Type ‘C’ soils, OSHA requires a maximum slope inclination of 1.5:1 (H:V) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than 5 feet deep, depending on the strength, moisture content and homogeneity of the soils as observed

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during construction. If raveling, caving, or wet soils are encountered, a flatter slope will be required. As an alternative to sloped excavations, excavation walls can be shored or braced.

6.4.2 Shoring

Shoring may be required where space or other restrictions do not allow a sloped excavation. A braced or cantilevered shoring system may be used. The contractor should be responsible for the structural design and safety of all temporary shoring systems.

Using a friction angle, Φ, of 34° and soil unit weight, γ_t , of 130 pcf determined from recent shear test data and Rankine active earth pressure coefficient, $K_a = \tan^2(45 - \Phi/2) = 0.28$, we recommend an equivalent fluid pressure of $(K_a \gamma_t) = 36$ or 37 pcf for design of cantilevered shoring. For braced excavation, the horizontal pressure approaches the value of an at-rest condition. Using Jaky's equation $K_o = 1 - \sin \Phi = 0.44$ for at-rest pressure condition, we recommend an equivalent fluid pressure of $(K_o \gamma_t) = 57$ or 58 pcf for design of braced shoring. These values assume a level backfill condition.

Fifty percent of an areal surcharge placed adjacent to the shoring may be assumed to act as an <u>additional</u> uniform horizontal pressure against the shoring. Special cases such as combinations of slopes and shoring or other surcharge loads (not specified above) may require an increase in the design values recommended above. These conditions should be evaluated by the project geotechnical engineer on a case-by-case basis. The above pressures do not include hydrostatic pressures, however, groundwater is not expected within the excavations.

Cantilevered shoring must extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. We recommend required embedment depths be determined using methods for evaluating sheet pile walls and based on the principles of force and moment equilibrium. For this method, the allowable passive pressure against shoring, which extends below the level of the excavation, may be assumed to be equivalent to a fluid weighing 400 pcf. Additionally, we recommend a factor of safety of at least 1.2 be applied to the calculated embedment depth and that passive pressure be limited to 3,000 psf.

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6.4.3 Construction Considerations for Shoring System

The contractor is solely responsible to determine the type and extent of shoring. Engineered and stamped Shoring Plans shall be required prior to final approval and issuance of permit for final construction.

Since the on-site soils consist of dense sands, gravels, cobbles and boulders, driving sheet piles or even steel H-piles for shoring system will be difficult. In our opinion, a cast-in-drilled-hole (CIDH) soldier pile wall with lagging will be the most appropriate shoring system to use during construction, where shoring is required. Caving of loose granular materials is expected. The contractor should consider the use of temporary casing, a slurry method of construction, or any other appropriate measures to prevent caving of soils during construction and ensure the integrity of the CIDH piles. Furthermore, the construction method should not result in loose/disturbed soils or voids around the pile. Groundwater was not encountered during our field exploration. Therefore, groundwater is not expected to be an issue during construction. However, if groundwater is encountered during construction, a proper dewatering plan should be implemented.

6.5 PIPE BEDDING AND TRENCH BACKFILL

6.5.1 General

All trench excavations within existing or proposed State Right-of-Way (R/W) shall be in compliance with Caltrans Trench Standard. The following subsections present recommendations for bedding material and the pipe-zone. At a minimum, the bedding materials should meet the requirements of the pipe manufacture's and/or the City of Fontana's specifications. Recommendations provided above for backfill are minimum requirements only. More stringent material specifications may be required to fulfill local building requirements and/or bedding requirements for specific types of pipes. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

The soils exposed at the bottom of the trench excavation should be in a firm, and unyielding condition. Voids within the trench subgrade or sidewalls should be filled with material compacted in accordance with the recommendations presented within.

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6.5.2 Pipe Bedding

Native poorly graded granular soils with gravel and cobbles are expected to be exposed at the invert elevation along most of the alignment. In general, the in-situ soils do not appear to meet bedding requirements. Bedding materials should consist of sand, gravel, crushed aggregate or native free-draining granular material with a maximum particle size of 1 inch. Imported or native pipe bedding, and pipe-zone backfill should consist of granular soils with a sand equivalent (SE) of at least 30. There should exist a minimum of 6 inches of bedding material below the pipe barrel.

6.5.3 Pipe-Zone Backfill

The pipe-zone backfill area includes the full width of the trench from the bottom to a horizontal level 12 inches above the top of the pipe. Based upon the anticipated nature of the predominant in-situ soils along the proposed pipeline alignment, the excavated in-situ soils are generally not suitable for use as pipe-zone backfill. Processed materials may be suitable for use as pipe-zone backfill, if time exists, based upon the construction schedule, to test and evaluate the material suitability before placement. Pipe-zone backfill should have a maximum particle size of 1 inch, a sand equivalency (SE) of at least 30, and be free of vegetation, debris, organics and other deleterious material.

6.5.4 Above Pipe-Zone Backfill in Local Right-of-Way

The above pipe-zone backfill area is the full width of the trench above the pipe-zone to the street pavement section, if any. Soils generated from the trench excavation along the alignment are considered suitable for use as backfilling above the pipe-zone, provided there is a maximum particle size of 6 inches in maximum dimension, and the backfill material is free of vegetation, oversize material, debris, organics and other deleterious materials.

6.5.5 Import Material

We recommend import material used for pipe bedding and pipe-zone backfill consist of granular material with a sand equivalent of at least 30. Import materials should have a “very low” expansion potential, i.e. have an expansion index of less than 20. The import material should be uniformly graded with no greater than 30 percent of the particles passing the No. 200 sieve and no particles greater than 6 inches in dimension if placed above the pipe-zone, or a maximum dimension of 1 inch if placed in the pipe-zone. Import materials should be tested for corrosion potential before placement or importing.

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All imported fill should be compacted to the general recommendations provided in the following section.

6.5.6 Compaction Methods in State Right-of-Way

No jetting or ponding in existing or proposed State Right-of-Way (R/W) is allowed. The in-situ and anticipated bedding materials along the alignment should be suitable for placement and compaction utilizing conventional mechanical compaction methods, or as determined by the contractor. Flooding of any backfill materials is not recommended.

Bedding

Bedding material should be moisture conditioned to near optimum moisture content and placed in horizontal lifts less than 8 inches in loose thickness and compacted to a firm, and unyielding condition, as evaluated by a representative from our firm or to at least 90 percent of the maximum dry unit weight based on ASTM Test Method D1557. Reduction of the lift thickness may be necessary to achieve the above recommended compaction.

Pipe-Zone

Pipe-zone backfill should be moisture conditioned to near optimum moisture content and placed in horizontal lifts less than 8 inches in loose thickness and compacted to a firm, and unyielding condition or to at least 90 percent of the maximum dry unit weight based on ASTM Test Method D 1557. Backfill materials should be brought up at substantially the same rate on both sides of the pipe. Reduction of the lift thickness may be necessary to achieve the above recommended compaction. Pipe-zone soils should in a non-voided, stable, firm, and unyielding state before additional fill materials are placed. “Pooled” water should not be permitted.

Above Pipe-Zone

Above pipe-zone backfill should be moisture conditioned to near optimum moisture content and placed in horizontal lifts less than 8 inches in loose thickness and compacted to at least 90 percent of the maximum dry unit weight based on ASTM Test Method D1557. Reduction of the lift thickness may be necessary to achieve the above recommended compaction.

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To minimize any potential settlement, excess soil material and/or fill material removed during any trench excavation should not be spread or placed over compacted finished grade soils unless subsequently compacted to at least 90 percent of the maximum dry unit weight, as evaluated by ASTM D1557 test procedure, at near optimum moisture content.

6.5.6A Compaction Methods in Local Right-of-Way

No Jetting or ponding in existing or proposed Local Right-of-Way (R/W) is allowed. The in-situ and anticipated bedding materials along the alignment should be suitable for placement and compaction utilizing conventional mechanical compaction methods, or as determined by the contractor. Flooding of any backfill materials is not recommended.

For Bedding, Pipe-Zone and Above Pipe-Zone backfill/ compaction recommendations, please refer to Section 6.5.6.

6.5.7 Shrinkage

We anticipate the majority of the proposed compacted, engineered backfill for the project will consist of alluvial type soil materials. Based upon the relative compaction of these native soils, we estimate compaction shrinkage of 5 to 15 percent. These values are exclusive of losses due to stripping or the removal of other subsurface obstructions, if encountered, and may vary due to differing conditions within the project boundaries and the limitations of this study. Bulking of cut material placed as engineered backfill is not anticipated.

Values presented for shrinkage and bulking are preliminary estimates only based on our experience and a limited amount of soil testing. Shrinkage and bulk testing should be conducted during the construction phases. Final grades should be adjusted as required. Alternately, contingency plans to import or export material can be made to accommodate possible variations in actual quantities during site grading.

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6.5.8 Pipe and Fill Settlement

Settlement of soils underlying the pipe and bedding materials is estimated to be on the order of ½ inch or less. Since the subsurface soils at the site are generally granular, this settlement is anticipated to occur during construction or shortly thereafter. The post-construction settlement of backfill soils following site preparation and fill construction, as described in previous sections of this report, is estimated to be approximately 0.3 to 0.4 percent of the fill thickness for fills placed and compacted in accordance with the recommendations provided within. This settlement could cause a differential between existing soils and newly placed fill.

6.6 SOIL CORROSIVITY

According to Section 5.5 of Caltrans *Corrosion Guidelines Version 1.1* (2003), a site is considered corrosive to foundation elements if one or more of the following conditions exist for the 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, and/or
- pH is 5.5 or less.

Three representative soil samples were tested to determine the corrosion potential of encountered near-surface soils. The tests included minimum electrical resistivity, pH, soluble sulfate content, and soluble chloride content using procedures described in California Test Methods 643, 532, 417, and 422, respectively.

Test results, presented in Table B-2 in Appendix B, indicate a minimum resistivity ranging from 2,600 to 5,600 Ohm-cm, pH value ranging from 6.7 to 7.5, sulfate content less than 10 ppm, and chloride content between 60 and 62 ppm. Based on these results and Caltrans Corrosion Guidelines, the on-site soils are not considered corrosive to concrete and ferrous metals. As a minimum, the Caltrans standard Type II modified cement should be used for the proposed project.

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7.0 ADDITIONAL SERVICES AND LIMITATIONS

7.1 ADDITIONAL SERVICES

We recommend that a general review of the project plans and specifications be conducted before they are finalized to verify that our geotechnical recommendations have been properly interpreted and implemented during design. We understand that the review shall be performed by Caltrans staff. The purpose and intent of the Geotechnical Design Report is to evaluate the subsurface conditions along the proposed alignment to develop geotechnical engineering recommendations that will aid in the proposed project design and construction. Upon review, concurrence and approval of the proposed project by Caltrans, the contractor is responsible for reading, understanding and interpreting the geotechnical report to assist them in determining actual construction techniques for the construction and completion of this proposed project. We can assume no responsibility for misinterpretation of our recommendations.

7.2 LIMITATIONS

The recommendations contained in this report are for the proposed storm drain as described in this report. Our recommendations are based on field observations, data from nine exploratory borings, laboratory tests, and our present knowledge of the proposed construction. Subsurface conditions will vary between and beyond the points explored. If soil conditions are encountered during construction which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, changes from that described in this report, our recommendations should also be reviewed.

Our corrosion recommendations are preliminary in general. Kleinfelder is not a corrosion engineering consultant. Specific recommendations for corrosion protection should be obtained from a corrosion specialist.

Our evaluation of subsurface conditions at the site has considered subgrade soil and groundwater conditions present at the time of our investigation. The influence(s) of post-construction changes to these conditions such as introduction of water into the subsurface will likely influence future performance of the proposed project. Whereas

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our scope of services addresses present groundwater conditions, future irrigation, broken water pipelines, etc. may adversely influence the project and should be addressed and mitigated, as needed.

Other Standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference," as the latter term is used relative to contracts or other matters of law.

We have strived to present the findings, conclusions and recommendations in this report in a manner consistent with the standards of care and skill ordinarily exercised by members of this profession practicing under similar conditions in the geographic vicinity and at the time the services were performed. No warranty or guarantee is express or implied. The Client has the responsibility to see that all parties to the project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. This report contains information, which may be useful in the preparation of contract specifications. However, the report is not designed as a specification document and may not contain sufficient information for this use without proper modification.

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by Kleinfelder during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report for an adjacent or nearby project shall notify Kleinfelder of such intended use. Based on the intended use of this report and the nature of the new project, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

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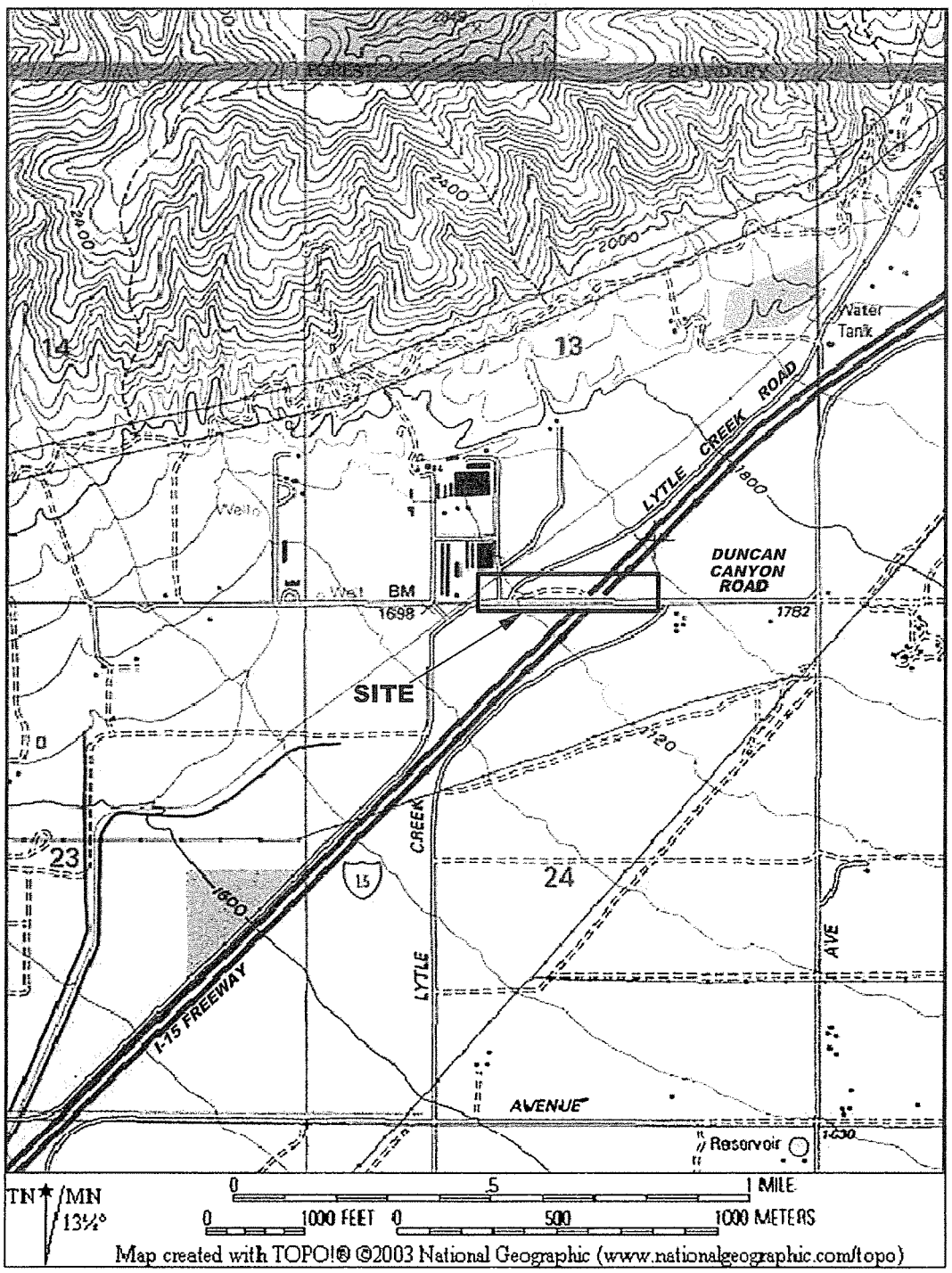
PLATES



