

FOR CONTRACT NO: 05-0L7014
PROJECT ID: 0500020286

INFORMATION HANDOUT

MATERIALS INFORMATION

ALTERNATIVE CRASH CUSHION SYSTEM

LOCATION 22 CROSS SECTIONS

FOR CONTRACT NO.: 05-0L7011

INFORMATION HANDOUT

MATERIALS INFORMATION

ALTERNATIVE CRASH CUSHION SYSTEM
CRASH CUSHION SYSTEM (TYPE SMART SCI-100GM)
CRASH CUSHION SYSTEM (TYPE QUADGUARD ELITE)
CRASH CUSHION SYSTEM (TYPE COMPRESSOR)

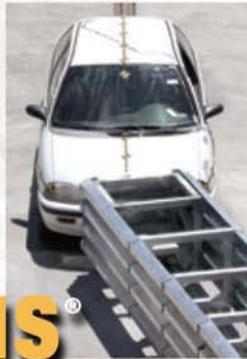
ROUTE: 05-SCr-17-6.0/12.6



SCI Products Inc.

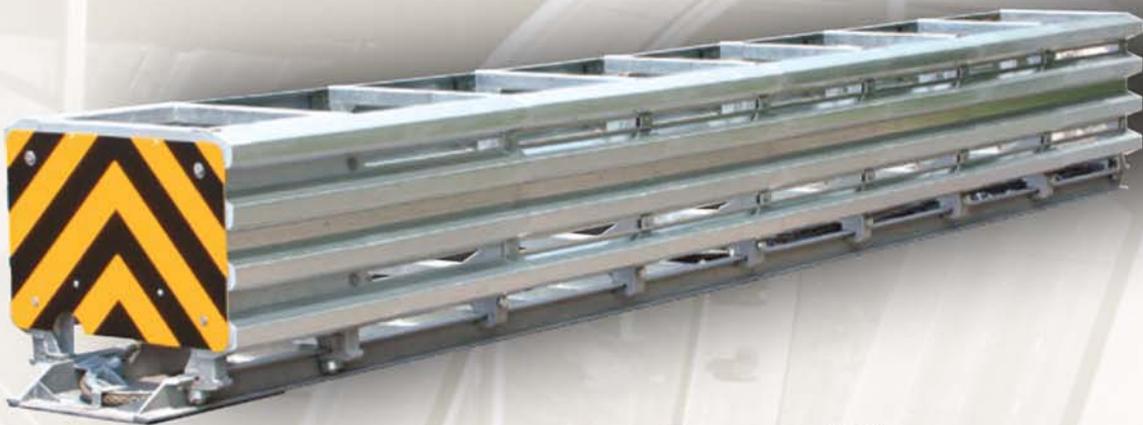
**SCI70GM AND SCI100GM
DESIGN AND INSTALLATION
MANUAL**

**The World's Only
Speed-Dependent
Crash Attenuator**



SMART CUSHION INNOVATIONS®

NCHRP 350 Approved



**Corporate Office:
2500 Production Drive
St. Charles, IL 60174
Telephone: 800-327-4417
www.workareaprotection.com**



Work Area Protection

TABLE OF CONTENTS

OVERVIEW	1
Product.....	1
Maintenance.....	1
Crash Performance	1
SPECIFICATIONS	2
Description.....	2
System Dimensions & Weight	2
DESIGN CRITERIA	2
General.....	2
Foundations	2
Support Structure	3
Location.....	3
Transition Design.....	3
INSTALLATION.....	6
Installation and Performance Statements.....	6
Safety.....	6
Equipment List	Appendix B
Site Preparation.....	6
Foundations	6
Placement of the Crash Cushion.....	7
Anchor Installation.....	7
Delineator Panel Attachment	8
Transition Installation	8
Final Inspection	8
RESETTING CRASH CUSHION AFTER IMPACT	9
Site Preparation.....	9
Re-Extension and Inspection after Frontal Impact	9
Side Impact Inspection and Repair.....	10
Cable Inspection and Replacement Procedure	11
Cylinder Inspection	11
Anchor Bolt Inspection	11
Side Panel Inspection.....	12
Side Guide Inspection	12
Final Inspection	12
Non-Repairable Impacts.....	12

APPENDICES

<u>SCI Attenuator Parts List</u>	A
<u>Equipment List</u>	B
<u>Attenuators</u>	
SMART CUSHION®, TEST LEVEL 2	C
SMART CUSHION®, TEST LEVEL 3	D
<u>Foundations</u>	
Foundation Test Level 2	E1
Foundation Test Level 3	E2
<u>Layouts</u>	
Gore Assembly	F
Gore Assembly Calculations	F3
<u>Transitions</u>	
Jersey/F Shape Barrier	G
Concrete Block, 24" (610 mm)	H
Concrete Block, 30" (762 mm)	I
Concrete Block, 36" (915 mm).....	J
Concrete Block, 30" (762 mm), Flared	K
Concrete Block, 36" (915 mm), Flared	L
Thrie-Beam	M
W-Beam (Reverse Direction Traffic Design)	N
Jersey/F Shape, 36" (915 mm) Base X 32" (813 mm) Tall	O
Jersey/F Shape, 36" (915 mm) Base X 42" (1067 mm) Tall	P
Median Barrier, Single Slope	Q
W-Beam 28" Tall (no reverse direction traffic design)	R
W-Beam 32" Tall (no reverse direction traffic design)	S

OVERVIEW

Product

The SMART CUSHION® impact attenuators are some of the many safety products manufactured and sold by SCI Products, Inc. They are NCHRP Report 350, Test Levels 2 and 3 (TL2 and TL3) compliant (Models SCI 70 GM and SCI 100 GM, respectively) and are fully redirective, non-gating, and bi-directional. SMART CUSHION® impact attenuators are used to help protect motorists from obstacles in both permanent and work zone locations. They can be attached to most types of median and roadside barriers.

The SMART CUSHION® attenuators use a patented system for stopping vehicles. The system is speed dependent and stops small and large vehicles by automatically regulating the stopping force exerted on a vehicle. Small vehicles are stopped more slowly than large vehicles to minimize the forces on the occupants and reduce the chance of injuries.

The SMART CUSHION® attenuators are slightly tapered from front to rear. This allows the side panel sections to collapse over the next section with minimum stress and damage. During collapse, the parts move freely past each other and do not become wedged upon impact.

Neither wide temperature variations nor temperature extremes affect the performance of SMART CUSHION® impact attenuators. The viscosity of the fluid in the shock-arresting cylinder has very little effect on performance.

Maintenance

SMART CUSHION® impact attenuators are low-maintenance units. In a two-year performance evaluation report submitted to the Federal Highway Administration, the average cost of parts to repair a SMART CUSHION® impact attenuator was \$39, excluding two catastrophic impacts. More than four out of five of the reported repairs only required two shear bolts costing under \$2. A trained, two-person maintenance crew can return most impacted SMART CUSHION® attenuators to full service within 30 – 60 minutes. This short repair time reduces the maintenance workers' exposure to traffic and minimizes motorist inconvenience. Side impacts usually result in no damage to the impact attenuator.

Crash Performance

The SMART CUSHION® impact attenuators broke new ground during NCHRP Report 350 crash testing. In the high-speed test, 100 kilometers per hour (63 miles per hour) the small vehicle's deceleration rate was significantly lower than any previously recorded value (-9.8 G's as compared to -13.4 G's). This means less impact forces on the vehicle's occupants and a reduced risk of injury occurrence and severity.

Another amazing fact is that all the tests were conducted on the same SMART CUSHION® unit over four consecutive days with no damage to non-expendable parts. The only parts replaced after each crash test were the two shear bolts, costing less than \$2 for each reset.

SPECIFICATIONS

Description

The SMART CUSHION® is a redirective, non-gating crash attenuator that consists of a base, supporting frames, a sled, side panels, a wire rope cable, sheaves, and a shock-arresting cylinder. The base is anchored to the mounting surface and provides support for the frames that are mounted on it. The support frames hold the side panels that provide a flat outer redirective surface for side impacts. The sled provides redirective support for side impacts and deceleration force for frontal impacts. The SMART CUSHION® telescopes rearward upon frontal impact and can be reset with minimal repair parts. It is NCHRP 350 Test Levels 2 and 3 approved.

System Dimensions & Weight

Table 1 – Dimensions & Weight

	SCI 70 GM	SCI 100 GM
Width	24" (610 mm)	24" (610 mm)
Length	13 ½ ft (4115 mm)	21 ½ ft (6550 mm)
Height	33" (840 mm)	33" (840 mm)
Weight	2465 lbs (1120 kg)	3450 lbs (1570 kg)
NCHRP 350, Test Level	2	3

DESIGN CRITERIA

General

SMART CUSHION® impact attenuators comply with NCHRP Report 350, TL2 and TL3, and are designed for work zone and permanent applications.

Foundations

Foundations must be a flat surface with longitudinal and cross slopes of 10:1 (horizontal: vertical) or less. SMART CUSHION® impact attenuators should not be located over drainage basins or expansion joints. Portland cement concrete foundation pads are preferred for permanent installations; asphaltic concrete foundation pads are appropriate for work zone installations. The following table describes the foundations that may be used. See Appendices for drawings.

Table 2 – Foundations

Pad Material and Thickness	Anchor Embedment
6" (150 mm) reinforced PCC ¹	5 ½" (140 mm)
8" (205 mm) non-reinforced PCC	5 ½" (140 mm)
3" (75 mm) AC ^{2,3} over 3" (75 mm) non-reinforced PCC	16 ½" (420 mm)
6" (150 mm) AC over compacted subgrade ³	16 ½" (420 mm)
8" (205 mm) AC ³	16 ½" (420 mm)

- Notes: 1. Portland cement concrete
 2. Asphaltic concrete
 3. Minimum compaction: 95% of optimal

Concrete compressive strength shall be 4000 psi (28 MPa) at 28 days.

Foundation lengths may vary when using wide transitions.

Support Structure

SMART CUSHION® impact attenuators are self-supporting and do not require an additional support structure.

Location

The SMART CUSHION® impact attenuator's location determines its position and transition requirements.

1. **Approach Zone** – SMART CUSHION® impact attenuators should not be placed directly behind raised curbs. The longitudinal and cross slopes in front of the device should be 10:1 (horizontal: vertical) or less.
2. **Barrier Width** – SMART CUSHION® impact attenuators are 24" (610 mm) wide at the rear. Barriers 24" (610 mm) wide, or less, can be shielded without using a transition if there is no reverse direction traffic. Barriers that are wider than 24" (610 mm) and/or have reverse direction traffic require a transition, available from SCI Products, Inc.
3. **Barrier Height** – SMART CUSHION® impact attenuators are approximately 33 3/8" (848 mm) high. Barriers should be as high, or higher, than the SMART CUSHION® to provide the proper support and transition attachment.
4. **Barrier Shape** – SMART CUSHION® transitions allow for connection to many barrier shapes. A rectangular concrete block provides the most economical and simplest shape to connect to.

Transition Design

SMART CUSHION® impact attenuators can be attached to many different barrier shapes. The attenuators are designed for direct attachment to 24" wide barriers and Jersey/F-Shape barriers with base widths up to 27 1/2" (700 mm). **The SMART CUSHION® side panels move rearward beyond the end of the attenuator up to 30" (760 mm) upon impact.** This area is known as the travel zone. SMART CUSHION® transitions provide this travel zone in front of wider barriers and obstacles.

See appendices for SMART CUSHION® transition drawings. SCI Products, Inc. can make transitions for other applications. Contact us for details.

Transitions

Necessary Locations (see Figure 1 – Necessary Locations):

There is reverse direction traffic within the clear zone.

The barrier intrudes into the side panels' travel zone.