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SITE VICINITY MAP

DUNCAN CANYON "LINE A" STORM DRAIN
FONTANA, CALIFORNIA

DRAWN BY: DRD
REVISED BY:
CHECKED BY:
PLATE **1**

DATE: 3-2008	APPROVED BY:	PROJECT: 55633	FILE NAME:

L:\2007\55633\Site Vicinity Map.dwg
Attached Image: L:\2007\55633\Duncan Canyon.bmp

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DB-L:\2007\CADD

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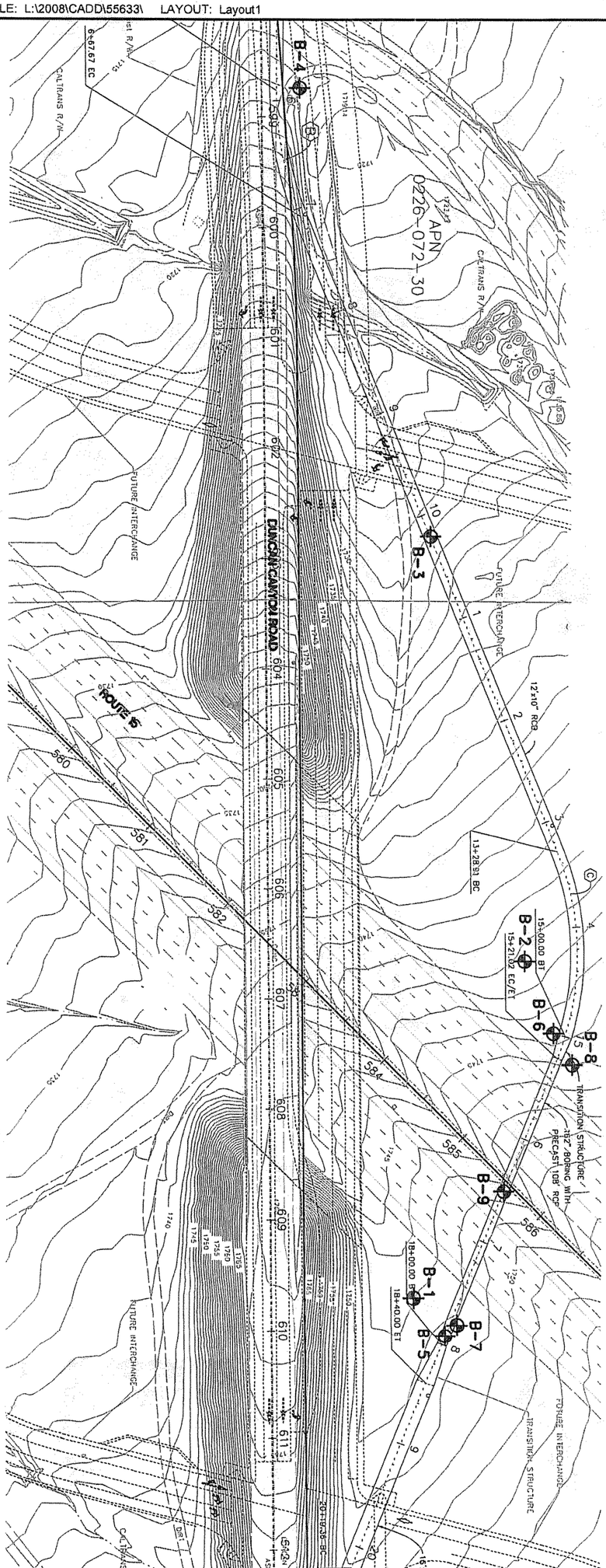
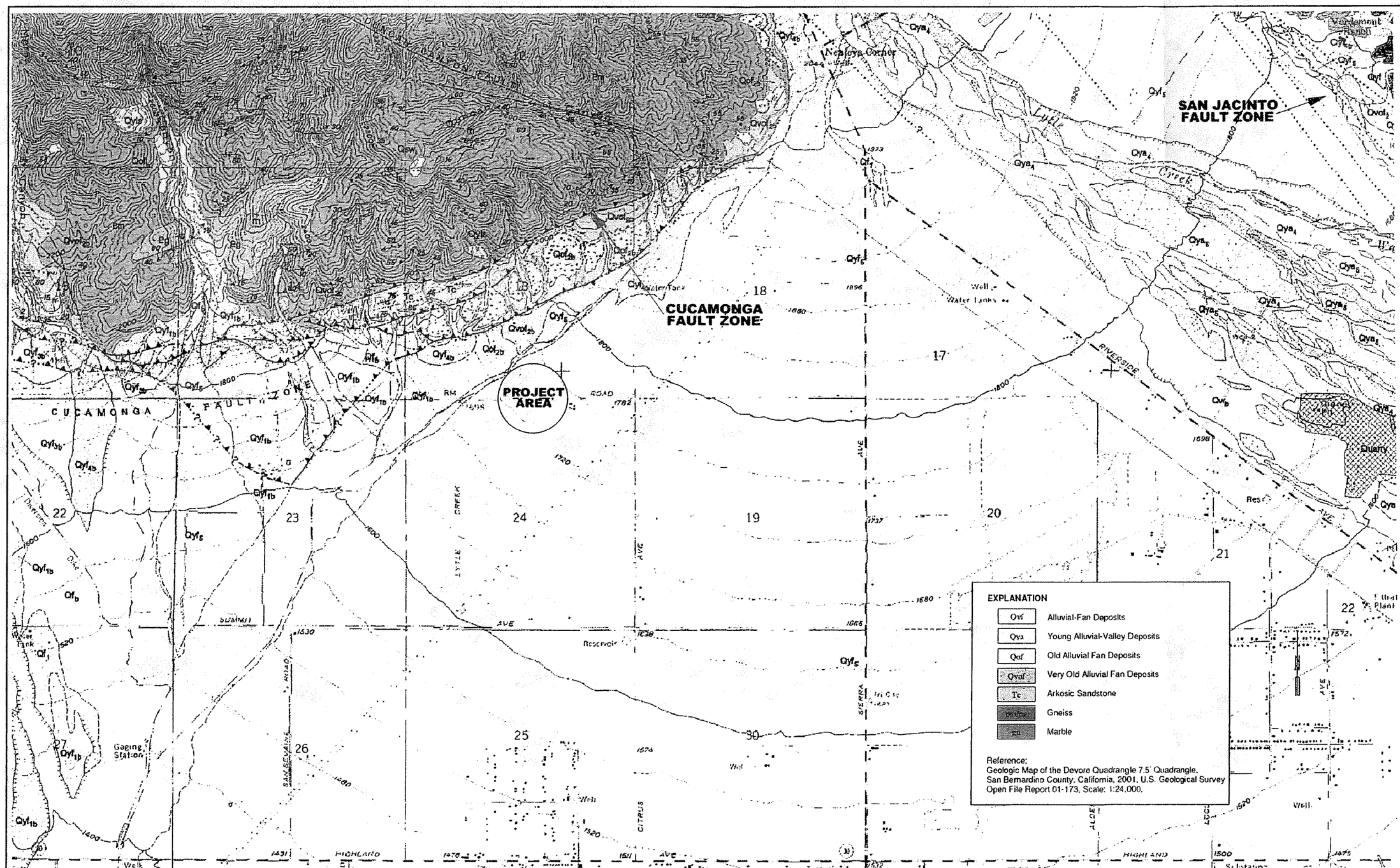


DRAWN BY: D. FAHRNEY	**BORING LOCATION MAP**	KLEINFELDER	PLATE
REVISED BY: D. FAHRNEY		1220 Research Drive, Suite B Redlands, CA 92374 PH. (909) 793-2691 FAX. (909) 792-1704 www.kleinfelder.com	2
CHECKED BY: R. ESCANDON	DUNCAN CANYON "LINE A" STORM DRAIN FONTANA, CALIFORNIA		
DATE: 03/24/08 / APPROVED BY: _____	PROJECT NO. 55633 / FILE NAME: 55633p2.dwg		

PLOTTED: 24 Mar 2008, 11:28am, dfahrney



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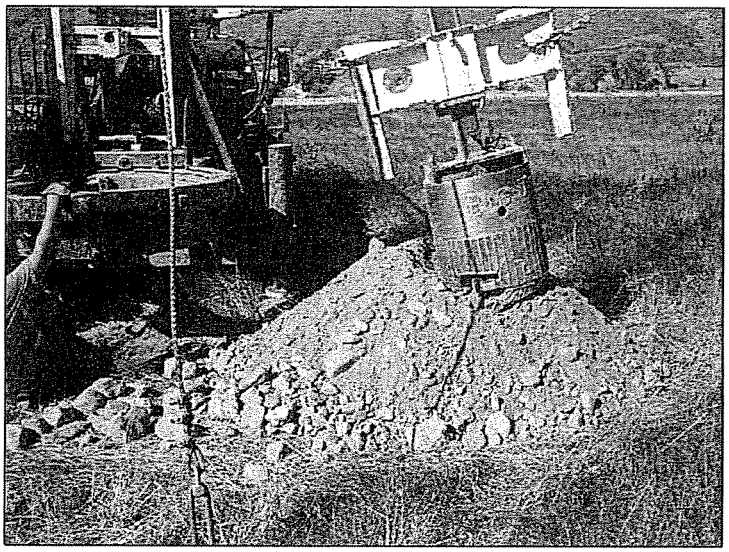
DATE: 3-2008 / APPROVED BY:	PROJECT: 55633 / FILE NAME:		

APPROXIMATE SCALE
1" = 2000'

BUCKET AUGER BORING B-1 SHOWING DRILL SPOILS WITH COBBLES AND BOULDERS.



BUCKET AUGER BORING B-1 SHOWING DRILL SPOILS.

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DUNCAN CANYON "LINE A" STORM DRAIN
FONTANA, CALIFORNIA

DRAWN BY:	D. FAHRNEY
REVISED BY:	D. FAHRNEY
CHECKED BY:	ESCANDON
PLATE	4

DRAWN: 03/24/08	APPROVED BY:_____	PROJECT NO. 55633	FILE NAME: 55633p4.dwg

ATTACHED IMAGES: Images: Photo 1 - Bucket Auger Boring B-1 showing drill spoils with cobbles and boulders.JPG Images: Photo 2 - Bucket Auger Boring B-1 shwoing drill spoils.jpg
ATTACHED XREFS:
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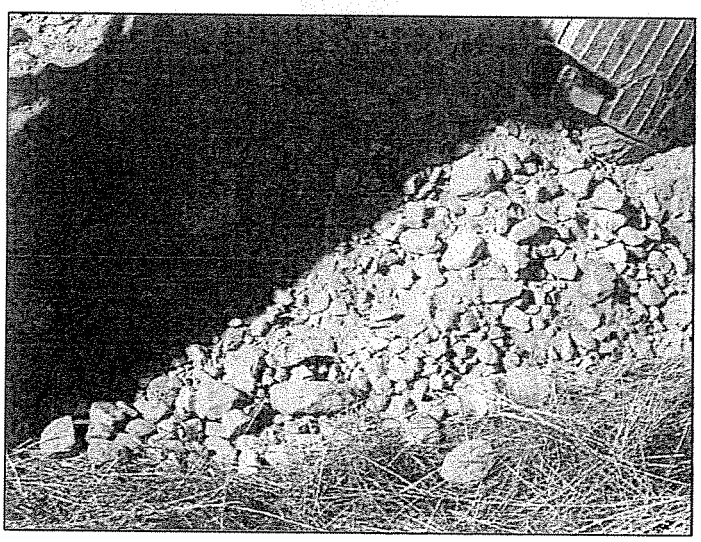
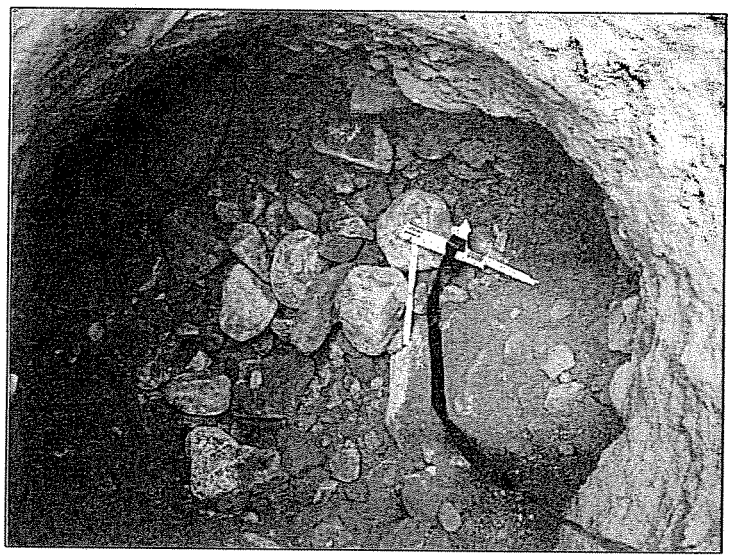


CLOSE UP OF DRILL SPOILS – BUCKET AUGER BORING B-1.



LOOKING DOWNHOLE IN BORING B-1 NOTE BELLING OF 24 INCH DIAMETER HOLE TO APPROXIMATELY 48 INCHES DUE TO CAVING.