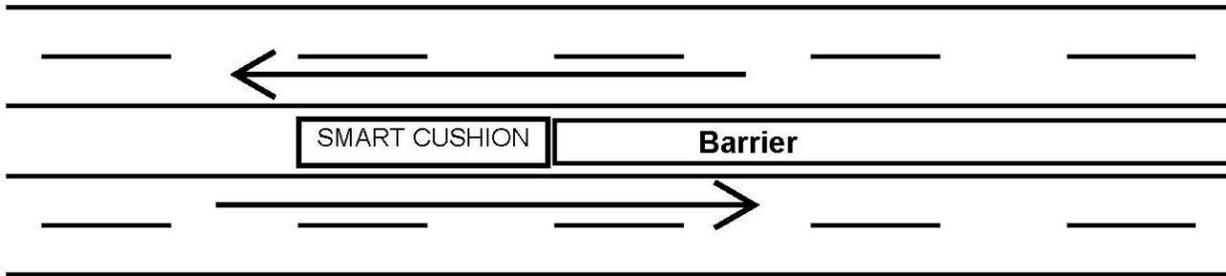


Figure 1 – Necessary Locations

Examples are median applications with bidirectional traffic, two lane roads with crossover potential, etc.

Unnecessary Locations (see Figure 2 – Unnecessary Locations):

No reverse direction traffic within the clear zone.

The barrier does not intrude into the side panels' travel zone.

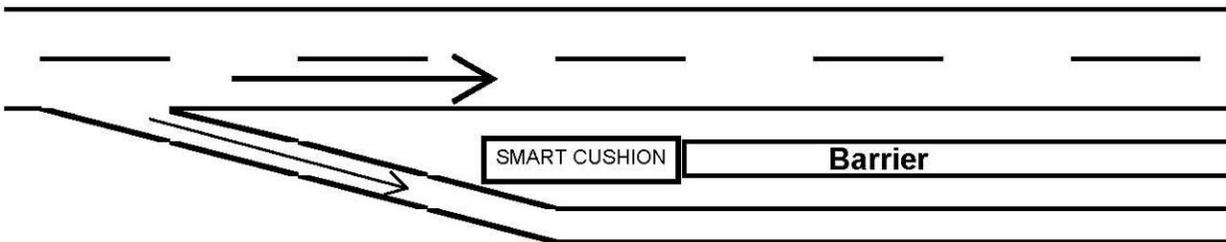


Figure 2 – Unnecessary Locations

Examples are traffic splits, shoulder applications with no crossover potential, one-way roads, etc.

Determining Side of Transition

The transition's side is determined by standing at the front of the attenuator looking rearward toward the barrier to choose between left and right.

Drawings

The following SMART CUSHION® transitions and layouts are available from SCI Products, Inc. Diagrams are shown in the Appendices as follows:

- Layout – Gore Assembly, Appendix F & F2 - Rigid design for wide obstacles.
- Layout – Gore Assembly Calculations, Appendix F3 - Used to calculate longitudinal distances and parts requirements.
- Transition - Jersey/F Shape, Appendix G - Used on standard Jersey/F shaped barriers with a 24" Base
- Transition - Concrete Block, 24", Appendix H - Used on 24" Concrete Block that must be 30" longitudinal length for our travel zone.
- Transition - Concrete Block, 30", Appendix I - Used on 30" Concrete Block and will extend our installation length 38".
- Transition - Concrete Block, 36", Appendix J - Used on 36" Concrete Block and will extend our installation length 53".
- Transition - Concrete Block, 30", Flared, Appendix K - Used on 30" Concrete Block/Pillars and will extend our installation length 54".
- Transition - Concrete Block, 36", Flared, Appendix L - Used on 36" Concrete Block/Pillars and will extend our installation length 71".
- Transition – Thrie-Beam Rigid Assembly, Appendix M - Rigid design for possible reverse direction impacts.
- Transition – W-Beam Rigid Assembly, Appendix N - Rigid design for possible reverse direction impacts.
- Transition – Jersey, 36" Base, Appendix O - Used on 32" high Jersey Shape that has a 19" starting width at the top of the barrier.
- Transition – Jersey, 36" Base, Appendix P - Used on 42" high Jersey Shape that has a 19" starting width at the top of the barrier.
- Transition – Single Slope Barrier, Appendix Q - Used on 42" and 48" Single Slope barrier up to 26" wide at the base.
- Transition – W-Beam 28" High, Appendix R – Connection to 28" high W beam Guardrail with no reverse direction traffic
- Transition – W-Beam 32" High, Appendix S – Connection to 32" high W beam Guardrail with no reverse direction traffic

Installation

Installation and Performance Statements

Proper performance within these limits depends on correct installation of the system on an approved foundation. Any crash cushion not installed according to the drawings and the requirements of this installation manual may present an unsafe condition and should be reinstalled accordingly.

Impacts with vehicles whose size or mass are outside of those tested according to NCHRP 350 or with vehicles traveling at speeds greater than those tested according to NCHRP 350 will not necessarily produce results within the test criteria. While the tests account for most crash conditions, they do not cover all situations. The crash cushion is in conformance with the requirements of NCHRP 350 Levels 2 & 3 but is not guaranteed to safely stop a vehicle in a situation not encompassed by the test conditions.

Safety

All work during installation, repair and inspection of the crash cushion should be performed according to federal, state and local laws.

Equipment List

See Appendix B

Site Preparation

Check to make sure there are no drains; expansion joints; or buried conduit, cables or utility lines in the footprint space where the attenuator will be placed. Remove any curbs or obstacles in front of or beside where attenuator will be installed for a minimum distance of 12 ft from any edge of the attenuator. Be sure to set up proper traffic control before beginning any installation or repair work at the site.

Foundations – (reference Appendices E1 and E2)

New foundations should be installed according to Appendix E – Foundation Drawing. Concrete should reach full cure strength before use. The surface of the foundation must be cleaned of all debris, dirt, mud, sand, etc., as the crash cushion must sit on a level plane, although cross slope of up to 10:1 (horizontal: vertical) is allowed.

Any of the following foundations will meet the minimum requirements:

- 6" reinforced concrete pad
- 8" non-reinforced concrete pad
- 3" asphalt over 3" of concrete
- 6" asphalt over 6" of compacted sub base
- 8" asphalt

Note: Concrete should be 28 MPa or 4000 psi minimum at full cure. The slope should not exceed 10:1.

Installing the crash cushion on an existing foundation may result in anchor bolt locations corresponding to rebar positions in the foundation. It may be necessary to use more elaborate drilling equipment than simply an impact drill with standard concrete bits.

Prior to installing the crash cushion on an existing foundation, the concrete must be thoroughly inspected for slope, signs of cracking, surface wear, shifting from original position, undercut of earth below or to the sides supporting the foundation, settling, and any other signs of age or deterioration which may make the foundation unusable. If any of these signs are evident, the foundation must be removed and a new one must be installed according to requirements stated. If prior bolt patterns are present, use proper engineering calculations to assure adequate strength in the new holes.

Placement of the Crash Cushion

Measure the correct distance and offset of the crash cushion according to the type of obstruction being shielded and the type of transition being used. The dimensions shown on the transition drawings may be used as a guide for this. System drawings are also available.

The crash cushion is shipped in one piece, fully assembled. Using a choked four-point attachment at the designated lift points on the appropriate panel support frames behind the sled, lift the crash cushion off the transporting vehicle with a boom or forklift of sufficient capacity and place it in the position marked on the foundation.

Once in place, double-check the measurements to be sure of the proper location of the crash cushion.

Warning: On a full collapse, the last set of side panels will telescope 30" beyond the last terminal brace at the rear of the crash cushion. All objects that may interfere with this motion can affect the performance of and cause undue damage to the crash cushion.

Anchor Installation

Embedment Requirements are as follows:

6" reinforced concrete pad – anchor embedment of 5 ½" and a torque value of 125 ft-lbs

8" non-reinforced concrete pad – anchor embedment of 5 ½" and a torque value of 125 ft-lbs

3" asphalt over 3" of concrete – anchor embedment of 16 ½" and a torque value of less than 10 ft-lbs

6" asphalt over 6" of compacted sub base – anchor embedment of 16 ½" and a torque value of less than 10 ft-lbs

8" asphalt – anchor embedment of 16 ½" and a torque value of less than 10 ft-lbs

Using the holes in the base as a template, drill 7/8" diameter holes to the proper depth as previously defined. If the crash cushion is being installed on an existing foundation and the drills are hitting rebar, use a core drill or rebar cutter to ensure that straight, vertical holes are made at each location. Take care that the holes do not break out the bottom of the foundation as this may result in loss of epoxy during anchor placement.

Once the holes are drilled, clean the hole of all debris using suitable means. To ensure epoxy adhesion, concrete holes MUST be cleaned with a bottle brush to remove embedded dust, and a final check conducted that all holes are clean of debris and dry. Inject the epoxy into each hole at an angle to avoid air entrapment. Use a sufficient amount of epoxy so that the hole will be filled when the bolt is inserted. Screw the nut on the anchor bolt flush with the end, put the washer on the stud, and immediately insert the anchor stud all the way to the bottom while turning the anchor. This method assures the anchor bolts are vertically plumb and the threads are coated with epoxy. ****Stud locations that can restrict the movement of the mobile sheaves should not project more than ½" above the nut after final torque is completed.**

There is a quantity of 48 anchors for the SCI 100 GM, TL-3 attenuator.

There is a quantity of 34 anchors for the SCI 70 GM, TL-2 attenuator.

The epoxy will be ready for bolt tightening after 30 minutes at 80 degrees F (27 degrees C). See the container label for other temperatures and bolt up times. After sufficient time has passed to allow the epoxy to cure, torque the anchor nuts to 170 N-m (125 ft-lbs). Substitute epoxy must match our specifications. Asphalt anchors are longer and should only be torqued to less than 10 ft-lbs.

Delineator Panel Attachment

Installation of the front delineation plate will be determined by the location of the attenuator and state regulations. A delineation plate is shipped with the yellow background applied and no striping. It is attached by four bolts. Applying the striping to the plate is easier while it is removed from the attenuator. Examples of the delineation plate are as follows:



Right Shoulder



Gore Area



Left Shoulder

Transition Installation

Transitions may be required. Any use of a crash cushion with a possible reverse direction impact will require a transition. In all applications, be sure to install the transition anchors that are exposed to traffic, so that there is no extension of the studs beyond the outside face of the nut. Refer to the transition drawings for details of the required anchor locations. For horizontal stud installation in concrete use mechanical anchors, or if using studs repeat the same epoxy installation process as the anchor bolts using plugs to retain the epoxy to secure the transition to the barrier. Transition drawings and parts explosions are in the appendices.

Final Inspection

After the anchor bolts have been tightened to the proper torque value, check that the crash cushion is not distorted in any way as might happen if the unit is secured to a foundation which is not an even surface. Check that the front section is pulled out to within 1" of the front stop bolts and that no part of the unit has been damaged by shipping and handling. Verify that all assembly

bolts are tight and have not come loose during shipping or installation. Finally, check that no tools or other equipment have been left within the crash cushion structure.

Resetting Crash Cushion after Impact

In the event of any impact, the crash cushion will require a full evaluation to determine the necessary repairs to return it to service. To do this, proceed as follows:

Site Preparation

Do not begin work until all accident debris has been cleared and the area declared safe and accessible by government authorities.

Re-Extension and Inspection after Frontal Impact



1. Remove the front delineator panel and attach pulling means to the **bottom brace** of the front sled.

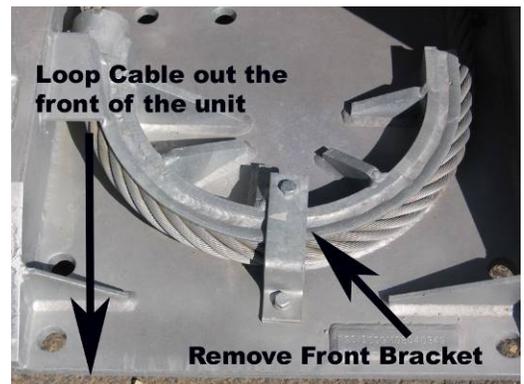
2. Use wire or strap on the bottom brace at the front of the sled to hold the spelter socket up in the air while pulling out or it will catch on the base frame cross braces.



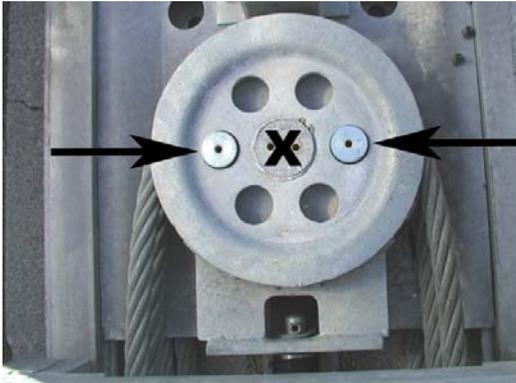
3. Remove the front cable bracket that is located on the front sheave at the front of the attenuator.

4. Pull the sled forward one to two feet to give you slack on the cable.

5. If necessary, use two long-handled flat screw drivers to break cable loose from the sheave at the front of the attenuator if the zinc coating has attached the cable to the sheave. Start feeding the cable out of the front of the unit.
6. Pull the sled out the rest of the way in **short smooth increments** so you can help feed the cable out the front of the attenuator. This will give you a cable loop in front of the attenuator. **When you are past the last cross brace, you will need to remove the strap or wire to allow the cable to follow the path into the front sheave.** The sled **must** be fully extended to replace the shear bolts. The sled should be less than 1" from the stop bolts in the front.



7. During frame pullout, inspect front part of the cable from the spelter socket, as it will be partially obscured after extension of the mobile frames and sheaves. **See the cable inspection procedure.**



8. Remove the front and rear sheave cover plates at each end of the cylinder by removing the two hex bolts that hold them down.

9. Remove the anti-rotation pins, which are the two outer pins, inserted through the holes in the sheaves from both the front and back sheaves. This will be easily done if you make a tool with a handle and a threaded $\frac{3}{8}$ " NC end to screw into the pins. SCI has a tool available for purchase for use during this step. **Caution: Do not remove the center pin. Also, the rear pins are longer than the front sheave pins and**

cannot be intermixed so leave them by their locations.

10. Remove shear bolt remnants in the holes on both sides of the mobile sheaves. These are grade 8 bolts so they can be difficult to remove without a 90 degree pry bar with a claw to pry out.

11. Attach a pulling means to the shackle on the mobile sheaves.

12. Slowly pull out the mobile sheaves. **Be sure the cable doesn't ride up over the front sheave while the slack is taken up, as it will be difficult to regain slack. Do not stand inside the cable loop or be in the pulling strap danger zone.**



13. Finish pulling out the mobile sheaves until you can see through the shear bolt holes **but do not put in the shear bolts yet.**

14. If the cable passes inspection, release any tension on your pulling strap and reinstall the anti-rotation pins in the front and back sheave assemblies and reinstall the cover plates for those sheaves using marine grade anti-seize on the bolt threads. The sheaves may be aligned by inserting a pry bar into the sheave holes. Work your way from the bottom up.

15. Put tension on your pulling strap and replace the two $\frac{1}{4}$ " Grade 8 shear bolts in the front corners of the mobile sheaves.

16. Inspect the cylinder, anchor bolts and side panels according to the procedures listed after this section.

Side Impact Inspection and Repair

17. Inspect and replace any damaged side panels.

18. Inspect and replace any damaged side keeper bolts on all panels. There are three styles of side keeper bolts. The winged style is for the panel connected to the sled and bolts through the first frame behind the sled. The center side keepers have a $\frac{1}{2}$ " shoulder while the last side keeper, which is bolted to the terminal frame, has a $\frac{1}{4}$ " shoulder.

19. Inspect and repair any damaged side guides.

Cable Inspection and Replacement Procedure

The cable should be visually inspected for damage. The most common sign of rope deterioration is broken wires. The wire must be clean and not under tension to perform a visual inspection. The visual inspection should include looking for broken wire strands, localized wear or crowns. A sharp awl or marlin spike can be used to separate wires to check if internal damage is present, indicated by loose wires or crowns. If internal inspection shows any damage to any core wires, the cable should be replaced. If there are more than six random broken wires in one rope lay or three broken wires in one strand in one rope lay, the wire rope should be replaced. A rope lay is the length along the rope in which one strand makes a complete revolution around the rope.

Inspect the spelter socket for broken wires, damaged eyes or other fatigue. Any signs of broken wires at the spelter socket will require a new cable.

Replacement of the cable may be required. The anti-rotation pins in the sheaves will need to be removed for this procedure. Remove the wire rope clips on the old cable and pull the unattached spelter socket out through the front of the attenuator. Feed the new cable through the front sheave bell reducer, wrap around the sheave and back to the bottom rear sheave. Insert a pry bar through the holes to the rear of the sheaves to help guide the cable around the sheave. The cable arrangement travel path is as follows: bottom rear sheave, bottom front sheave, middle rear sheave, middle front sheave, top rear sheave, and top front sheave to cable adjustment bolt. The cable path to the adjustment bolt should be above all other cables. The cable will be marked where the Cable Adjustment bend will be. Attach the spelter socket. Adjust the cable adjuster eyebolt all the way out and thread cable through the eye loop. Wrap cable back against itself with the mark at the bolt eye. Start wire rope clips on the ends of the large loop. Work the wire rope clips up by clamping the wire rope loop in front of the clips. Work the last clip up to 4" from the eyebolt loop, then position the other three wire rope clips back at 3" intervals. When the wire clips are all positioned, tighten them to 225 ft-lbs or 305 N-m.

Cylinder Inspection

The cylinder should be inspected for:

- Dented or swollen tube jacket
- Visible cracks in any welds and fluid leakage from the welds
- Piston rod surface damage, bending or fluid leakage in seal area
- If fully collapsed or over design impact speed, disconnect piston rod from the mobile sheave after the unit is pulled out and push the piston rod in checking for free movement.

If any of these inspections are suspect, replace cylinder and have it examined by the manufacturer. Current models have PTFE seals with an unlimited static life.

Anchor Bolt Inspection

Anchor bolts may come loose or be damaged upon impact. These bolts can be replaced by welding a nut or putting a double nut on them and backing them out of the hole. Drill out the old epoxy and reinstall new bolts with new epoxy.

Side Panel Inspection

Side Panels are designed to nest and collapse with minimal or no damage upon frontal impact. The side keepers sustain a shock upon impact. These side keepers should be replaced if there are any signs of fatigue, bending or other visible damage. Inspect the side panels for any bending or torn metal. If damage is found, any side panel is removable by removing four bolts. It may be necessary to remove the bolts on the panel upstream to slide out a panel located in the middle of the unit. The side keepers used to hold the large front sled panels are different than the side keepers on the center panels. Also, the side keeper used on the last terminal brace, which is the rearmost support, has a shorter shoulder ($\frac{1}{4}$ " vs. $\frac{1}{2}$ "), as it does not have a panel overlap. These shoulders must seat into the outer overlapping panel and pin the inside panel to the frames using a torque value of 270 N-m (200 ft-lbs). Be careful not to pin the edge of the outside panel as it will restrict free sliding of that panel.

Side Guide Inspection

At the bottom of each support frame, there are two guides to stabilize and guide collapse of the attenuator. Inspect each side guide for damage. These guide assemblies are very rugged. The guides should be inspected for any damage. If they are not damaged they can be reused. Upon frontal impact, these guides should be inspected for damage. The torque value for the side guides is 920 N-m (680 ft-lb). These side guides are stronger than the rail, so visually inspect the rail for crowns. Any crowning of the rail can be straightened.

Final Inspection

After the resetting of the crash cushion is complete, verify by visual inspection that all assembly bolts are tight and show no sign of damage. Finally, check that no tools and other equipment or debris have been left within the crash cushion structure. Verify that no other damage unrelated to the most recent impact has occurred and that no significant corrosion or other deterioration has taken place.

Non-Repairable Impacts

There can be instances where the impact is outside the scope of the crash cushion's design. This may render the crash cushion unsafe to reuse and it should be replaced.

APPENDIX A—SCI ATTENUATOR PARTS LIST

SCI CRASH CUSHION PARTS LIST				
Part No.	Description	Qty Per Unit TL2/TL3	Unit of Measure	Spare Parts Kit TL2/TL3
9400	Attenuator 24" wide w/Concrete Anchors TL3			
9450	Attenuator 24" Wide w/Asphalt Anchors TL3			
9451	Attenuator 24" wide w/Concrete Anchors TL2			
9452	Attenuator 24" wide w/Asphalt Anchors TL2			
9401	Bolt Concrete Anchor 3/4" x 7" TL3 *(included in P/N 9400)	*	KIT/48 pcs.	
9402	Bolt Asphalt Anchor 3/4" x 18" TL3 *(included in P/N 9450)	*	KIT/48 pcs.	
9453	Bolt Concrete Anchor 3/4" x 7" TL2 **(included in P/N 9451)	**	KIT/34 pcs.	
9454	Bolt Asphalt Anchor 3/4" x 18" TL2 **(included in P/N 9452)	**	KIT/34 pcs.	
9403	Bolt Cable Adjuster	1	EACH	
9404	Bolt Sled Side Panel	8	EACH	
9405	Bolt Front Stop	2	EACH	
9406	Bolt Shear	2	EACH	10/10
9407	Bolt Side Guide	12	EACH	
9408	Bolt Terminal Brace	4	EACH	
9409	Brace Terminal	1	EACH	
9410	Cable 1 1/8" with Spelter Socket TL3	1	EACH	
9455	Cable 1 1/8" with Spelter Socket TL2	1	EACH	
9411	Clip Wire Rope TL2 & TL3	4	EACH	
9412	Cylinder Shock Arresting TL3	1	EACH	
9445	Cylinder Shock Arresting TL2	1	EACH	
9413	Strap Cylinder TL3	1	EACH	
9448	Strap Cylinder TL2	1	EACH	
9414	Frame Mobile #1 TL3	0/1	EACH	
9415	Frame Mobile #2 TL3	0/1	EACH	
9416	Frame Mobile #3 TL3	0/1	EACH	
9417	Frame Mobile #4 TL2 & TL3	1	EACH	
9418	Frame Mobile #5 TL2 & TL3	1	EACH	
9419	Frame Mobile #6 TL2 & TL3	1	EACH	
9420	Guide Side TL2 & TL3	6/12	EACH	
9421	Keeper Side #3 (Sled Panels) TL2 & TL3	4	Each	4/4
9422	Keeper Side #1 (Side Panels) TL2 & TL3	8/20	EACH	6/6
9423	Keeper Side #2 (Rear Panels) TL2 & TL3	4	EACH	2/2
9424	Panel Delineator (Painted Yellow) TL3	0/1	EACH	0/1
9496	Panel Delineator (Painted Black) TL3		EACH	
9497	Panel Delineator Diamond Grade Chevron 6" stripes TL3		EACH	