ATTACHED IMAGES: Images: Photo 3 - Close up of drill spoils - Bucket Auger Boring B-1.jpg Images: Photo 4 - Looking downhole in Boring B-1, note belling of 24 inch diameter hole to approximately 48 inche
ATTACHED XREFS:
DB-L:\2007\CADD CAD FILE: L:\2008\CADD\55633\ LAYOUT: Layout1

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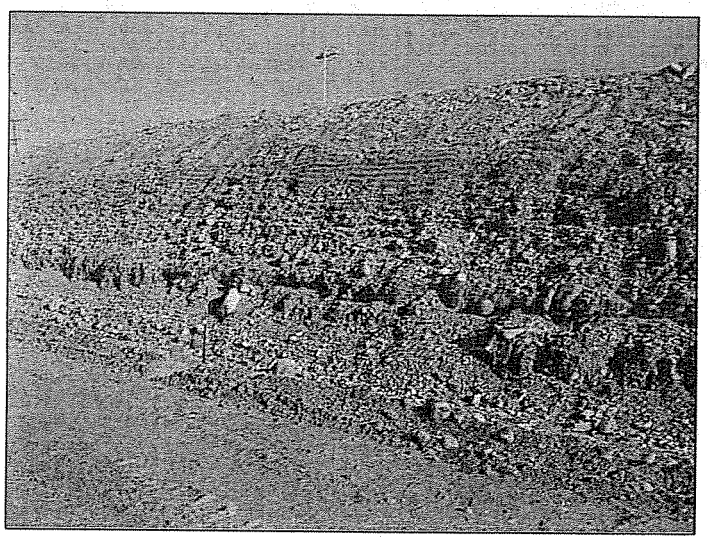
SITE PHOTOGRAPHS

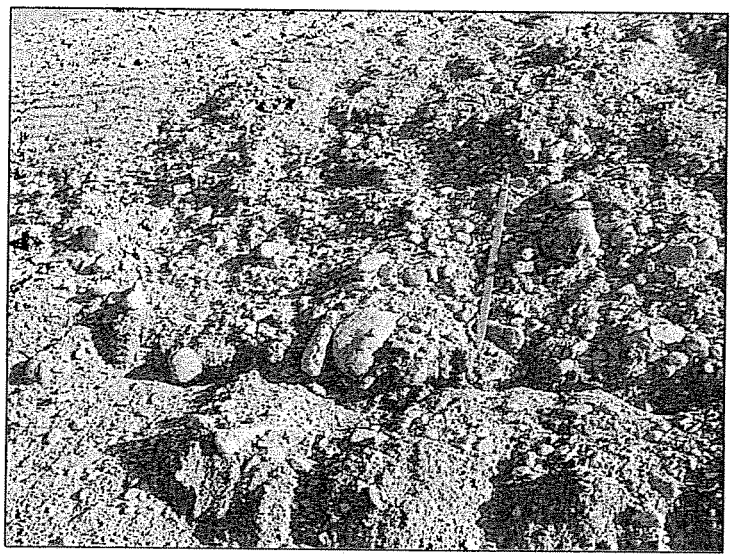
DUNCAN CANYON "LINE A" STORM DRAIN
FONTANA, CALIFORNIA

DRAWN BY:	D. FAHRNEY
REVISED BY:	D. FAHRNEY
CHECKED BY:	ESCANDON
PLATE	5

DRAWN: 03/24/08	APPROVED BY:_____	PROJECT NO. 55633	FILE NAME: 55633p5.dwg



HAWKER CRAWFORD CHANNEL NORTHWEST OF SITE.



COBBLES AND SMALL BOULDERS IN SAND AND GRAVEL MATRIX - HAWKER CRAWFORD CHANNEL.

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PHOTOGRAPHS

DUNCAN CANYON "LINE A" STORM DRAIN
FONTANA, CALIFORNIA

DRAWN BY:	D. FAHRNEY
REVISED BY:	D. FAHRNEY
CHECKED BY:	ESCANDON
PLATE	6

DRAWN: 03/24/08	APPROVED BY:_____	PROJECT NO. 55633	FILE NAME: 55633p6.dwg

ATTACHED IMAGES: Images: Photo 5 - Hawker Crawford Channel northwest of site.JPG Images: Photo 6 - Cobbles and small boulders in sand and gravel matrix - Hawker Crawford Channel.JPG
ATTACHED XREFS:
DB-L:\2007\CADD
CAD FILE: L:\2008\CADD\55633\ LAYOUT: Layout1

APPENDIX A

FIELD EXPLORATION

APPENDIX A
FIELD EXPLORATION

The original subsurface exploration program consisted of excavating and logging six exploratory borings (B-1 through B-6). Borings were excavated to depths between 6-1/2 and 11-1/2 feet below existing grades using a Caldwell Bucket Auger Drill rig equipped with a 24-inch diameter bucket, and a Mobile B-53, truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers.

Since all the previous borings did not reach the bottom of the proposed storm drain, Kleinfelder performed additional borings after consultation with Caltrans and LAN. Three additional borings (B-7 through B-9) were drilled on September 11 and 12, 2007 along the proposed storm drain alignment at I-15 freeway using mud-rotary drilling method to depths ranging from approximately 25 to 40 feet bgs. Proper traffic control and safety devices were used during drilling operation, including K-Rails and Crash Cushions (Boring B-8) and delineators (Borings B-7 and B-9) in accordance with the requirements of Caltrans Permit Department. The approximate locations of the exploratory borings are shown in Plate 2. The boring locations were established from current landmarks, pacing, and rough measurements. The described excavation locations should be considered accurate only to the degree implied by the method of measurement used.

A legend to the logs is presented as Plate A-1. The Logs of Borings are presented as Plates A-2 through A-10. The logs of the borings describe the earth materials encountered, indicate the locations of the samples obtained, and show field and laboratory tests performed. The borings were logged by an engineer or geologist from this firm using methods outlined in the Unified Soil Classification System (USCS) and general procedures established in ASTM D2488. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual. Bulk and drive samples of representative earth materials were obtained from the borings.

In-place soil samples were obtained at the test boring locations using a California-type Sampler driven a total of 18-inches (or until practical refusal) into the undisturbed soil at the bottom of the boring. The soil sampled by the California-type sampler (3-inch O.D., 2.4 inches I.D.) was returned to our laboratory for testing. The samplers were driven

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using a 140- and 300-pound “down-hole” hammer falling 30 inches. The total number of hammer blows required to drive the sampler the final 12 inches is termed the blow count and is recorded on the Logs of Borings. Bulk samples of the near-surface soils were retrieved directly from the auger blades. All borings were backfilled using the soil from cuttings.

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UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISION		LTR	ID	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		Well-graded gravels, gravel-sand mixtures
		GP		Poorly-graded gravels, gravel-sand mixtures
		GM		Silty gravels, gravel-sand-silt mixtures
		GC		Clayey gravels, gravel-sand-clay mixtures
	SAND AND SANDY SOILS	SW		Well-graded sands, gravelly sands
		SP		Poorly-graded sands and gravelly sands
		SM		Silty sands, sand-silt mixture
		SC		Clayey sands, sand-clay mixture

MAJOR DIVISION		LTR	ID	DESCRIPTION
FINE GRAINED SOILS	SILTS AND CLAYS LL < 50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands
		CL		Inorganic clays of low to medium plasticity; gravelly clays silty clays,sandy clays, lean clays
		OL		Organic silts and organic silt-clays of low plasticity
	SILTS AND CLAYS LL > 50	MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
		CH		Inorganic clays of medium to high plasticity
		OH		Organic clays of medium to high plasticity
	HIGHLY ORGANIC SOILS	Pt		Peat, muck and other highly organic soils

Approximate water level observed in boring following drilling

SOIL SAMPLE

- Bulk Sample
- Drive Sample - California Sample
- Shelby Tube Sample
- Standard Penetration Test (SPT) Sample

ADDITIONAL TESTS

CN	- Consolidation
COR	- Corrosion
CP	- Collapse Potential
DS	- Direct Shear
EI	- Expansion Potential
MAX	- Maximum Dry Density
OC	- Organic Content
PI	- Plasticity Index
RV	- R-Value
SE	- Sand Equivalent
GS	- Grain Size Distribution

NOTES:

Blow counts represent the number of blows of a 140-pound hammer falling 30 inches required to drive a sampler through the last 12 inches of an 18-inch penetration, unless otherwise noted.

The lines separating strata on the logs represent approximate boundaries only. The actual transition may be gradual. No warranty is provided as to the continuity of soil strata between borings. Logs represent the soil section observed at the boring location on the date of drilling only.

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LEGEND TO LOGS

PLATE A-1

Date Drilled	1/26/07	Water Depth:	Not Encountered
Drilled By:	Big Johnny's Drilling	Date Measured:	1/26/07
Drilling Method:	24" Bucket Auger	Elevation:	1747 feet (approx.)
Logged By:	Mike Cook	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
1745						SM	**Fill (Af):** **Silty Sand with Gravel:** brown to yellow-brown, slightly moist, dense, fine to medium grained sand, fine gravel			
	5	1	4/6"			GP-GM	**Alluvial Fan Deposits (Qyf):** **Sandy Gravel with Cobbles and Silt:** brown, dry to slightly moist, dense, friable, cobbles to 12", boulders to 18", very heavy caving and belling of hole at 6' to 7'			RV, COR, GS, Kelly wt. 2500 lbs.
1740		2				GW	**Gravel with Sand**: no recovery of driven sample, bulk sample only, cobbles greater than 8", some boulders to 18", very heavy caving			MAX, DS, GS

Boring terminated at 9.5 feet due to heavy caving and cobbles and boulders.
Practical drill refusal at 9.5 feet.
Groundwater was not encountered.
Borehole backfilled with cuttings.

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-1

PLATE A-2

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/25/08

Date Drilled	1/26/07	Water Depth:	Not Encountered
Drilled By:	Big Johnny's Drilling	Date Measured:	1/26/07
Drilling Method:	24" Bucket Auger	Elevation:	1742 feet (approx.)
Logged By:	Mike Cook	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
1740						SM	**Alluvial Fan Deposits (Qyf):** **Silty Sand:** yellow-brown to red-brown, dry, fine to medium grained sand, some coarse gravel to 1", some caving			
1735	5	1 2	8/10"			GP-GM	**Sandy Gravel with Cobbles:** brown, dry, gravel to 2", heavy caving, silty sand matrix –no recovery of driven sample, bulk sample only, cobbles greater than 8", some boulders to 18", very heavy caving			GS, Kelly wt. 2500 lbs.

Boring terminated at 7 feet due to heavy caving and cobbles, boulders.
Practical drill refusal at 7 feet.
Groundwater was not encountered.
Borehole backfilled with cuttings.

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-2

PLATE A-3

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/26/08

Date Drilled	5/18/07	Water Depth:	Not Encountered
Drilled By:	Cal Pac Drilling	Date Measured:	5/18/07
Drilling Method:	8" Hollow Stem Auger	Elevation:	1729 feet (approx.)
Logged By:	James Perry	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
		1				SM	**Fill (Af):** **Silty Sand:** Light brown, dry, fine sand, trace medium sand.			
1725	5	2	65			GM	**Alluvial Fan Deposits (Qyf):** **Silty Gravel:** Light brown, dry, some fine sand, cobbles and boulders. -fine to medium sand	117	0.7	SE
1720	10	3				GP-GM	**Gravel with silt and sand:** Light brown, dry, some fine sand, cobbles and boulders. -medium to coarse gravel. -cobbles to 4".			GS
		4	42							

Practical drill refusal at 11.5 feet.
Ground water was not enocountered.
Hole backfilled using soil from cuttings.

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-3

PLATE A-4

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/25/08

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

Date Drilled	5/18/07	Water Depth:	Not Encountered
Drilled By:	Cal Pac Drilling	Date Measured:	5/18/07
Drilling Method:	8" Hollow Stem Auger	Elevation:	1723 feet (approx.)
Logged By:	James Perry	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
						SM	**Fill (Af):** **Silty Sand:** Brown, dry, fine sand, trace gravel.			
1720		1				GM	**Alluvial Fan Deposits (Qyf):** **Silty Gravel with Sand:** Brown to gray brown, dry, fine to medium sand, cobbles and boulders.			
	5	2	33 50/3"					122	0.6	RV, SE

Practical drill refusal at 6.5 feet.
Ground water was not encountered.
Hole backfilled using soil from cuttings.

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Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-4

PLATE A-5

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/25/08

Date Drilled	5/18/07	Water Depth:	Not Encountered
Drilled By:	Cal Pac Drilling	Date Measured:	5/18/07
Drilling Method:	8" Hollow Stem Auger	Elevation:	1748 feet (approx.)
Logged By:	James Perry	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
		1 2	12			SM	**Fill (Af):** **Silty Sand:** Light brown, dry, loose, fine sand.	104	1.4	
1745						GM	**Alluvial Fan Deposits (Qyf):** **Silty Gravel with Sand:** Light brown, dry, medium dense, fine to medium sand, numerous cobbles.			
	5	3	18							
							Practical drill refusal at 6.5 feet. Ground water was not encountered. Hole backfilled using soil from cutting.			

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-5

PLATE

A-6

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/25/08

Date Drilled	5/18/07	Water Depth:	Not Encountered
Drilled By:	Cal Pac Drilling	Date Measured:	5/18/07
Drilling Method:	8" Hollow Stem Auger	Elevation:	1744 feet (approx.)
Logged By:	James Perry	Datum:	MSL

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
		1				SM	**Fill (Af):** **Silty Sand:** Brown to yellow brown, dry, fine sand, trace medium sand.			
1740	5	2	46			GM	**Alluvial Fan Deposits (Qyf):** **Silty Gravel:** Light brown, dry, dense, some fine sand, gravel to 3", numerous cobbles.			
							Practical drill refusal at 6.5 feet. Ground water was not encountered. Hole backfilled using soil from cutting.			

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-6

PLATE A-7

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633 DUNCAN CANYON CULVERT.GPJ KA_RDLND.GDT 3/25/08

Date Drilled	9/11/07	Water Depth:	Not Encountered
Drilled By:	C and L	Date Measured:	9/11/07
Drilling Method:	Mud Rotary	Elevation:	1748 feet (approx.)
Logged By:	Lisa Battiato	Datum:	M.S.L

Elevation (approx.) (feet)	Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
						SM	**Fill (Af):** **Silty Sand:** Brown, dry, fine to coarse sand with gravel and cobbles			
1745						GP	**Alluvial Fan Deposits (Qyf):** **Sandy Gravel:** Brown, dry to damp, dense, coarse sand, cobbles			
	5	1	70							
1740							--cobble layer			
	10	2	84				--yellow brown, moist, very dense			
1735										
	15		50/3"							
							--large cobbles, boulders			
1730										
	20		50/4"				--slightly weathered tonalite, trace iron oxide deposits on tonalite			
1725										
	25	3	100/6"				--dark gray-olive, trace silt			

Practical drill refusal at 25.5 feet.
Boring caved twice at 15 feet.
Groundwater was not encountered.
Hole backfilled using the material from cuttings.

Note:
All samples driven with 140 lb hammer falling 30".