SCI CRASH CUSHION PARTS LIST				
Part No.	Description	Qty Per Unit TL2/TL3	Unit of Measure	Spare Parts Kit TL2/TL3
9498	Panel Delineator Diamond Grade Left 6" stripes TL3		EACH	
9499	Panel Delineator Diamond Grade Right 6" stripes TL3		EACH	
9456	Panel Delineator (Painted Yellow) TL2	1/0	EACH	1/0
9506	Panel Delineator (Painted Black) TL2		EACH	
9501	Panel Delineator Diamond Grade Chevron 6" stripes TL2		EACH	
9502	Panel Delineator Diamond Grade Left 6" stripes TL2		EACH	
9503	Panel Delineator Diamond Grade Right 6" stripes TL2		EACH	
9425	Panel Side TL2 & TL3	4/10	Each	3/3
9426	Panel Sled	2	EACH	2/2
9427	Panel Rear	2	EACH	1/1
9428	Sheave (pulley)	6	EACH	
9429	Sled (with guide rollers)24" TL3	0/1	EACH	
9457	Sled (with guide rollers) 24" TL2	1/0	EACH	
9439	Epoxy 28 oz. Cartridge and Nozzle ***	***	EACH	
9515	Epoxy Kit for TL3 Concrete Attenuator		EACH	
9516	Epoxy Kit for TL3 Asphalt Attenuator		EACH	
9517	Epoxy Kit for TL2 Concrete Attenuator		EACH	
9518	Epoxy Kit for TL2 Asphalt Attenuator		EACH	
9440	Nozzle Epoxy Mixing ***	***	EACH	
9441	Dispenser Epoxy	0	EACH	
9443	Boot Cylinder TL3	1	EACH	
9449	Boot Cylinder TL2	0	EACH	
9444	Spare Parts Kit TL3	0	EACH	
9458	Spare Parts Kit TL2	0	EACH	
9488	Reset Parts Kit TL3	0	EACH	
9489	Reset Parts Kit TL2	0	EACH	
9495	Tool Anti-Rotation Pin Removal	0	EACH	
9507	Anchor Drop-In	0	EACH	
9508	Pin Anti-Rotation Front	0	EACH	
9509	Pin Anti-Rotation Rear	0	EACH	
9510	Plate Sheave Cover	0	EACH	
9525	Cable Release Tool	0	EACH	

TRANSITIONS AND TRANSITION PARTS			
9431	Transition Jersey Barrier - Right	O	EACH
9432	Transition Jersey Barrier - Left	O	EACH
9433	Transition 24" Concrete - Left & Right	O	EACH
9437	Transition Thrie Beam - Right	O	EACH
9438	Transition Thrie Beam—Left	O	EACH
9511	Transition W Beam 28" High Right	O	EACH
9512	Transition W Beam 28" High Left	O	EACH
9513	Transition W Beam 32" High Right	O	EACH
9514	Transition W Beam 32" High Left	O	EACH
9459	Transition Assembly 30" Concrete Straight Connection	O	EACH
9460	Transition Assembly 36" Concrete Straight Connection	O	EACH
9461	Transition Assembly 30" Concrete Outside Connection	O	EACH
9462	Transition Assembly 36" Concrete Outside Connection	O	EACH
9475	Transition Assembly Gore to End of Flared Transition	O	EACH
9476	Transition Assembly Median Barrier 36B X 19T X 42H	O	EACH
9492	Transition Assembly Median Barrier 36B X 19T X 32H	O	EACH
9463	Transition 30" Concrete Straight Connection	O	EACH
9464	Transition 36" Concrete Straight Connection	O	EACH
9465	Transition 30" Concrete Outside Connection	O	EACH
9466	Transition 36" Concrete Outside Connection	O	EACH
9467	Transition Thrie Beam 10 Degree Flare - Right	O	EACH
9468	Transition Thrie Beam 10 Degree Flare - Left	O	EACH
9469	Transition Concrete Spanner Brace	O	EACH
9470	Transition Concrete #1 Tapered Spanner Brace	O	EACH
9471	Transition Concrete #2 Tapered Spanner Brace	O	EACH
9472	Transition Gore Tapered #1 Spanner Brace	O	EACH
9473	Transition Gore Tapered #2 Spanner Brace	O	EACH
9474	Thrie Beam Concrete Leg Brace	O	EACH
9477	Transition Median Barrier 36B X 19T X 42H Right	O	EACH
9478	Transition Median Barrier 36B X 19T X 42H - Left	O	EACH
9493	Transition Median Barrier 36B X 19T X 32H - Right	O	EACH
9494	Transition Median Barrier 36B X 19T X 32H - Left	O	EACH
9479	Transition Spanner Brace Median Barrier 36B	O	EACH
9480	Transition Rub Rail Median Barrier - Right	O	EACH
9481	Transition Rub Rail Median Barrier - Left	O	EACH
9490	Transition Single Slope 24-26 9/32" Wide Median Barrier - Right	O	EACH
9491	Transition Single Slope 24-26 9/32" Wide Median Barrier - Left	O	EACH
9504	Transition Profile B Right	O	EACH
9405	Transition Profile B Left	O	EACH
9524	Blockout	O	EACH

O = Optional

APPENDIX B—EQUIPMENT LIST

The following tools and equipment will be required to install and repair the Crash Cushion:

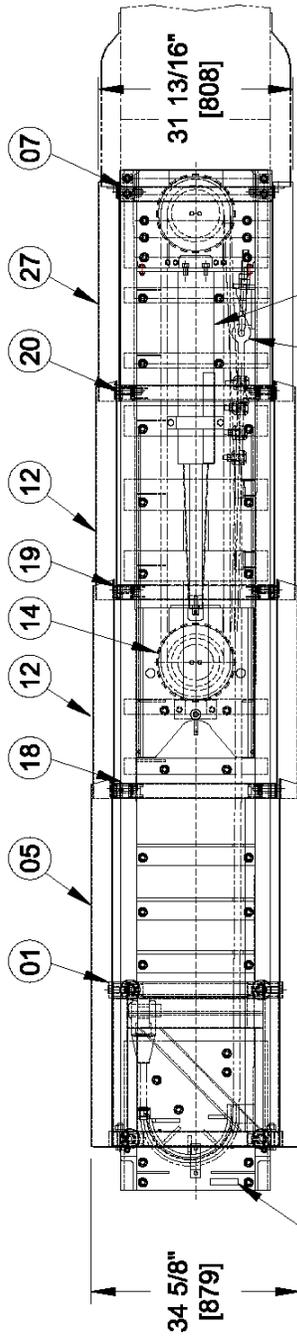
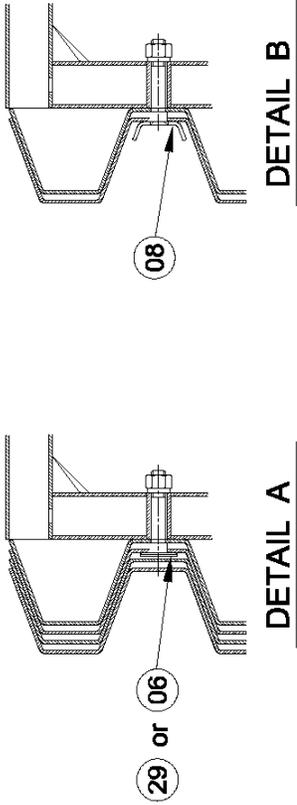
- Standard roadside work area safety equipment
- Personal safety equipment (gloves, latex gloves for epoxy, eye/face protection, etc.)
- Means of safely unloading 3500 lb
- Compressed air source/Vacuum
- 1" bottle brush (McMaster Carr # 73075T55)
- Safety goggles
- Four lifting slings or four-point sling
- Bosch rotary hammer drill 13 ½ amp #11263EVS Model 0 611 263 739 or equal
- 7/8" X 22" concrete drill bit for concrete installations or 7/8" X 28" drill bit for asphalt installations
- Renton rebar eater bit #RB-14 - 7/8" rebar cutter bit or equal
- 1" X 12" concrete drill bit for drop-in anchors on transitions
- Punch or setting tool for drop-in anchors.
- ½" electric drill for rebar bit and bottle brush (cordless will work for bottle brush)
- Epoxy dispenser for 28 oz dual cartridge system (should have spare in case of malfunction)
- Combination wrenches, deep sockets (Including 7/16" – 5/8", 1 ¼", 1 ½", 1 5/8") and 3+" extension
- Socket wrench and breaker bar
- Torque wrench (225 ft-lb capacity) with 3 ft extension
- Measuring and layout equipment (tape measure, chalk line, markers, etc.)
- 5 ft wedge and round-ended pry bar
- Loctite #34395 marine grade anti-seize
- Suitable pulling means (strap or chain)
- 2 long-handled flat screwdrivers
- Misc. small tools (hammers, pliers, screw drivers, vise grips, etc.)
- Bear claw pry bar to remove ¼" shear bolt remnants

This list is adequate for general installation and repair. However, depending on site conditions, additional tools and equipment may be required.

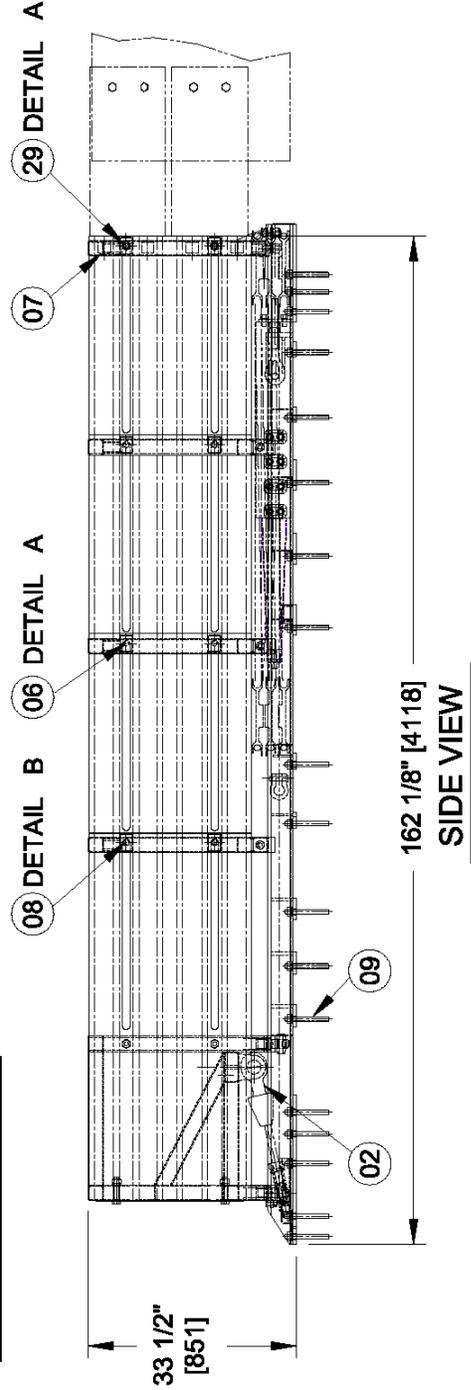
APPENDIX C - SMART CUSHION®, TEST LEVEL 2

PARTS LIST

- 01 - Front Sled
- 02 - Cable Assembly
- 05 - Sled Panel
- 07 - Terminal Brace
- 09 - Anchor Bolts
- 12 - Side Panels
- 14 - Mobile Sheave Assembly
- 17 - Cable Adjuster Bolt
- 18-20 - Mobile Frames 4-6
- 26 - Cylinder
- 27 - Rear Panel
- 06, 08, 29 - Side Keepers