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-7

PLATE A-8

GEOTECH TEMECULA 55633-DUNCAN CANYON.GPJ KA_RDLND.GDT 3/25/08

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

Date Drilled	9/11/07	Water Depth:	Not Encountered
Drilled By:	C and L	Date Measured:	9/11/07
Drilling Method:	Mud Rotary	Elevation:	1743 feet (approx.)
Logged By:	Lisa Battiato	Datum:	M.S.L

Elevation (approx.) (feet) Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
					SM	**Fill (Af):** **Silty Sand:** Brown, damp, fine to coarse sand with gravel and cobbles			
1740									
5	1	100			GP	**Alluvial Fan Deposits (Qyf):** **Sandy Gravel:** Black and white, moist, very dense, coarse sand with gravel, cobbles, and boulders, sampled granodiorite boulder			
1735									
10	2	110/9"				--yellow brown, some cobbles, trace silt	136	7.9	COR
1730									
15	3	100/6"				--gravel consists of granodiorite and gabbro	125	8.1	GS
1725						--bouncing on rocks			
20	4	150/4"							GS
1720									
25	5	60/6"							
1715									
30	6	100/5"				--moderately weathered gabbro rock			
1710									

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-8

PLATE A-9a

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633-DUNCAN CANYON.GPJ KA RDLND.GDT 3/25/08

Elevation (approx.) (feet) Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION *(Continued From Previous Page)*	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
		50/1"				**Alluvial Fan Deposits (Qyf):** **Sandy Gravel:** Black and white, moist, very dense, coarse sand with gravel, cobbles, and boulders, sampled granodiorite boulder *(continued)* --yellow brown, bouncing on rocks			
1705									
40	7	60/6"							
						Boring terminated at 40.5 feet. Groundwater was not encountered. Hole backfilled using the material from cuttings.			
						Note: CAL ring samples driven with 300 lb hammer, 18" drop. SPT samples driven with 140 lb hammer, 30" drop.			

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-8

PLATE A-9b

GEOTECH TEMECULA 55633-DUNCAN CANYON.GPJ KA_RDLND.GDT 3/25/08

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

Date Drilled	9/12/07	Water Depth:	Not Encountered
Drilled By:	C and L	Date Measured:	9/12/07
Drilling Method:	Mud Rotary	Elevation:	1747 feet (approx.)
Logged By:	Lisa Battiato	Datum:	M.S.L

Elevation (approx.)	Depth (feet)	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
1745						SP	**Fill (Af):** **Gravelly Sand:** Brown, damp, fine to coarse sand, some cobbles			
	5	1	12			SM	**Alluvial Fan Deposits (Qyf):** **Silty Sand:** Brown, moist, loose, medium grained sand, some gravel	114	11.0	
1740						GP	**Sandy Gravel:** Yellow brown, moist, very dense, coarse sand			
	10	2	100				-- matrix supported	115	10.8	DS
1735										
	15	3	100					124	8.6	DS, COR
1730										
	20	4	100/4"							GS
1725										
							--dark gray, some cobbles, rock fragments (gabbro).			
	25	5	50/4"							
1720										
	30	6	100/2"							
1715							--cobble layer			

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Duncan Canyon "Line A" Storm Drain
Fontana, CA

PLATE A-10a

PROJECT NO. 55633

LOG OF BORING B-9

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

GEOTECH TEMECULA 55633-DUNCAN CANYON.GPJ KA RDLND.GDT 3/25/08

Elevation (approx.) (feet) Depth	Sample Number	Blows per Foot	Sample Type	Graphic Log	USCS Description	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION *(Continued From Previous Page)*	Dry Unit Weight (pcf)	Moisture Content (%)	Additional Tests & Remarks
1710		50/0"				**Sandy Gravel:** Yellow brown, moist, very dense, coarse sand *(continued)*			
40	7	100/3"							

Boring terminated at 40.25 feet.
Boring caved at 13.0 feet.
Groundwater was not encountered.
Hole backfilled using the material from cuttings.

Note:
CAL ring samples driven with 300 lb hammer, 18" drop.
SPT samples driven with 140 lb hammer, 30" drop.

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PROJECT NO. 55633

Duncan Canyon "Line A" Storm Drain
Fontana, CA

LOG OF BORING B-9

PLATE A-10b

GEOTECH TEMECULA 55633-DUNCAN CANYON.GPJ KA RDLND.GDT 3/25/08

Note: The boundaries between soil types shown on the logs are approximate as the transition between different soil layers may be gradual.

APPENDIX B

LABORATORY TESTING

APPENDIX B
LABORATORY TESTING

Geotechnical laboratory tests were performed on selected drive and bulk soil samples to estimate engineering characteristics of various earth materials encountered at the site. Testing was performed in general accordance with procedures outlined by the American Society for Testing and Materials (ASTM) and the California Department of Transportation test methods (CTM).

IN-SITU MOISTURE CONTENT AND DRY UNIT WEIGHT

In-situ moisture content and dry unit weight tests were performed on samples that could be recovered in a relatively undisturbed condition. Moisture content was evaluated in general accordance with ASTM D2216; dry unit weight was evaluated using procedures similar to ASTM D2937. The results are presented on the Logs of Borings (see Appendix A).

GRAIN SIZE DISTRIBUTION

Sieve analyses were performed on seven soil samples to evaluate the gradation of the encountered materials and to aid in soil classification. Tests were performed in general accordance with ASTM D422. The results of these tests are presented on Plates B-1 through B-7, *Grain Size Distribution*.

COMPACTION TEST

A laboratory compaction test (ASTM D1557) was performed on one representative bulk samples to determine the maximum dry unit weight and optimum moisture content of encountered earth materials. Test results are summarized in Table B-1.

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Table B-1
Summary of Compaction Test Results

Location	Depth (feet)	USCS Soil Type	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
B-1	8 – 9.5	GP-GM	140.3	6.5

DIRECT SHEAR TEST

Direct shear tests were performed on remolded specimens obtained from a bulk sample to evaluate the drained shear strength of potential on-site backfill soils. The samples were remolded to 90% relative compaction and actual in-situ densities, soaked and tested in a near-saturated condition, in general accordance with ASTM D3080 (consolidated drained test). Test results are graphically presented on Plates B-8 through B-10, *Direct Shear Test Results*.

CORROSIVITY TESTS

Corrosivity tests were performed on a bulk sample to estimate pH, resistivity, soluble sulfate, and chloride contents of encountered earth materials, in general accordance with the following Caltrans Standard Test Methods: CTM 643 for electrical resistivity, CTM 532 for pH, CTM 417 for sulfate content, and CTM 422 for chloride content. Test results are summarized in Table B-2, below.

Table B-2
Summary of Corrosivity Test Results

Location	Depth (feet)	Minimum Resistivity (Ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-1	5 – 6.5	5,600	7.5	< 10	62
B-8	10 – 11.5	2,600	6.7	< 10	60
B-9	15 –16.5	4,000	7.4	< 10	62

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R-VALUE TESTS

Two resistance value (R-value) tests were performed on bulk soil samples to evaluate pavement support characteristics of the near-surface onsite soils. R-value testing was performed in general accordance with Caltrans Standard Test Method 301. Test results are presented in Table B-3, below.

Table B-3
Summary of R-Value Test Results

Location	Depth (feet)	USCS Soil Type	R-Value
B-1	5 – 6.5	GP-GM	84
B-4	2 – 6	GM	72

SAND EQUIVALENT TEST

The sand equivalent test provides an indication of the relative proportions of fine-dust or clay-like material in soil or fine aggregates. A selected sample was tested using California Test Method (CTM) 217. The prepared sample was poured into a calcium chloride solution in a plastic cylinder. After a wetting period, the sample was agitated by 100 strokes in a manual shaker. Following cylinder irrigation and a 20 minute standing time, the height of the top of the sediment column was recorded as the clay reading. The sand reading was taken with a weighted foot that rests on the sand in the cylinder. The sand equivalent is calculated as one hundred times the sand reading divided by the clay reading. Test results are presented in Table B-4, below.

Table B-4
Summary of Sand Equivalent Test Results

Location	Depth (feet)	USCS Soil Type	Sand Equivalent (SE)
B-3	5 – 6.5	GM	65
B-4	2 – 6	GM	20

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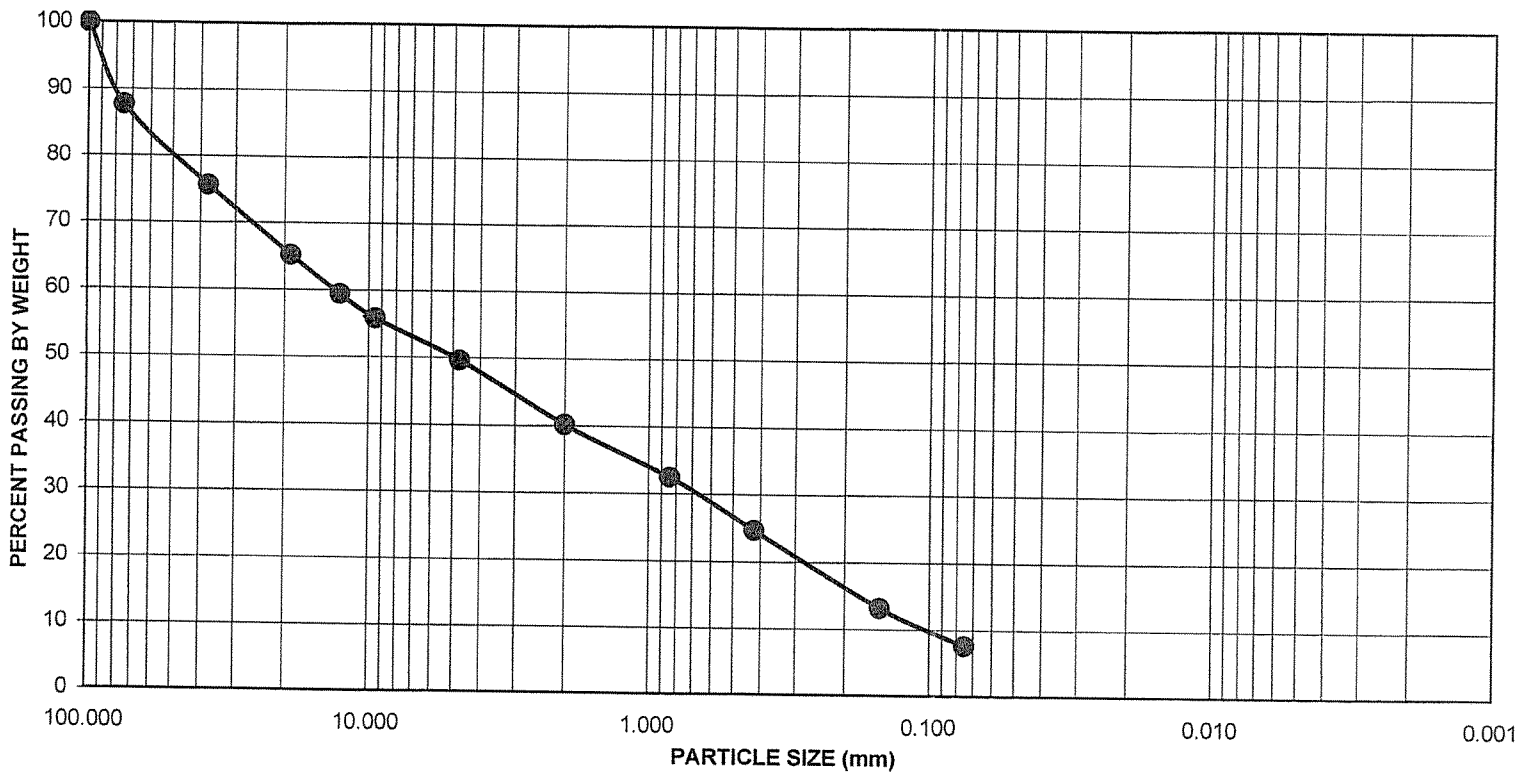
GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



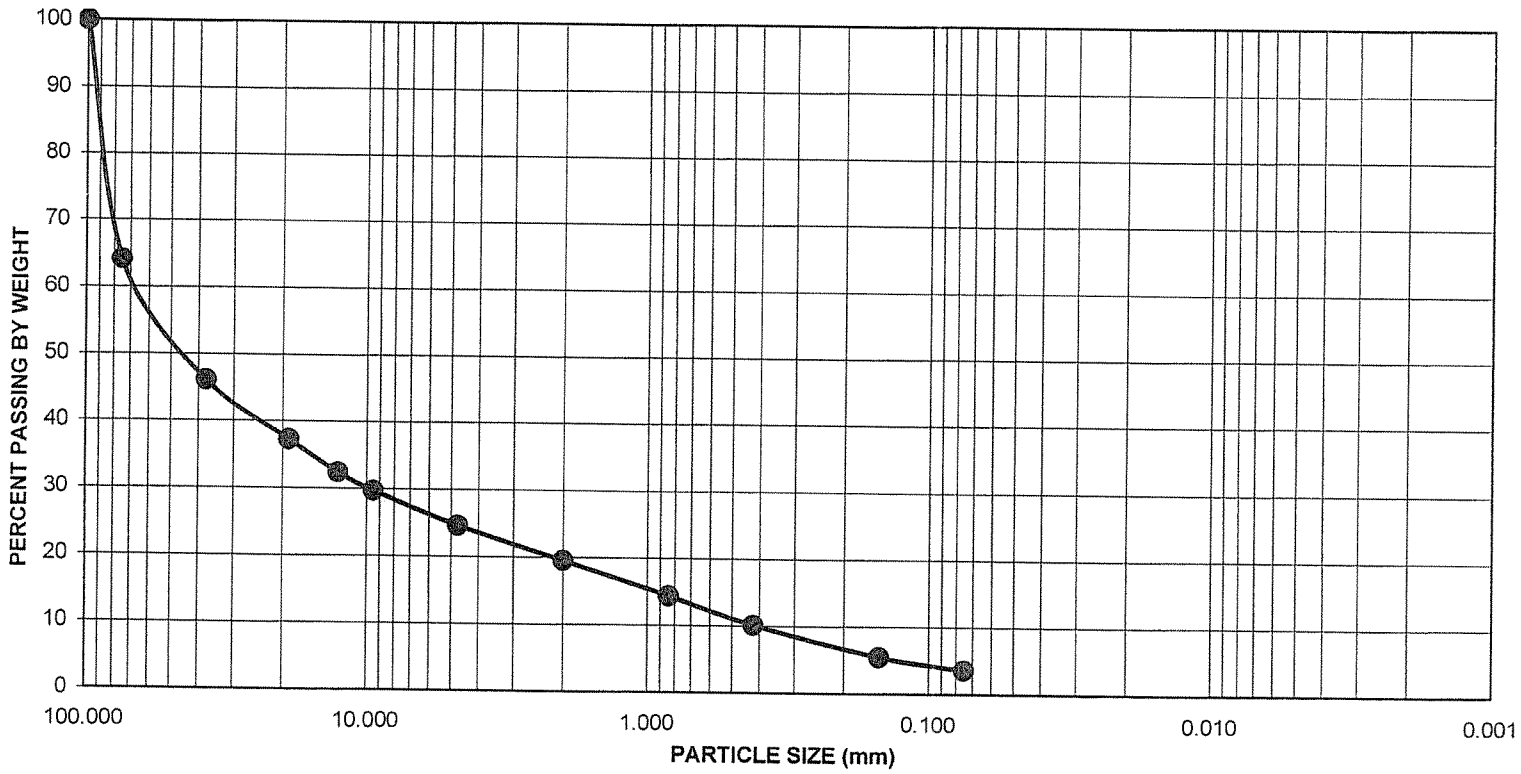
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-1	1	5.0 - 6.5	Sandy Gravel with Cobbles and Silt	50 : 42 : 8	GP-GM

KLEINFELDER	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-1

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



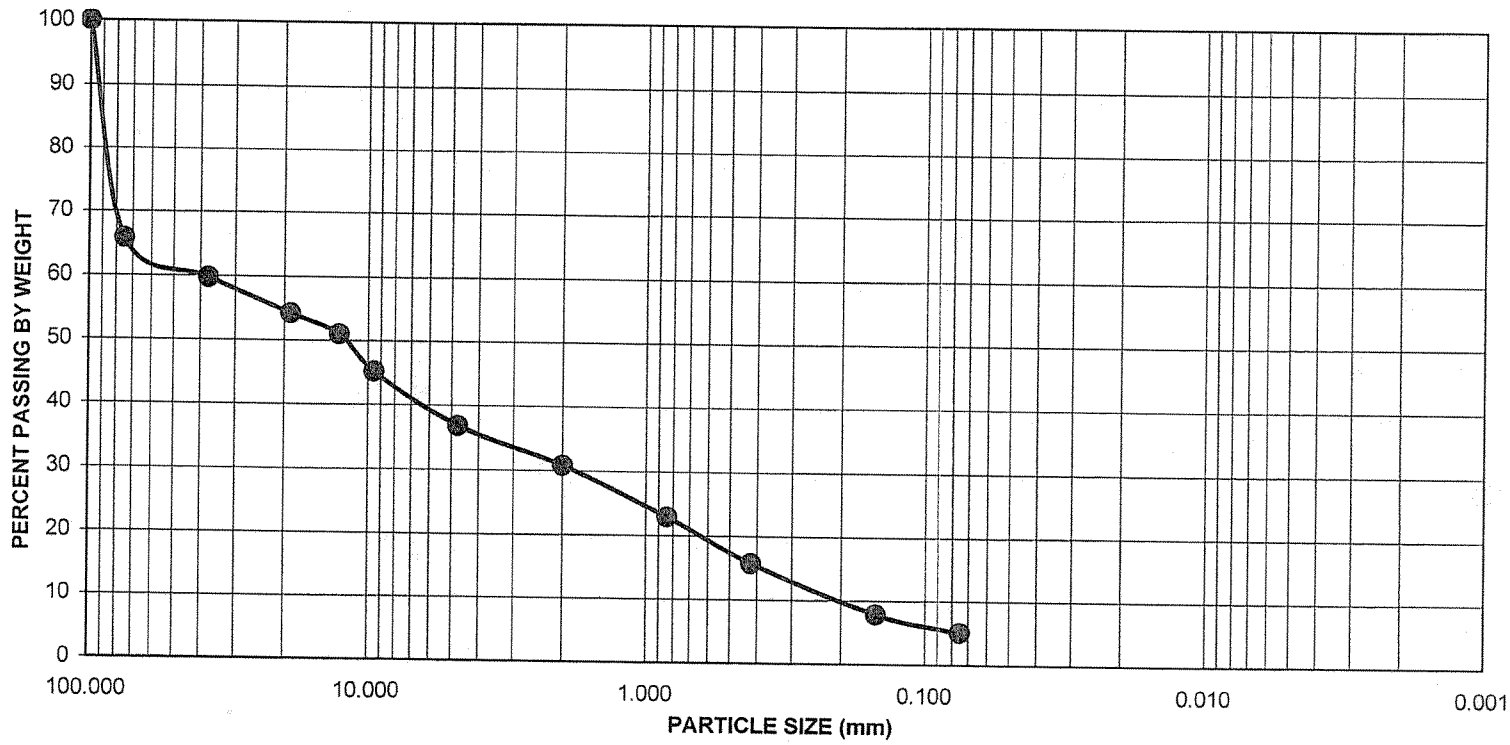
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-1	2	8.0 - 9.5	Sandy Gravel with Cobbles	75 : 21 : 4	GW

K L E I N F E L D E R	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-2

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



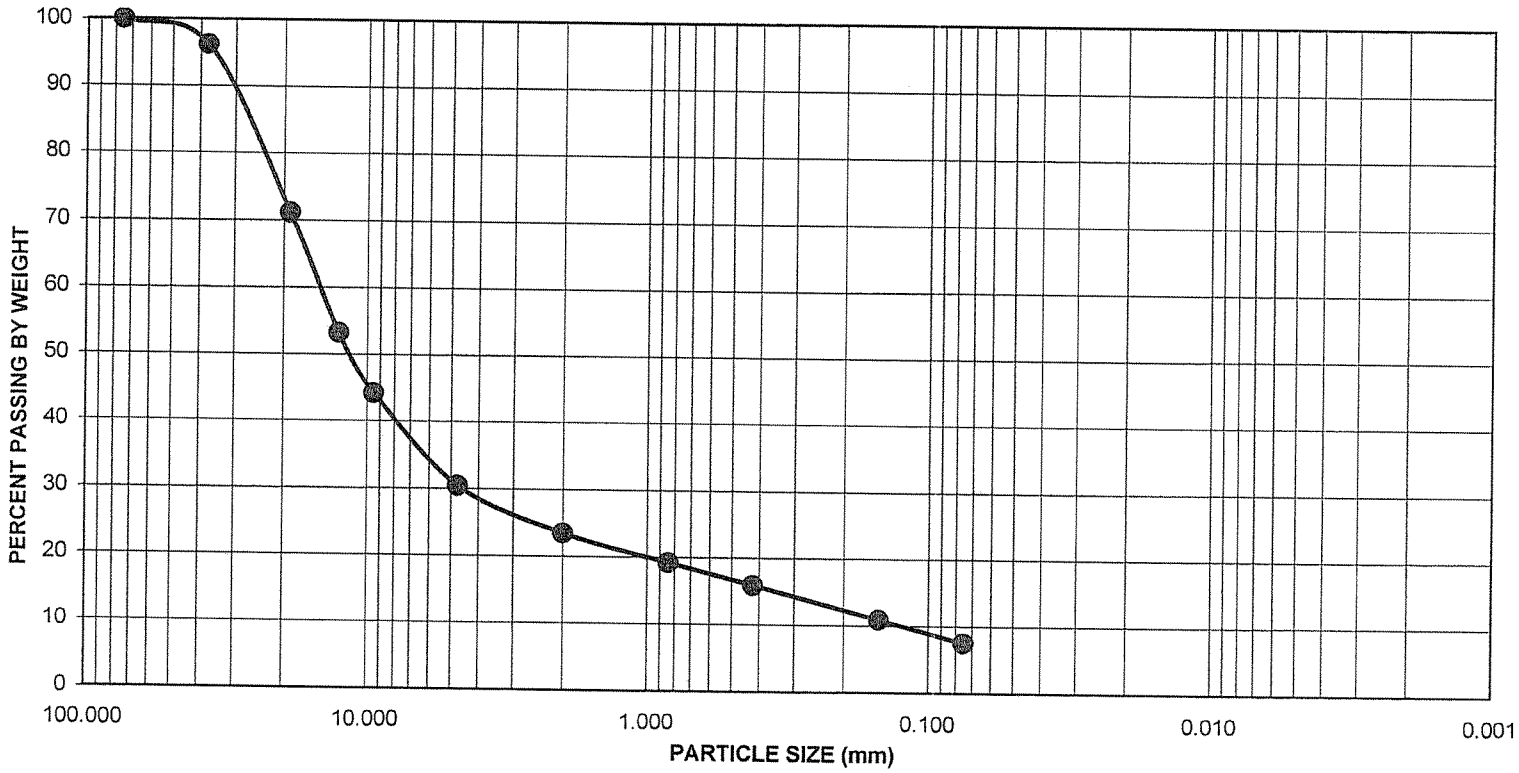
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-2	2	5.0 - 6.5	Sandy Gravel with Cobbles and Silt	63 : 32 : 5	GP-GM

K L E I N F E L D E R	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-3

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



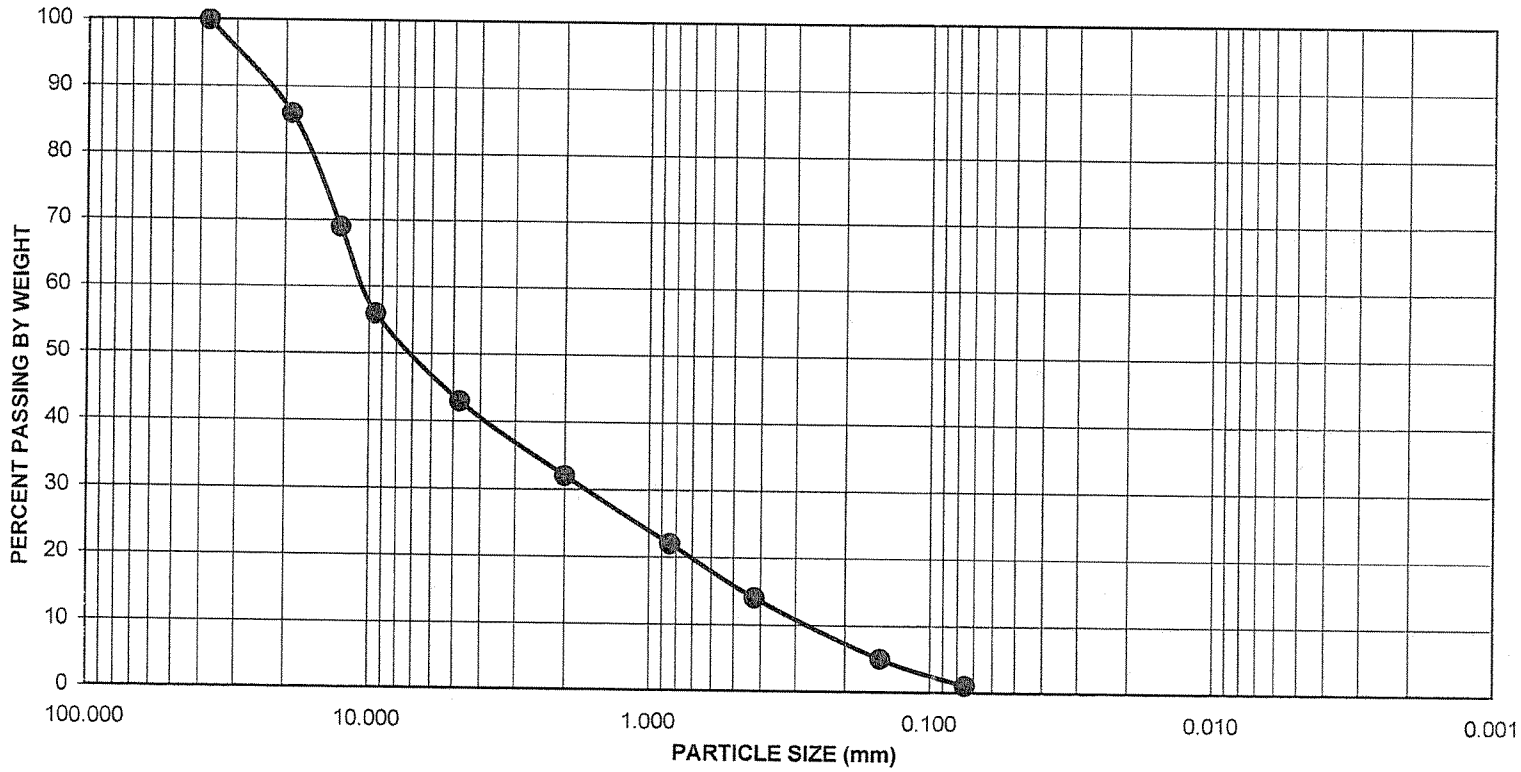
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-3	3	7.0 - 10.0	Sandy Gravel with Cobbles and Silt	70 : 23 : 7	GP-GM

KLEINFELDER	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-4

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



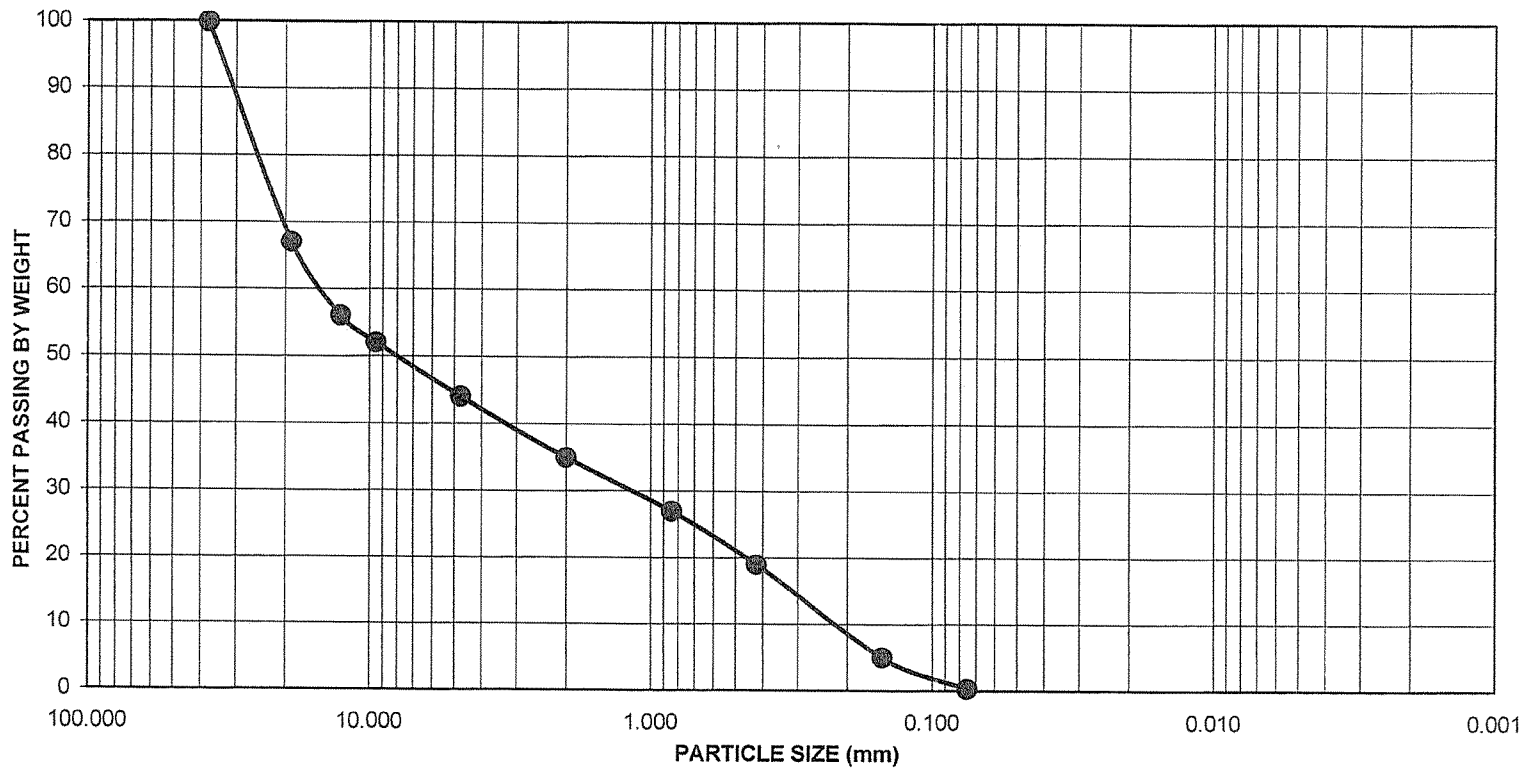
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-8	3	15.0 - 15.5	Sandy Gravel	57 : 42 : 1	GP