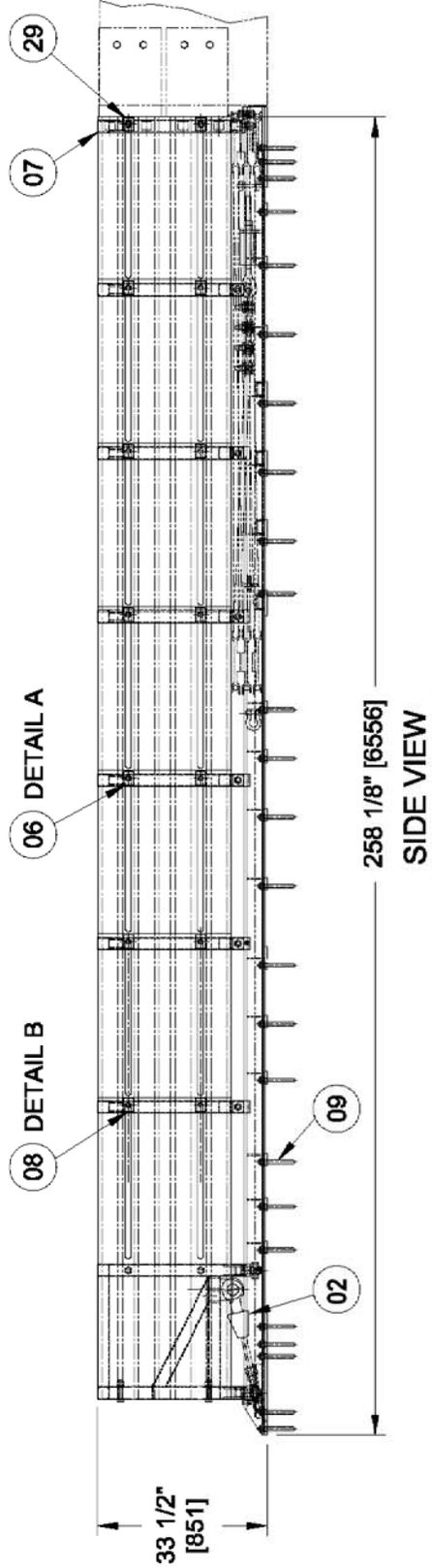
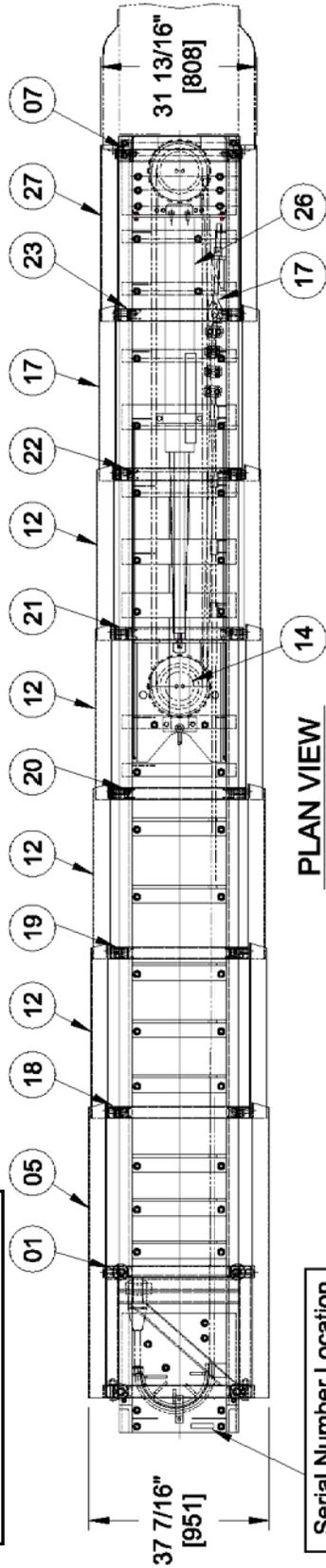
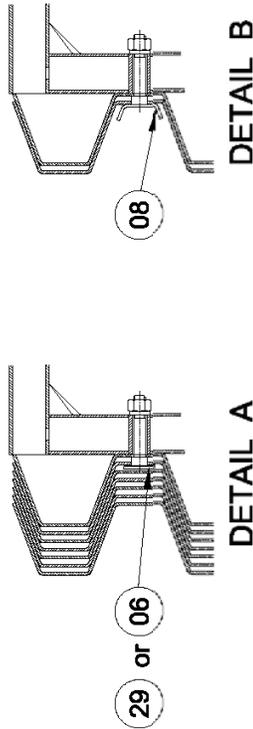
PLAN VIEW



SIDE VIEW

APPENDIX D - SMART CUSHION®, TEST LEVEL 3

PARTS LIST	
01	Front Sled
02	Cable Assembly
05	Sled Panel
07	Terminal Brace
09	Anchor Bolts
12	Side Panels
14	Mobile Sheave Assembly
17	Cable Adjuster Bolt
18-23	Mobile Frames 1-6
26	Cylinder
27	Rear Panel
06, 08, 29	Side Keepers

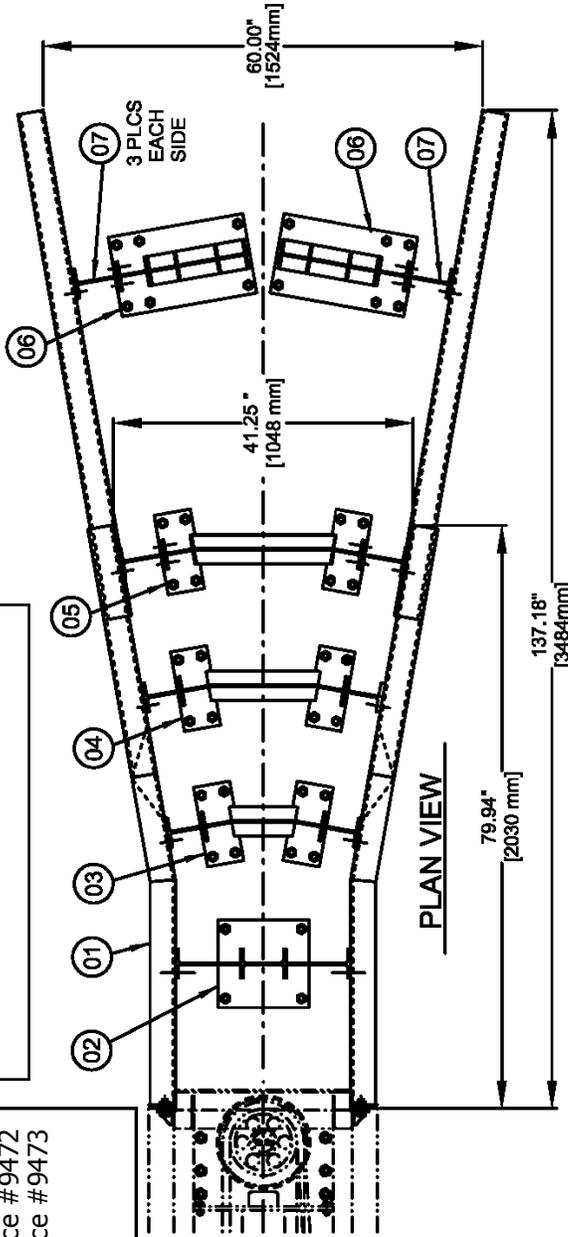


APPENDIX F - TRANSITION, GORE ASSEMBLY

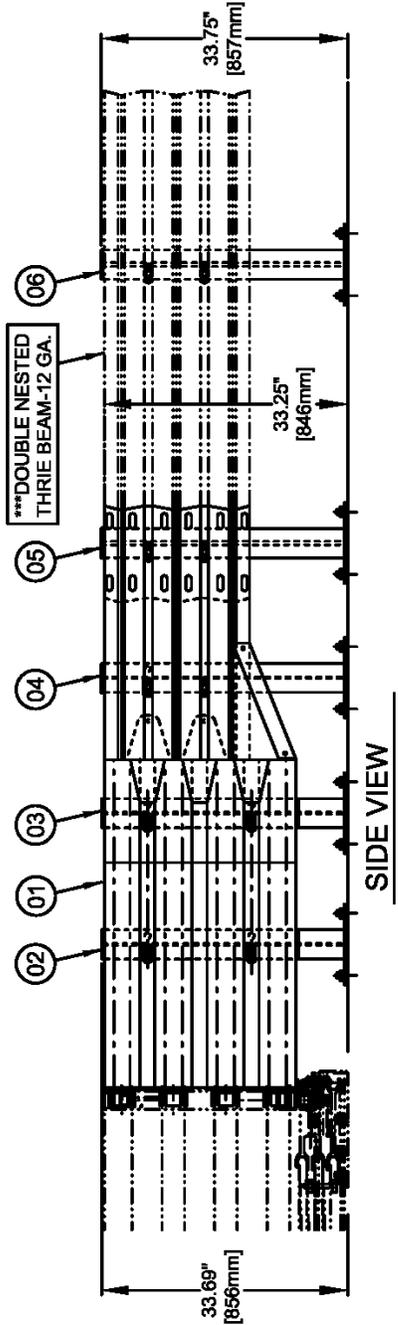
PARTS LIST

- Gore Assembly #9475
- 01 - Transition 10 Degree Flare Right #9467
- 02 - Transition 10 Degree Flare Left #9468
- 03 - Transition Concrete Spanner Brace #9469
- 04 - Transition Concrete #1 Spanner Brace #9470
- 05 - Transition Gore Tapered #1 Spanner Brace #9473
- 06 - Transition Gore Tapered #2 Spanner Brace #9474
- 07 - Thrie Beam Concrete Leg Brace #9474
- 07 - Thrie Beam Blockout (AASHTO PWB02)