KLEINFELDER	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-5

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200



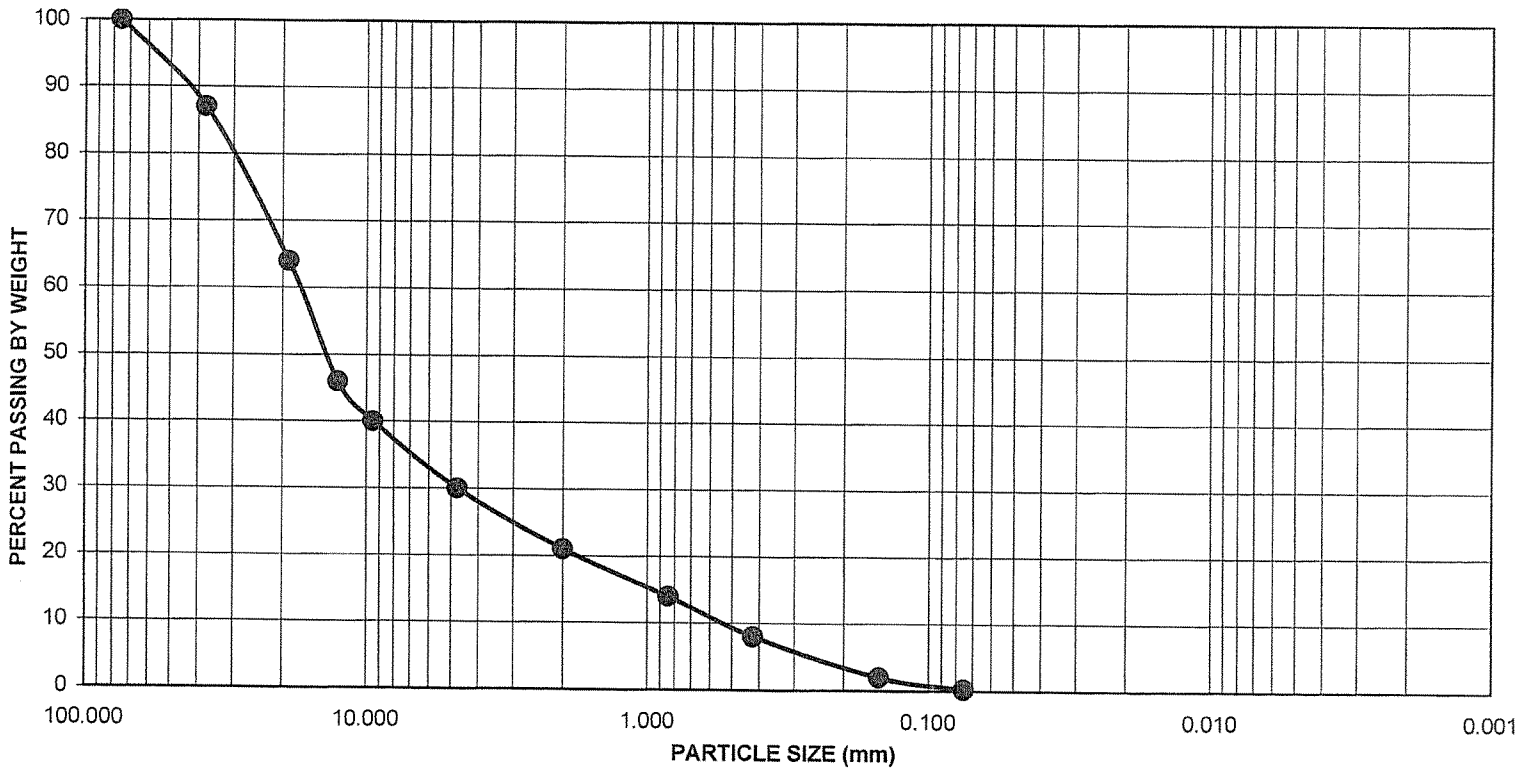
Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-8	4	20 - 20.5	Sandy Gravel	56 : 44 : 0	GP

K L E I N F E L D E R	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-6

GRAIN SIZE DISTRIBUTION
ASTM D422

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
SIEVE ANALYSIS					HYDROMETER	

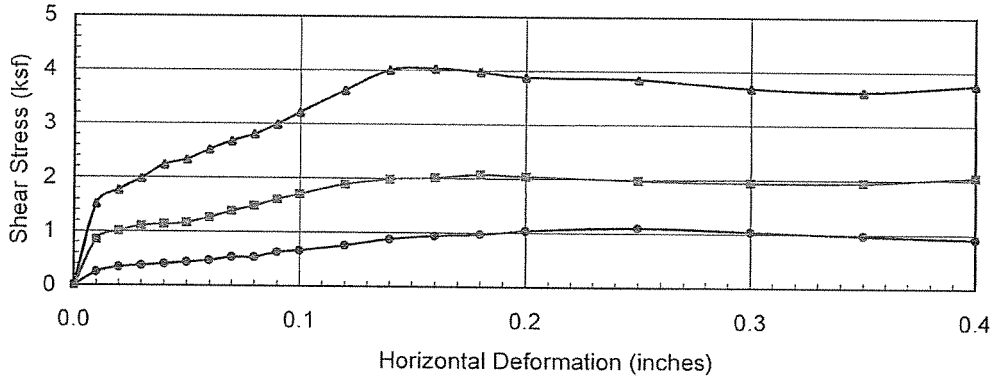
3" 1.5" 3/4" 3/8" #4 #10 #20 #40 #100 #200

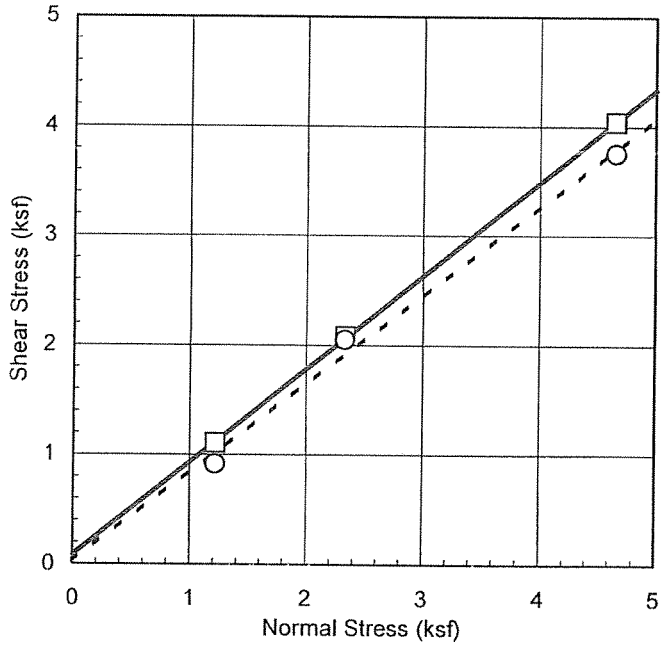


Symbol	Exploration No.	Sample No.	Depth (feet)	Sample Description	Gravel : Sand : Fines (%)	Soil Type
●	B-9	4	20 - 20.5	Sandy Gravel	70 : 30 : 0	GP

KLEINFELDER	Proposed Duncan Canyon Line "A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-7

DIRECT SHEAR TEST DATA
ASTM D3080





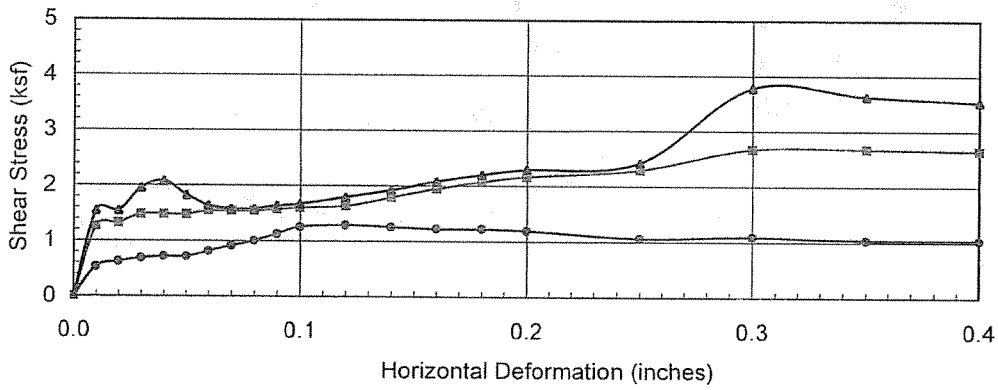
	Load 1	Load 2	Load 3
Normal Stress (ksf)	1.216	2.329	4.658
Peak Shear Stress (ksf) □	1.105	2.083	4.041
Ultimate Shear Stress (ksf) ○	0.915	2.052	3.757
Initial Moisture Content (%)	6.5	6.5	6.5
Dry Density (pcf)	125.3	125.0	127.7

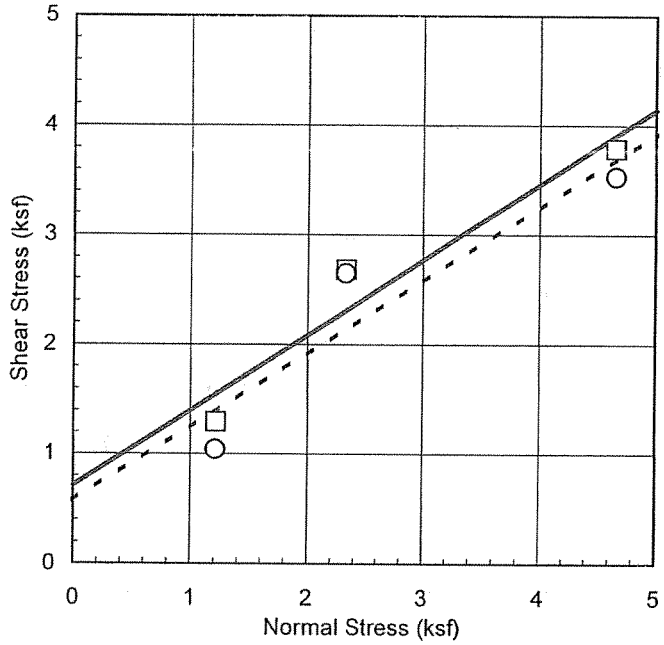
Exploration No.	B-1
Sample No.	2
Sample Type	Remolded to 90% Relative Compaction
Depth (feet)	8.0 - 9.5
Description	Sandy Gravel with Cobbles (GW)

Shear Strength Parameters		
	Cohesion C (psf)	Friction Angle ϕ (°)
Peak	82.7	40.4
Ultimate	23.4	39.0

KLEINFELDER	Proposed Duncan Canyon "Line A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-8

DIRECT SHEAR TEST DATA
ASTM D3080





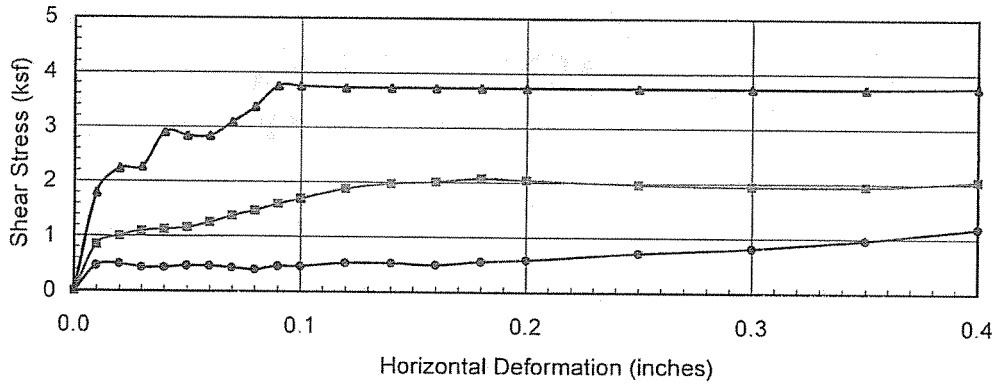
	Load 1	Load 2	Load 3
Normal Stress (ksf)	1.216	2.329	4.658
Peak Shear Stress (ksf) □	1.294	2.683	3.788
Ultimate Shear Stress (ksf) ○	1.042	2.652	3.536
Initial Moisture Content (%)	10.8	10.8	10.8
Dry Density (pcf)	116.3	115.0	112.1

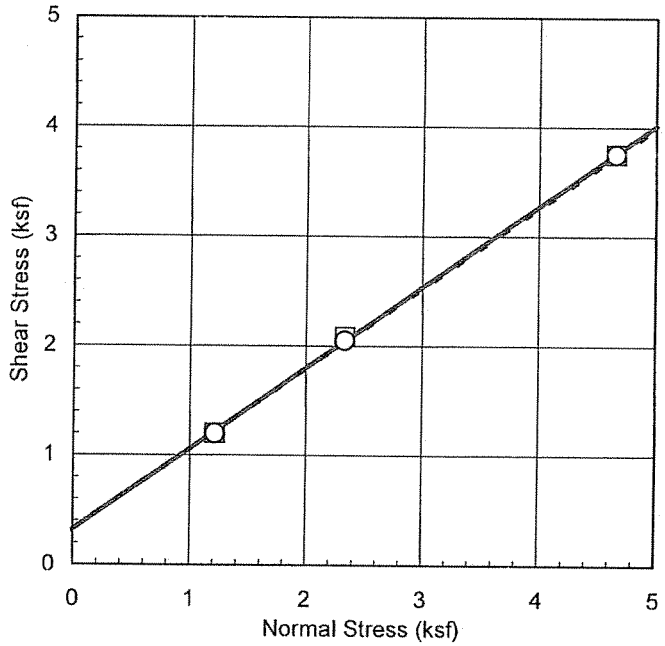
Exploration No.	B-9
Sample No.	2
Sample Type	Remolded to Actual In-Situ Density
Depth (feet)	10.0-11.5
Description	Sandy Gravel with Cobble (GP)

Shear Strength Parameters		
	Cohesion C (psf)	Friction Angle ϕ (°)
Peak	712.1	34.5
Ultimate	572.9	33.9

KLEINFELDER	Proposed Duncan Canyon "Line A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-9

DIRECT SHEAR TEST DATA
ASTM D3080





	Load 1	Load 2	Load 3
Normal Stress (ksf)	1.216	2.329	4.658
Peak Shear Stress (ksf) □	1.200	2.083	3.757
Ultimate Shear Stress (ksf) ○	1.200	2.052	3.757
Initial Moisture Content (%)	8.6	8.6	8.6
Dry Density (pcf)	119.8	122.0	130.3

Exploration No.	B-9
Sample No.	3
Sample Type	Remolded to Actual In-Situ Density
Depth (feet)	15.0-16.5
Description	Sandy Gravel with Cobble (GP)

Shear Strength Parameters		
	Cohesion C (psf)	Friction Angle ϕ (°)
Peak	325.5	36.5
Ultimate	309.3	36.5

KLEINFELDER	Proposed Duncan Canyon "Line A" Storm Drain	PLATE NO.
PROJECT NO. 55633	Fontana, California	B-10

APPENDIX C

ASFE INSERT

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from alight industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ-sometimes significantly from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in-this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer For Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone:' 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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IIGER06045.0M

APPENDIX D

RESPONSE TO CALTRANS REVIEW COMMENTS

KLEINFELDER
Bright People. Right Solutions.

1220 Research Drive, Suite B
Redlands, CA
92374

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f | 909.792.1704

kleinfelder.com

December 18, 2008
Project No. 55633

Mr. William Nascimento, PE, SE
Lim & Nascimento Engineering Corporation
20 Empire Drive
Lake Forest, California 92630

Subject: **Response to Caltrans Review Comments (Dated November 24, 2008)**
Final Geotechnical Design Report (Dated September 24, 2008)
Proposed Duncan Canyon "Line A" Storm Drain
City of Fontana
San Bernardino County, California
08-SBd- 15-PM-KP 11.0/11.4
EA 0K 05201

Dear Mr. Ryan:

Kleinfelder has prepared this letter in response to comments provided by the California Department of Transportation (Caltrans), Division of Program Project Management, pertaining to their review of our report entitled Final *Geotechnical Design Report, Proposed Duncan Canyon "Line A" Storm Drain, San Bernardino County, California,* dated September 24, 2008. Caltrans has requested responses and resolutions on three comments (Comments 1 through 3). The Caltrans review comments and our responses to these comments are presented below:

Comment No. 1. *The distance of the Red Hill-Etiwanda Avenue Fault (RHE) to the project site in Section 2.1 and Table 1 should be consistent.*

Response to Comment No. 1. We concur with Caltrans on the comment. The distance of the Red Hill-Etiwanda Avenue Fault (RHE) to the project site has been revised in Section 2.1 to be consistent with Table 1 of our report. Please see our revised report for changes.

Comment No. 2. *Table 1, Seismic Design Parameters: No ARS Curve with Peak Bedrock acceleration (PBA) of 0.9 g is available in Figure B.5 of the Caltrans Seismic Design Criteria (2006). Please clarify how to determine the ARS curve with PBA of 0.9g in the structural design.*

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Response to Comment No. 2. The ARS curve for the project site can be obtained by scaling up the ARS curve for the Peak Bedrock Acceleration (PBA) of 0.7g. This is done by multiplying the spectral acceleration values of the ARS curve by the ratio (0.9/0.7) for all periods.

Comment No. 3. *In Section 6.3.3 Excavation: Subsurface verification during excavation and design recommendations provided in the GDR should be verified by the consultant's representative, not by Caltrans' geotechnical engineer. Please revert the wordings of Section 6.3.3 back to the recommendations provided in the GDR prepared by Kleinfelder dated 4/3/08.*

Response to Comment No. 3. Section 6.3.3 has been revised accordingly. Please refer to the revised report for changes.

CLOSURE

The information contained in this letter/report is subject to the conditions and limitations contained within the Geotechnical Design Report. We appreciate the opportunity to be of service on this project. If you have any questions, comments or require additional information, please do not hesitate to contact our office at your convenience.

Respectfully submitted,

KLEINFELDER WEST, INC.

Carlos V. Amante, PE, GE
Geotechnical Group Manager

Richard F. Escandon, PG, CEG
Principal Geologist

CVA:lg

Attachment: Caltrans Comments

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DEPARTMENT OF TRANSPORTATION
DISTRICT 8
PROGRAM PROJECT MANAGEMENT (MS 1229)
464 WEST 4TH STREET, 6TH FLOOR
SAN BERNARDINO, CA 92401-1400
PHONE (909) 383-4616
FAX (909) 383-6230
TTY (909) 383-6300

Flex your power!
Be energy efficient!

November 24, 2008

Mr. Kevin Ryan
Senior Planner
City of Fontana
8353 Sierra Avenue
Fontana, CA 92335

File: 08-SBd-15-PM 11.0/11.4
Storm Drain Installation
Near Duncan Canyon
08-224-0K5201

Dear Mr. Ryan:

Final Geotechnical Design Report:

We have reviewed the Final Geotechnical Design Report dated September 24, 2008 for the proposed Duncan Canyon "Line A" Storm Drain located in the City of Fontana, County of San Bernardino. Based on the review of the report, the following are our comments.

1. The distance of the Red Hill-Etiwanda Avenue Fault (RHE) to the project site in Section 2.1 and Table 1 should be consistent.

2. Table 1, Seismic Design Parameters: No ARS Curve with Peak Bedrock acceleration (PBA) of 0.9g is available in Figure B.5 of the Caltrans Seismic Design Criteria (2006). Please clarify how to determine the ARS curve with PBA of 0.9g in the structural design.

3. In Section 6.3.3 Excavation: Subsurface verification during excavation and design recommendations provided in the GDR should be verified by the consultant's representative, not by Caltrans' geotechnical engineer. Please revert the wordings of Section 6.3.3 back to the recommendations provided in the GDR prepared by Kleinfelder dated 4/3/08.

If you have any questions regarding these comments, please contact me at (909) 659-7483.

Sincerely,

Mark Lancaster
Project Manager
Program Project Management

c: EHadipour, Design Oversight, MS 1164
William Nascimento, LAN Engineering Corp.
File

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kleinfelder.com

September 24, 2008
Project No. 55633

Mr. William Nascimento, PE, SE
Lim & Nascimento Engineering Corporation
20 Empire Drive
Lake Forest, California 92630

Subject: **Response to Caltrans Review Comments Dated August 5, 2008**
Geotechnical Design Report (Dated June 10, 2008)
Proposed Duncan Canyon "Line A" Storm Drain
Fontana, California
Caltrans EA No. 0K 05201

Dear Mr. Nascimento:

Kleinfelder West, Inc. (Kleinfelder) has prepared this letter in response to comments provided by the California Department of Transportation (Caltrans), District 8, Program/Project Management (MS 1229), dated August 5, 2008, pertaining to their review of our Geotechnical Design Report (dated June 10, 2008) for the proposed Duncan Canyon "Line A" Storm Drain located in Fontana, San Bernardino County, California. Caltrans has requested responses and resolutions on several issues of concern. Caltrans review comments and our responses to these comments are presented below:

Comment No. 1. *The controlling fault should be Red-Hill Etiwanda Avenue Fault (RHE) (CSHM, 1996) with Magnitude of 7.0 located about 0.8 km from the Duncan Canyon Overcrossing (OC). We generally assume reverse/thrust for unknown fault type. The recommended Peak Bedrock Acceleration (PBA) is 0.8g based on Sadigh's attenuation relationship. Please revise Section 6.1 and the seismic design accordingly.*

Response to Comment No. 1. We concur with Caltrans on the controlling fault, which is Red Hill-Etiwanda Avenue (RHE) Fault with a Magnitude of 7.0 and closest distance of 0.8 km based on the California Seismic Hazard Map 1996 (Mualchin, 1996).

The Red Hill-Etiwanda Avenue Fault has an unknown style of faulting based on Mualchin's (1996) map report. Assuming this fault is reverse/thrust, based on Caltrans practice, the computed PBA is 0.86g which arithmetically rounds to 0.9g. This estimate takes into account the correction due to style of faulting. The empirical coefficients in Sadigh's (1997) formula to calculate PBA are based on strike-slip faulting. Sadigh

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Sadigh's (1997) formula to calculate PBA are based on strike-slip faulting. Sadigh recommends that the spectral acceleration be multiplied by 1.2 to account for reverse/thrust faulting. Hence, the corrected PBA is equal to 0.72g x 1.2 = 0.86g. Therefore, we recommend a PBA of 0.9g be used for design. The revised Table 1 in Section 6.1 of our report is presented below.

Table 1
Seismic Design Parameters

Seismic Design Parameter	Design Recommendation and Reference
Controlling Fault	Red Hill- Etiwanda Avenue fault (Mualchin, 1996a,b)
Type of Fault	Unknown (assumed Reverse/Thrust)
Site Distance from the Fault	0.8 km
Earthquake Magnitude	7.0
Peak Bedrock Acceleration (PBA)	0.9g
Peak Ground Acceleration (PGA)	0.71g
Soil Profile Type	C (Table B.1, 2006 Caltrans Seismic Design Criteria)
Standard ARS Curve	Figure B.5 (2006 Caltrans Seismic Design Criteria); Damping = 5%

Comment No. 2. *Move the following statement as the first sentence in the paragraph. "The contractor is solely responsible to determine the type and extent of shoring. Engineered and stamped Shoring Plans shall be required prior to final approval and issuance of permit for final construction". Geologists recommendations should be listed afterwards.*

Response to Comment No. 2. We agree with Caltrans on the comment. Section 6.4.3, *Construction Considerations for Shoring System*, of our report has been revised accordingly.

Comment No. 3. *Revise the title to "Compaction Methods in State R/W". Revise the first paragraph to read, "No jetting or ponding in existing or proposed State Right of Way (R/W) is allowed. The in-situ and anticipated bedding materials along the alignment should be suitable for placement and compaction utilizing conventional mechanical compaction methods, or as determined by the contractor."*

Response to Comment No. 3. The title for Section 6.5.6 of the report has been revised to "Compaction Methods in State Right-of-Way" and the section has been revised accordingly.

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Comment No. 4. *Revise the paragraph to omit the following underlined statements, and corrections made, "Pipe-zone backfill....compacted to a firm, and unyielding condition, as evaluated by a representative from our firm or to at least 90 percent of the...Method D 1557. Backfill materials.....of the pipe. Reduction of the lift....recommended compaction. Jetting may be used to place and compact backfill within the pipe-zone. Jetting should be performed in substantial conformance with the City of Fontana's and/or the Specifications and methods, by contractors having sufficient experience in jetting methods and control. Pipe-zone soils should be in a non-voided, stable, firm and unyielding state and be fully drained of excess water before additional fill materials are placed. "Pooled" water shall not be permitted."*

Response to Comment No. 4. The underlined sentences have been omitted from the Section 6.5.6, "Pipe Zone" backfill recommendations and the paragraph has been revised accordingly.

Comment No. 5. *Revise the paragraph to omit the following underlined statements, and corrections made, "Above pipe-zone.....Method D 1557. Under the pavement or flatwork section, the upper 12 inches.....(ASTM D 1557). Reduction of the ....compaction."*

Response to Comment No. 5. The underlined sentence has been omitted from the Section 6.5.6, "Above Pipe Zone" backfill recommendations of the report.

Comment No. 6. Create an additional Section 6.5.6A- Compaction Methods in Local R/W. All section paragraphs may remain as is.

Response to Comment No. 6. An additional Section 6.5.6A has been created with the title "Compaction Methods in Local Right-of-Way". However, the recommendations are similar to the compaction methods in State right-of way.

Comment No. 7. *Remove Section 6.5.9-Observations and Testing During Construction. With State R/W, oversight is provided by State Representatives, in Local R/W, the Local Entity is responsible for stipulating who is to provide oversight and testing. The purpose and intent of the Geotechnical Design Report required by Caltrans is to attain information to assist the applicant in the design, their contractor in the construction and to ensure Caltrans that all parties involved are aware of the conditions of the location of the proposed project, NOT TO SOLICIT or TO STIPULATE A SOLICITATION FOR ADDITIONAL WORK.*

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Response to Comment No. 7. Section 6.5.9, Observations and Testing of the report has been removed from the report as suggested.

Comment No. 8. *Revise paragraph 8.1 to read, "Review shall be performed by Caltrans Staff. The purpose and intent of the Geotechnical Design Report is to evaluate the subsurface conditions along the proposed alignment to develop geotechnical engineering recommendations that will aid in the proposed projects design and construction. Upon review, concurrence and approval of the proposed project by Caltrans, the contractor is responsible for reading, understanding and interpreting the geotechnical report to assist them in determining actual construction techniques for the construction and completion of this proposed project."*

Response to Comment No. 8. Section 8.1, *Additional Services*, has been revised. However, the sentence, "we can assume no responsibility for misinterpretation of our recommendations" was not omitted from the paragraph.

CLOSURE

The information contained in this letter/report is subject to the conditions and limitations contained within the project geotechnical reports. We appreciate the opportunity to be of service on this project. If you have any questions, comments or require additional information, please do not hesitate to contact our office at your convenience.

Respectfully submitted,

KLEINFELDER WEST, INC.

Carlos V. Amante, PE, GE
Geotechnical Group Manager

Richard F. Escandon, PG, CEG
Principal Geologist

CVA:lg

REGISTERED PROFESSIONAL ENGINEER
CARLOS V. AMANTE
No 2724
Exp 6-30-10
GEOTECHNICAL
STATE OF CALIFORNIA

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DEPARTMENT OF TRANSPORTATION
DISTRICT 8
PROGRAM/PROJECT MANAGEMENT (MS 1229)
464 WEST 4TH STREET, 6TH FLOOR
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Flex your power!
Be energy efficient!

August 5, 2008

Mr. Paul Balbach
Strategic Transportation Engineering Manager
City of Fontana
8353 Sierra Avenue
Fontana, CA 92335

File: 08-SBd-15-PM 11.0/11.4
Storm Drain Installation
Near Duncan Canyon Road
08-224-0K5201

Dear Mr. Balbach:

Final Geotechnical Design Report Review

We have reviewed the Final Geotechnical Design Report date stamped June 13, 2008 for the "Line A" Storm Drain Installation project near Duncan Canyon Road in the City of Fontana, County of San Bernardino. Please submit three (3) copies of the revised documents. The resubmittal shall include resolutions and responses to all of the following comments.

HEADQUARTERS GEOTECHNICAL DESIGN

General

1. The controlling fault should be Red Hill-Etiwanda Avenue Fault (RHE) (CSHM, 1996) with Magnitude of 7.0 located about 0.8 km from the Duncan Canyon Overcrossing (OC). We generally assume reverse/thrust for unknown fault type. The recommended Peak Bedrock Acceleration (PBA) is 0.8g based on Sadigh's attenuation relationship. Please revise Section 6.1 and the seismic design accordingly.

HEADQUARTERS OFFICE OF ENCROACHMENT PERMITS

Section 6.4.3 Construction Considerations for Shoring System

2. Move the following statement as the first sentence in the paragraph, "The contractor is solely responsible to determine the type and extent of shoring. Engineered and stamped Shoring Plans shall be required prior to final approval and issuance of permit for final construction". Geologists recommendations should be listed afterwards.

Section 6.5.6 – Compaction Methods

3. Revise the title to "Compaction Methods in State R/W". Revise the first paragraph to read, "No jetting or ponding in existing or proposed State Right of Way (R/W) is allowed. The in-situ and anticipated bedding materials along the alignment should be suitable for placement and compaction utilizing conventional mechanical compaction methods, or as determined by the contractor."