***** SPLICE BOLTS AND
GUARDRAIL SUPPLIED BY
OTHERS *****

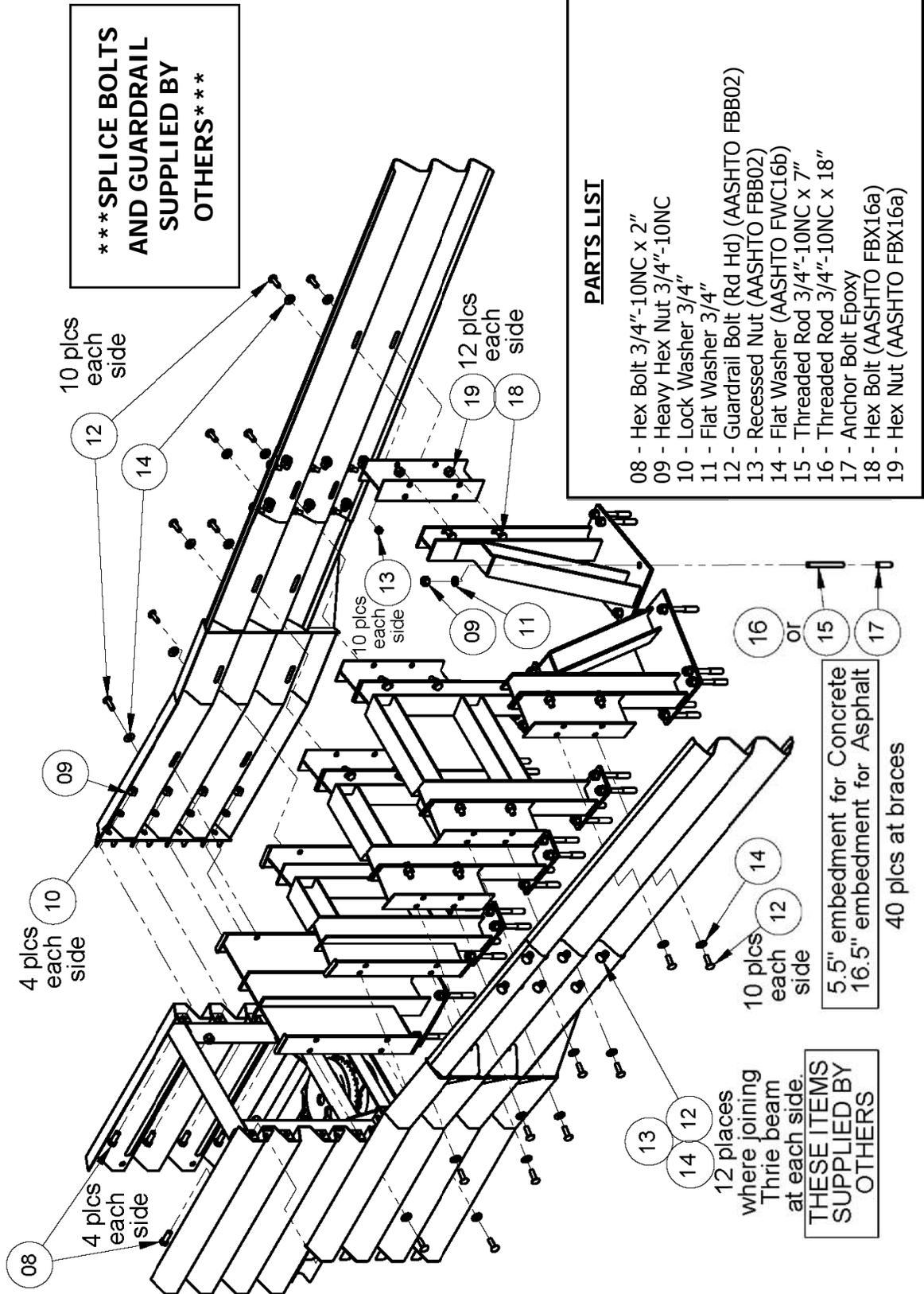


- NOTES:**
- 1) DIMENSIONS SHOWN ARE FOR 60" WIDTH
 - 2) FOR EACH 1" OF WIDTH CHANGE:
ADD OR SUBTRACT THE FOLLOWING:
2.88" [73.15mm] TO LENGTH OF GUARDRAIL
2.84" [72.13mm] TO OVERALL LENGTH
EACH SIDE FOR EACH 13" [330mm] CHANGE IN WIDTH.
 - 3) ADD OR SUBTRACT ADDITIONAL POST ON EACH SIDE FOR EACH 13" [330mm] CHANGE IN WIDTH.
 - 4) GUARDRAIL TERMINATION - YOU MUST ADD THE GUARDRAIL OVERLAP LENGTH AND TERMINATE PER STATE REGULATIONS.



The use of the last brace will be determined by whether the Thrie Beam can be attached to the obstruction or not. If the Thrie Beam distance from the last brace is 40 inches or less and can be attached, you will not need a brace at the obstruction. If you cannot attach to the obstruction, you may need a brace and drill holes in the Thrie Beam at the furthest rearward location.

APPENDIX F(2) - TRANSITION, GORE ASSEMBLY



***** SPLICE BOLTS AND GUARDRAIL SUPPLIED BY OTHERS *****

- PARTS LIST**
- 08 - Hex Bolt 3/4"-10NC x 2"
 - 09 - Heavy Hex Nut 3/4"-10NC
 - 10 - Lock Washer 3/4"
 - 11 - Flat Washer 3/4"
 - 12 - Guardrail Bolt (Rd Hd) (AASHTO FBB02)
 - 13 - Recessed Nut (AASHTO FBB02)
 - 14 - Flat Washer (AASHTO FWC16b)
 - 15 - Threaded Rod 3/4"-10NC x 7"
 - 16 - Threaded Rod 3/4"-10NC x 18"
 - 17 - Anchor Bolt Epoxy
 - 18 - Hex Bolt (AASHTO FBX16a)
 - 19 - Hex Nut (AASHTO FBX16a)

5.5" embedment for Concrete
16.5" embedment for Asphalt
40 pcs at braces

12 places where joining Thrie beam at each side.
THESE ITEMS SUPPLIED BY OTHERS

APPENDIX F(3) - TRANSITION, GORE ASSEMBLY CALCULATIONS

SCI GM WIDE TRANSITION CALCULATIONS

Guardrail

12.6" Splice overlap at Transition end

Must add length for barrier overlap and end termination per state specifications

Longitudinal distance increases 2.84" for each 1" increase in width

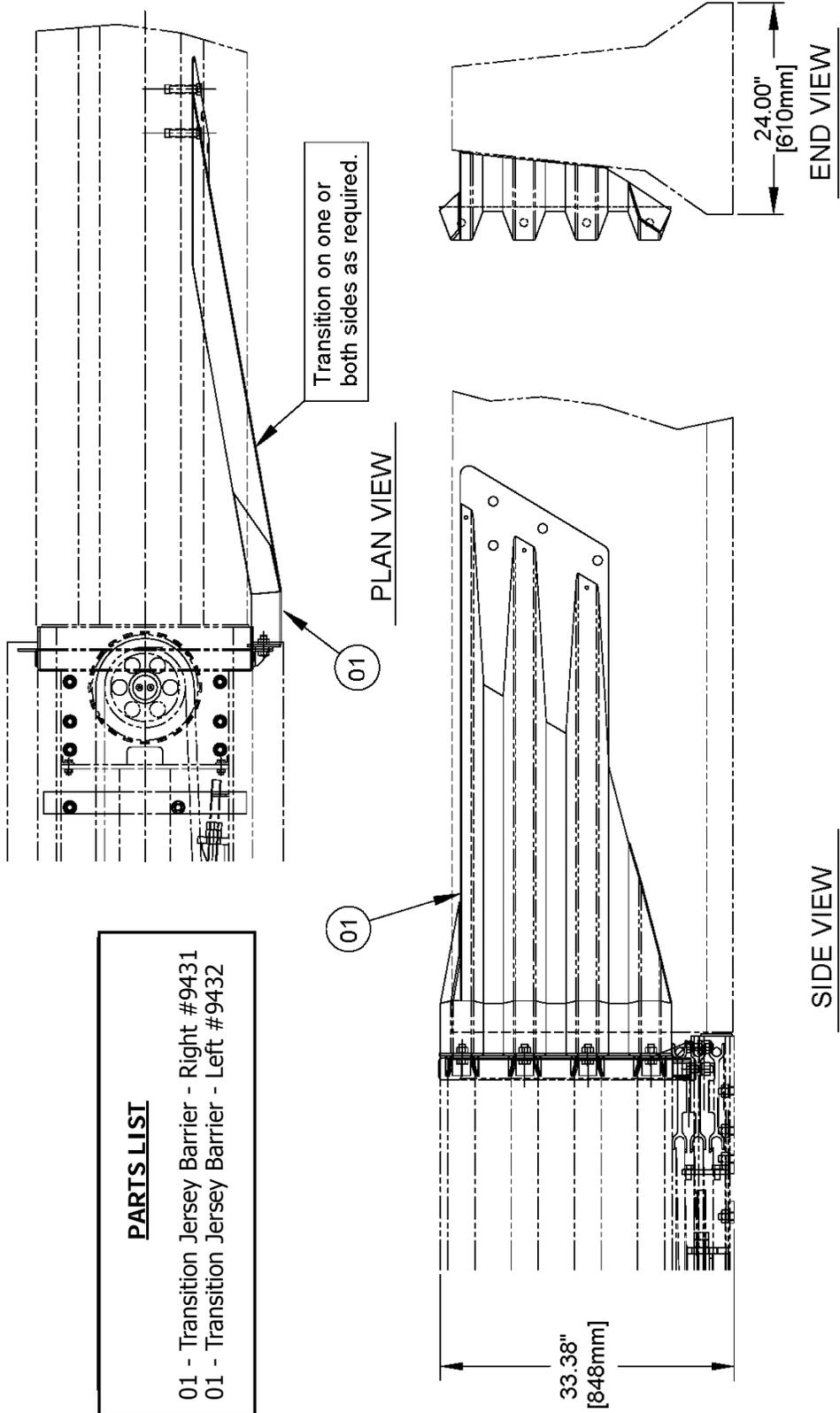
Thrie Beam Length increases 2.88" for each 1" increase in width

Gore Width Inches	Additional Long. Distance Inches	Additional Long. Distance Feet	Thrie Beam Length Inches	Overall System Length Feet	Additional Brace Count
41	79.2	6.6	12.6	28.1	All 4 Spanner Braces # 9469, 9470, 9472, 9473
48	99.1	8.3	32.8	29.8	All 4 Spanner Braces # 9469, 9470, 9472, 9473
55	118.9	9.9	52.9	31.4	Add 2-Thrie Beam Concrete Leg Brace #9474
60	133.1	11.1	67.3	32.6	Add 2-Thrie Beam Concrete Leg Brace #9474
68	155.8	13.0	90.4	34.5	Add 4-Thrie Beam Concrete Leg Brace #9474
69	158.6	13.2	93.2	34.7	Add 4-Thrie Beam Concrete Leg Brace #9474
81	192.7	16.1	127.8	37.6	Add 6-Thrie Beam Concrete Leg Brace #9474
88	212.5	17.7	148.0	39.2	Add 6-Thrie Beam Concrete Leg Brace #9474
94	229.5	19.1	165.2	40.6	Add 8-Thrie Beam Concrete Leg Brace #9474
100	246.5	20.5	182.5	42.1	Add 8-Thrie Beam Concrete Leg Brace #9474
107	266.4	22.2	202.7	43.7	Add 10-Thrie Beam Concrete Leg Brace #9474
112	280.6	23.4	217.1	44.9	Add 10-Thrie Beam Concrete Leg Brace #9474
120	303.3	25.3	240.1	46.8	Add 12-Thrie Beam Concrete Leg Brace #9474
126	320.3	26.7	257.4	48.2	Add 12-Thrie Beam Concrete Leg Brace #9474
133	340.1	28.3	277.6	49.9	Add 14-Thrie Beam Concrete Leg Brace #9474

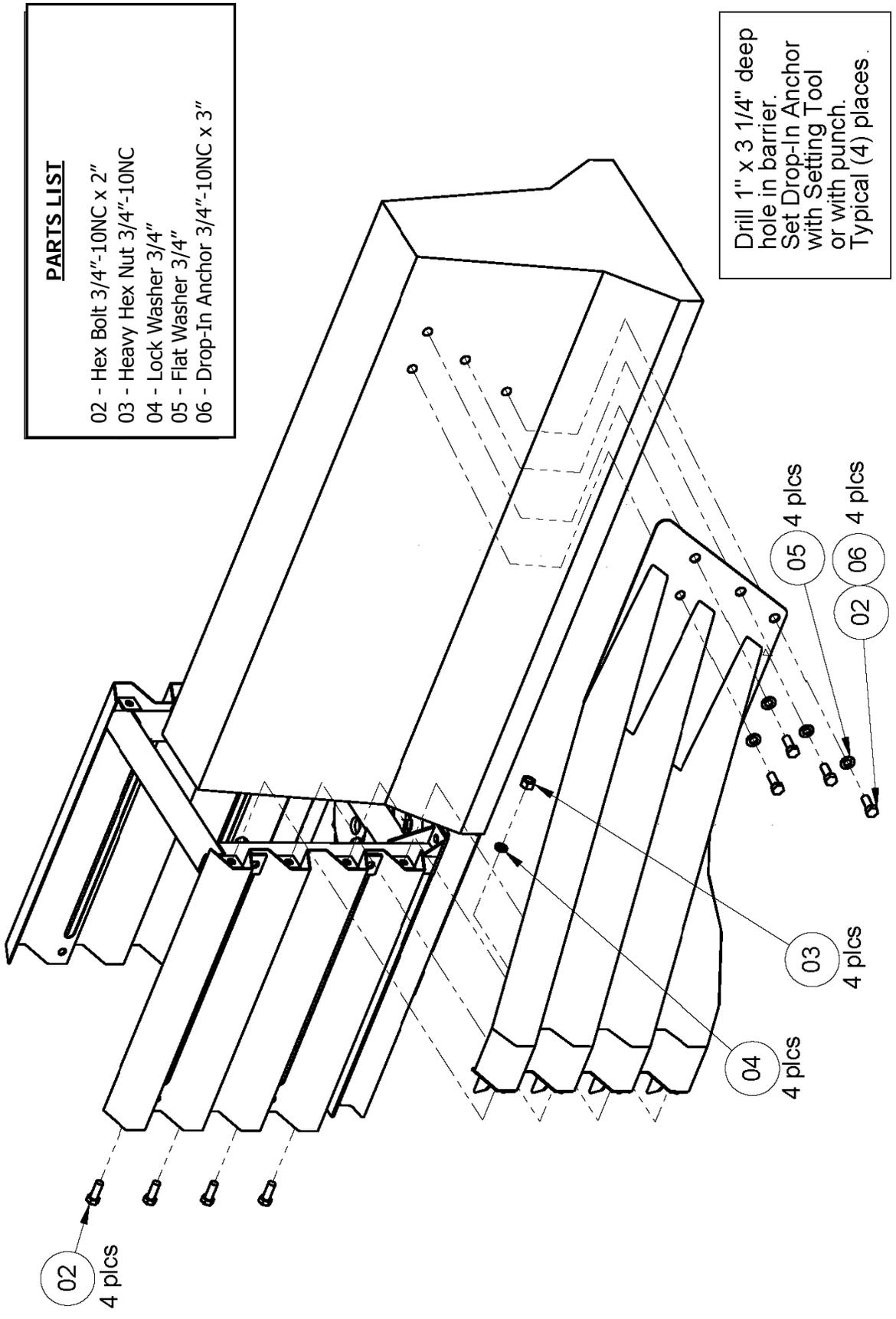
APPENDIX G - TRANSITION, JERSEY/F SHAPE BARRIER

PARTS LIST

- 01 - Transition Jersey Barrier - Right #9431
- 01 - Transition Jersey Barrier - Left #9432



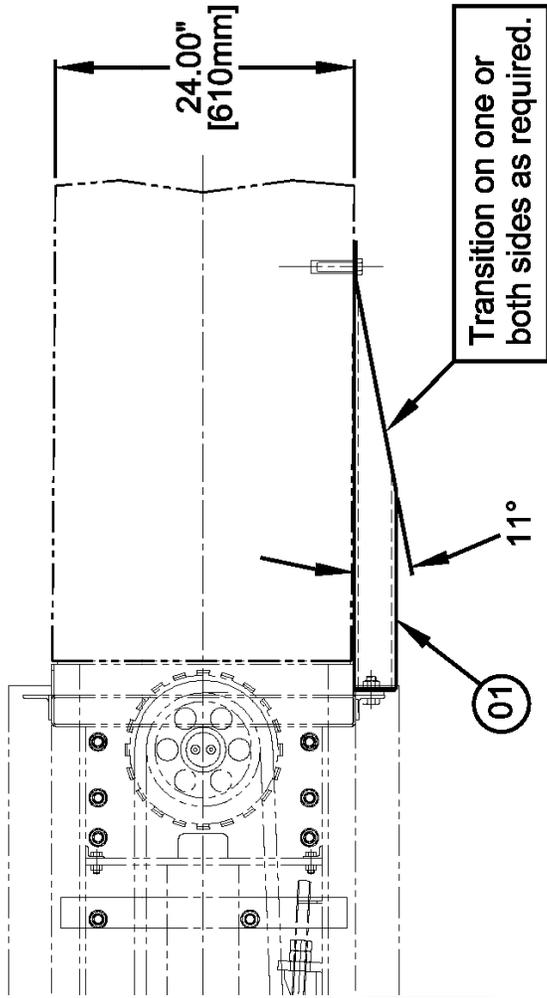
APPENDIX G(2) - TRANSITION, JERSEY/F SHAPE BARRIER



- PARTS LIST**
- 02 - Hex Bolt 3/4"-10NC x 2"
 - 03 - Heavy Hex Nut 3/4"-10NC
 - 04 - Lock Washer 3/4"
 - 05 - Flat Washer 3/4"
 - 06 - Drop-In Anchor 3/4"-10NC x 3"

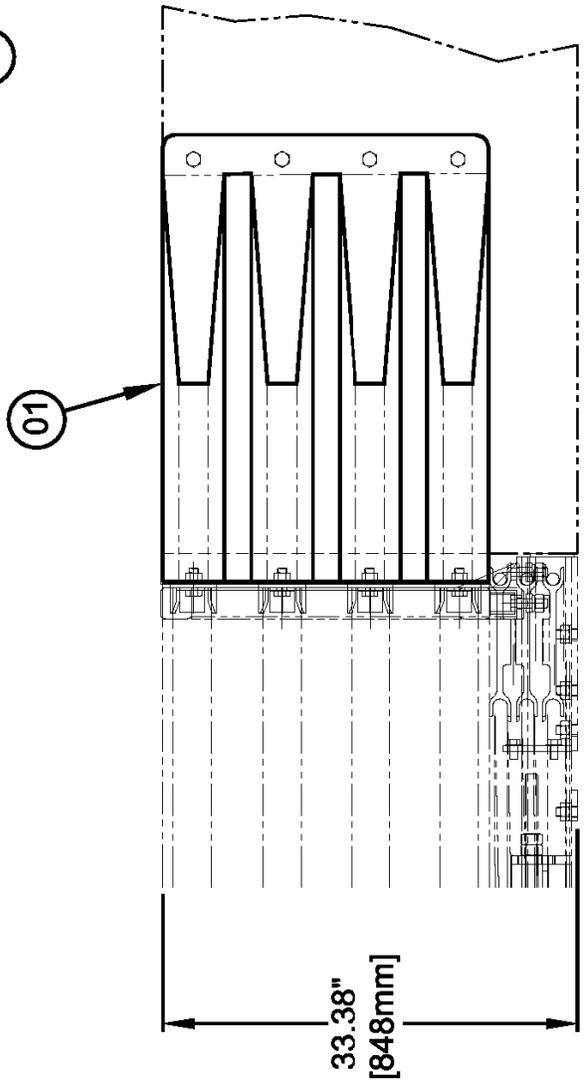
Drill 1" x 3 1/4" deep hole in barrier.
 Set Drop-In Anchor with Setting Tool or with punch.
 Typical (4) places.

APPENDIX H - TRANSITION, CONCRETE BLOCK, 24 INCH (610mm)



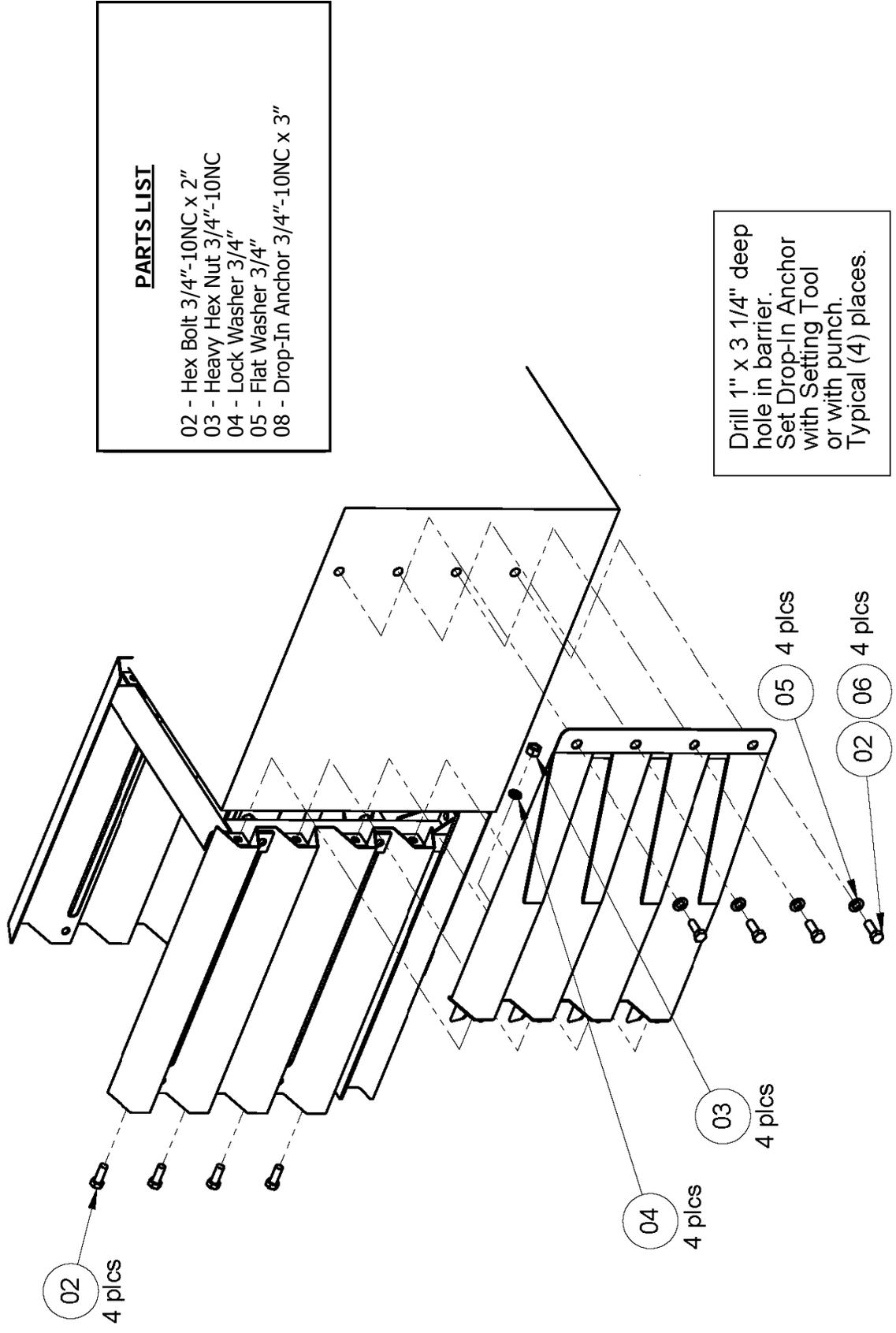
PLAN VIEW

PARTS LIST
 Transition 24" Concrete Block Right or Left #9433



SIDE VIEW

APPENDIX H(2) - TRANSITION, CONCRETE BLOCK, 24 INCH (610mm)



PARTS LIST

- 02 - Hex Bolt 3/4"-10NC x 2"
- 03 - Heavy Hex Nut 3/4"-10NC
- 04 - Lock Washer 3/4"
- 05 - Flat Washer 3/4"
- 08 - Drop-In Anchor 3/4"-10NC x 3"

Drill 1" x 3 1/4" deep hole in barrier.
Set Drop-In Anchor with Setting Tool or with punch.
Typical (4) places.