Pipe Zone

4. Revise the paragraph to omit the following underlined statements, and corrections made, "Pipe-zone backfill ..... compacted to a firm, and unyielding condition, <u>as evaluated by a representative from our firm</u> or to at least 90 percent of the.. Method D 1557. Backfill materials ..... of the pipe. Reduction of the lift ..... recommended compaction. <u>Jetting may be used to place and compact backfill within the pipe-zone. Jetting should be performed in substantial conformance with the City of Fontana's and/or the Specifications and methods, by contractors having sufficient experience in jetting methods and control.</u> Pipe-zone soils should be in a non-voided, stable, firm and unyielding state <u>and be fully drained of excess water</u> before additional fill materials are placed. "Pooled" water shall not be permitted."

Above Pipe-Zone

5. Revise the paragraph to omit the following underlined statements, and corrections made, "Above pipe-zone ..... Method D 1557. <u>Under the pavement or flatwork section, the upper 12 inches..... (ASTM D 1557).</u> Reduction of the..... compaction."

6. Create an additional Section 6.5.6A – Compaction Methods in Local R/W. All section paragraphs may remain as is.

7. Remove Section 6.5.9 – Observations and Testing During Construction. Within State R/W, oversight is provided by State Representatives, in Local R/W the Local Entity is responsible for stipulating who is to provide oversight and testing. The purpose and intent of the Geotechnical Design Report required by Caltrans is to attain information to assist the applicant in the design, their contractor in the construction and to ensure Caltrans that all parties involved are aware of the conditions of the location of the proposed project, NOT TO SOLICIT or TO STIPULATE A SOLICITATION FOR ADDITIONAL WORK.

Section 8.0 – Additional Services and Limitations

8. Revise paragraph 8.1 to read, "Review shall be performed by Caltrans Staff. The purpose and intent of the Geotechnical Design Report is to evaluate the subsurface conditions along the proposed alignment to develop geotechnical engineering recommendations that will aid in the proposed projects design and construction. Upon review, concurrence and approval of the

proposed project by Caltrans, the contractor is responsible for reading, understanding and interpreting the geotechnical report to assist them in determining actual construction techniques for the construction and completion of this proposed project."

If you have any questions regarding these comments, please contact me at (909) 383-6480.

Sincerely,

MEARDEY TIM
Project Manager
Program/Project Management

c: EHadipour, Design Oversight, MS 1164
William Nascimento, LAN Engineering Corp.
File

KLEINFELDER
Bright People. Right Solutions.

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June 10, 2008
File No. 55633

Mr. William Nascimento, PE, SE

Lim & Nascimento Engineering Corporation
20 Empire Drive
Lake Forest, California 92630

Subject: **Response to Caltrans Review Comments**
Geotechnical Design Report
Proposed Duncan Canyon "Line A" Storm Drain

Fontana, California

Caltrans EA No. 0K 05201

Dear Mr. Nascimento:

Kleinfelder West, Inc. (Kleinfelder) has prepared this letter in response to comments provided by the California Department of Transportation (Caltrans), District 8, Program Project Management (MS 1229), dated May 7, 2008, pertaining to their review of our Geotechnical Design Report, dated on April 3, 2008 for the proposed Duncan Canyon "Line A" Storm Drain located in Fontana, San Bernardino County, California. Caltrans has requested responses and resolutions on several issues of concern. Caltrans review comments and our responses to these comments are presented below:

Comment No. 1. *Remolded samples with different dry densities were used in the direct shear tests (Plate No. B-10). Samples with similar density should be used in the direct shear tests and ultimate shear strength parameters should be used to develop the design parameters.*

Response to Comment No. 1. The remolded samples used in the direct shear test were obtained from the same bulk sample obtained from the boring. Due to the presence of large size particles (i.e., gravels and cobbles) in the bulk sample, the remolded test specimen for "Load 3" had a higher dry density (130.3 pcf) than the other two specimens. Our laboratory technician maintained the moisture contents of the tested samples similar to the field condition. However, since the percentage of gravel varies, the dry unit weight of the remolded samples varies. A design friction angle of 36 degrees was obtained by taking the average of the ultimate friction angles obtained from direct shear tests of samples taken from borings B-1 and B-9 (see Plates B-8 through B-10). For conservative shoring design purposes, however, we concur with Caltrans to use a lower friction angle of 34 degrees (see response to Comment No. 2).

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Comment No. 2. *Due to soil matrix structural reconstitution, samples remolded to in-situ densities tend to give higher shear strength than undisturbed samples with similar densities and should be taken in design parameter consideration. In addition, with higher caving potential especially at shallow depth, lateral earth pressure coefficients (Table 2 of Section 6.2) for shoring design based on a frictional angle of 36° were not conservative.*

Response to Comment No. 2. The direct shear tests were based on limited samples collected and an optimal regression of limited data points. The design friction angle of 36 degrees was obtained by taking the average of the ultimate friction angles obtained from direct shear tests of samples taken from borings B-1 and B-9 (see Plates B-8 through B-10). A table of representative values for angle of internal friction from Bowles (Table 2-6, Foundation Analysis and Design, 5th Edition, 1996) shows that sandy gravel material has an internal friction angle (ϕ) ranging from 35 to 50 degrees. For conservative shoring design purposes, however, we concur with Caltrans to use a lower design friction angle of 34 degrees.

Comment No. 3. *The use of total soil unit weight of 130 pcf seems high especially at shallow depth.*

Response to Comment No. 3. A total soil unit weight of 130 pcf is within the high end of the range for soil material. However, due to presence of gravels and cobbles at the site, this assumed total soil unit weight is reasonable and will result in a conservative active earth pressure value for shoring design.

Comment No. 4. *The nearest fault should be Red-Hill-Etiwanda Avenue Fault (RHE) with Magnitude of 7.0 located about 0.7 km from the Duncan Canyon overcrossing (OC). For seismic design, the subsurface classification as soil profile type C is not appropriate that was based on unreliable blow counts with cobbles and boulders. It appears that soil profile type D is more appropriate. A Performance based Asphalt (PBA) of 0.9g based on Sadigh's attenuation relationship seems high. Please modify Table 1 of Section 6.1 accordingly.*

Response to Comment No. 4. The soil profile types in Table B.1, 2006 Caltrans Seismic Design Criteria are based on the average soil properties for the upper 100 feet of the site. Soil profile type C was selected for this site due to presence of dense to very dense sandy gravels and cobbles, typical in this area. Our analysis indicates that the Indian Hill-Cucamonga Fault is closer to the site with the closest distance of 0.5 km. For this fault, the design Peak Bedrock Acceleration (PBA) is 0.9g based on Sadigh's (1997) attenuation relationship for rock site. The Peak Ground Acceleration (PGA) is 0.72g based on Sadigh's attenuation relationship for deep soil site. The PGA value of 0.72g will be shown on Table 1 in our report. The PBA value of 0.9g will be removed. For shoring design, the PGA value will be used in the estimation of seismic wall

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pressure. Therefore, our uniform seismic wall pressure recommendation provided in Section 6.2 will be revised to 35H psf, where H is the wall height in feet.

Comment No. 5. *Section 6.3, Page 16 of 32: Remove the second sentence, "The subgrade soils exposed at the bottom of each excavation for the exposed pipeline should be observed by a representative from our firm prior to the replacement of any fill." Oversight shall be provided by Caltrans Geotechnical Staff.*

Response to Comment No. 5. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 6. *Section 6.3.1, Soil Stripping: Replace the sentence, "Prior to backfilling operations, all surficial vegetation, roots, organics, oversize material, etc, and deleterious materials should be removed from any material designated to be used as backfill. " with " No excavated materials containing surficial vegetation, roots, organics, oversize material, etc, and deleterious materials shall be used as trench and or structured backfill."*

Response to Comment No. 6. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 7. *Section 6.3.1, Soil Stripping: In the 2nd paragraph, 1st sentence revise the wording from, "....in accordance with the recommendations presented in this report." to "... or as directed by the Oversight Engineer."*

Response to Comment No. 7. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 8. *Section 6.3.3, Excavation: In the 1st paragraph, 3rd sentence revise the wording from, "A representative from our firm should be presented during excavation and fill placement operations..." to "Caltrans Geotechnical staff shall be present during excavation and fill placement operations..."*

Response to Comment No. 8. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 9. *Section 6.4.1, Temporary Excavations: Revise the sentence, "Excavation work should comply with the current requirements of Occupational Safety and Health Standards (OSHA 1989)" to "All work within existing or proposed State R/W shall be in compliance with State Standards dated May 2006."*

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Response to Comment No. 9. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 10. *Section 6.4.3, Construction Considerations for Shoring System: Add this paragraph to the section, "The contractor is solely responsible to determine the type and extent of shoring. Engineered and stamped Shoring Plans shall be required prior to final approval and issuance of permit for final construction."*

Response to Comment No. 10. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 11. *Section 6.5.1, General: Revise the sentence, "The following subsections present recommendations for bedding material, pipe-zone, and above pipe-zone backfill. At a minimum, bedding materials, and all backfill should meet the requirements of the City of Fontana and/or the pipe manufacturer's specifications, if available, and be placed according to the pipe manufacturer's and/or the City of Fontana's specifications." to "All trench excavations within existing or proposed State R/W shall be in compliance with Caltrans Trench Standard. The following subsections present recommendations for bedding material and the pipe-zone. At a minimum the bedding materials should meet the requirements of the pipe manufacturer's and/or the City of Fontana's specifications."*

Response to Comment No. 11. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 12. *Section 6.5.1, Remove this sentence, "A representative from our firm should be present during excavation……..presented herein."*

Response to Comment No. 12. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 13. *Section 6.5.4, Above Pipe-Zone Backfill: Revise the title to "Section 6.5.4 Above Pipe-Zone Backfill in Local R/W".*

Response to Comment No. 13. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

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Comment No. 14. *Section 6.5.6, All references to jetting or ponding in existing or proposed State right of way (R/W) shall be removed.*

Response to Comment No. 14. Kleinfelder concurs with the recommendation and will revise the report text accordingly.

Comment No. 15. *Section 8.1, Additional Services: Please add, "Review shall be performed by Caltrans Staff" to the paragraph.*

Response to Comment No. 15. Kleinfelder will revise the report text accordingly.

The information contained in this letter/report is subject to the conditions and limitations contained within the project geotechnical reports. We appreciate the opportunity to be of service on this project. If you have any questions, comments or require additional information, please do not hesitate to contact our office at your convenience.

Respectfully submitted,

KLEINFELDER WEST, INC.

Carlos V. Amante, PE, GE
Geotechnical Group Manager

REGISTERED PROFESSIONAL ENGINEER
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DEPARTMENT OF TRANSPORTATION
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Flex your power!
Be energy efficient!

May 7, 2008

Mr. Paul Balbach
Strategic Transportation Engineering Manager
City of Fontana
8353 Sierra Avenue
Fontana, CA 92335

File: 08-SBd-15-PM 11.0/11.4
Storm Drain Installation
Near Duncan Canyon
08-224-0K5201

Dear Mr. Balbach:

Geotechnical Design Report Review

We have reviewed the Geotechnical Design Report (prepared by Kleinfelder dated April 3, 2008) date stamped April 9, 2008 for the proposed Duncan Canyon "Line A" Storm Drain located in the City of Fontana, County of San Bernardino. Based on the review of the report, the following is our comments.

HEADQUARTERS GEOTECHNICAL DESIGN

1. Remolded samples with different dry densities were used in the direct shear tests (Plate No. B-10). Samples with similar density should be used in the direct shear tests and ultimate shear strength parameters should be used to develop the design parameters.

2. Due to soil matrix structural reconstitution, samples remolded to in-situ densities tend to give higher shear strength than undisturbed samples with similar densities and should be taken in design parameter consideration. In addition, with higher caving potential especially at shallow depth, lateral earth pressure coefficients (Table 2 of Section 6.2) for shoring design based on a frictional angle of 36° were not conservative.

3. The use of total soil unit weight of 130 pcf seems high especially at shallow depth.

4. The nearest fault should be Red Hill-Etiwanda Avenue Fault (RHE) with Magnitude of 7.0 located about 0.7 km from the Duncan Canyon overcrossing (OC). For seismic design, the subsurface classification as soil profile type C is not appropriate that was based on unreliable blow counts with cobbles and boulders. It appears that soil profile type D is more appropriate. A Performance based Asphalt (PBA) of 0.9g based on Sadigh's attenuation relationship seems high. Please verify and modify Table 1 of Section 6.1 accordingly.

HEADQUARTERS OFFICE OF ENCROACHMENT PERMITS

5. Section 6.3, Page 16 of 32: Remove the second sentence, "The subgrade soils exposed at the bottom of each excavation for the exposed pipeline should be observed by a representative from our firm prior to the replacement of any fill." Oversight shall be provided by Caltrans Geotechnical Staff.

6. Section 6.3.1, Soil Stripping: Replace the sentence, "Prior to backfilling operations, all surficial vegetation, roots, organics, oversize material, etc, and deleterious materials should be removed from any material designated to be used as backfill." with " No excavated materials containing surficial vegetation, roots, organics, oversize material, etc, and deleterious materials shall be used as trench and or structured backfill."

7. Section 6.3.1, Soil Stripping: In the 2nd paragraph, 1st sentence revise the wording from "...in accordance with the recommendations presented in this report." to "...or as directed by the Oversight Engineer."

8. Section 6.3.3, Excavation: In the 1st paragraph, 3rd sentence revise the wording from, "A representative from our firm should be presented during excavation and fill placement operations..." to "Caltrans Geotechnical staff shall be present during excavation and fill placement operations..."

9. Section 6.4.1, Temporary Excavations: Revise the sentence" Excavation work should comply with the current requirements of Occupational Safety and Health Standards (OSHA 1989)" to "All work within existing or proposed State R/W shall be in compliance with State Standards dated May 2006."

10. Section 6.4.3, Construction Considerations for Shoring System: Add this paragraph to the section, "The contractor is solely responsible to determine the type and extent of shoring. Engineered and stamped Shoring Plans shall be required prior to final approval and issuance of permit for final construction."

11. Section 6.5.1, General: Revise the sentence, "The following subsections present recommendations for bedding material, pipe-zone, and above pipe-zone backfill. At a minimum, bedding materials, and all backfill should meet the requirements of the City of Fontana and/or the pipe manufacturer's specifications, if available, and be placed according to the pipe manufacturer's and/or the City of Fontana's specifications" to "All trench excavations within existing or proposed State R/W shall be in compliance with Caltrans Trench Standard. The following subsections present recommendations for bedding material and the pipe-zone. At a minimum the bedding materials should meet the requirements of the pipe manufacturer's and/or the City of Fontana's specifications.

12. Section 6.5.1, General: Remove this sentence, "A representative from our firm should be present during excavation.....presented herein."

13. Section 6.5.4, Above Pipe-Zone Backfill: Revise the title to "Section 6.5.4 Above Pipe-Zone Backfill in Local R/W".

14. Section 6.5.6: All references to jetting or ponding in existing or proposed State right of way (R/W) shall be removed.

15. Section 8.1 Additional Services: Please add, "Review shall be performed by Caltrans Staff" to the paragraph.

If you have any questions regarding these comments, please contact me at (909) 383-6480.

Sincerely,

MEARDEY TIM
Project Manager
Program Project Management

c: EHadipour, Design Oversight, MS 1164
William Nascimento, LAN Engineering Corp.
File