02
4 plcs

04
4 plcs

03
4 plcs

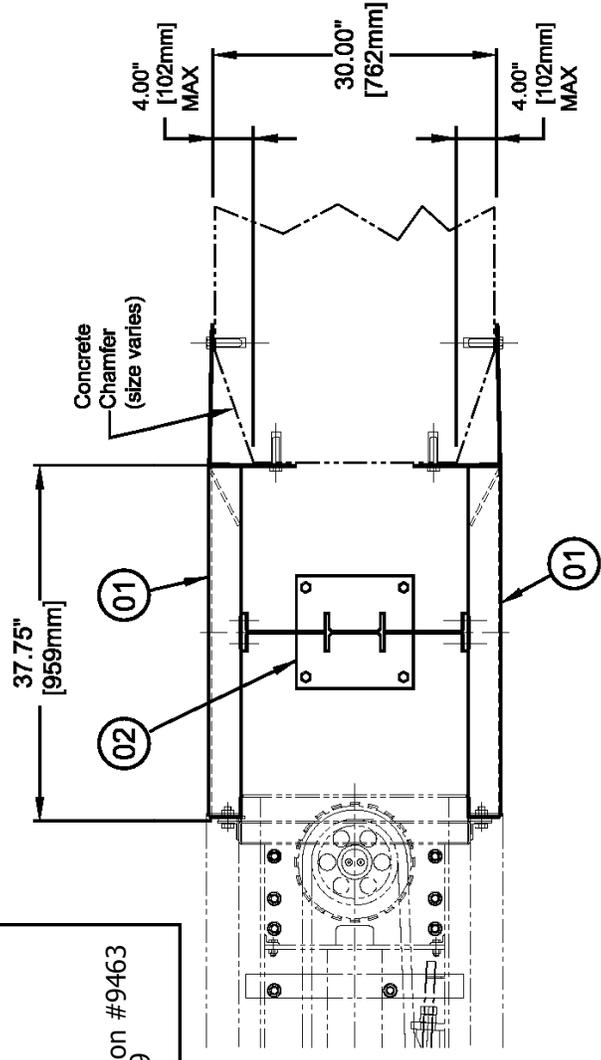
05
4 plcs

06
4 plcs

APPENDIX I - TRANSITION, CONCRETE BLOCK, 30 INCH (762mm)

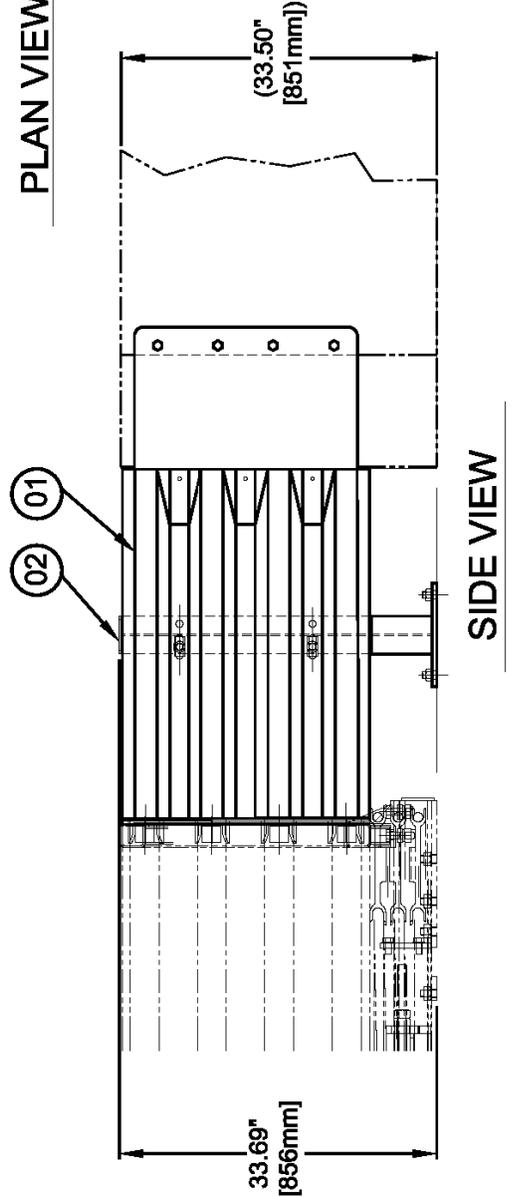
PARTS LIST

- Two Sided Full Assembly #9459
- 01 - Transition 30" Concrete Straight Connection #9463
- 02 - Transition Concrete Spanner Brace #9469



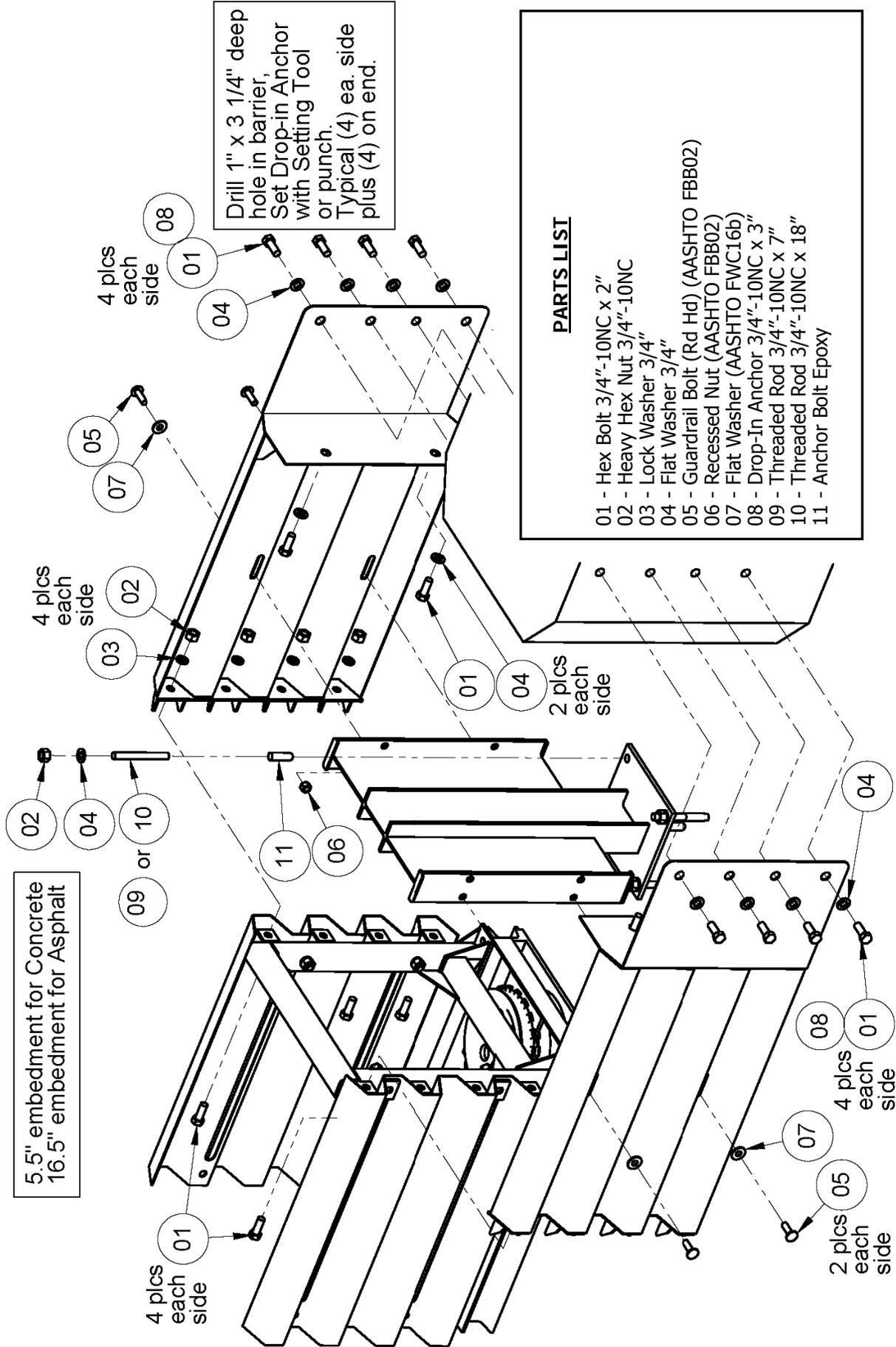
USED FOR:
 1. Unchamfered Concrete Block ***
 2. Chamfered Concrete Block ***
 *** Chamfer limited to <4" ***

PLAN VIEW



SIDE VIEW

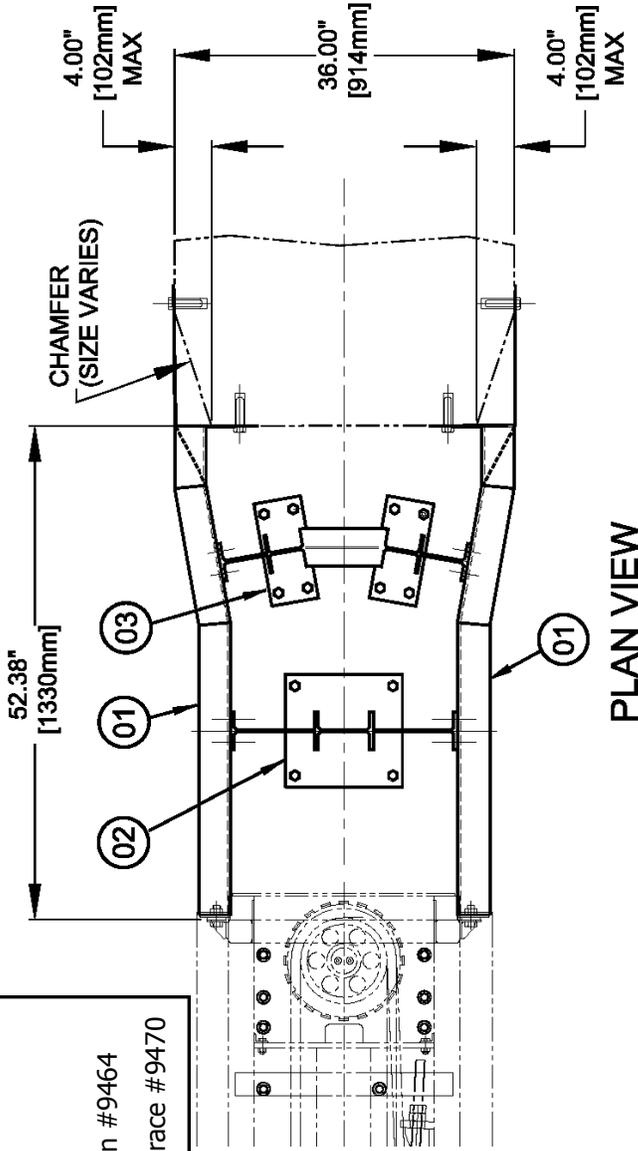
APPENDIX I(2) - TRANSITION, CONCRETE BLOCK, 30 INCH (762mm)



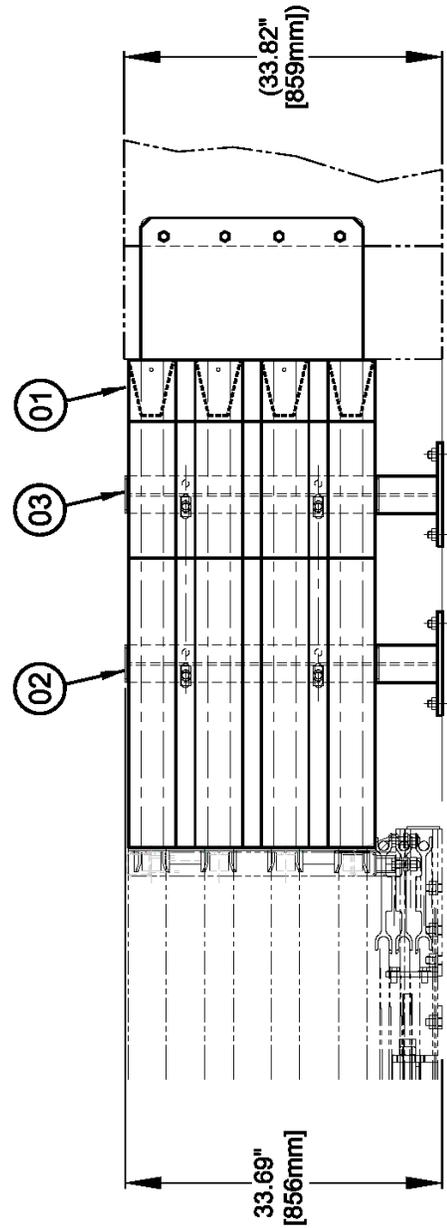
APPENDIX J - TRANSITION, CONCRETE BLOCK, 36 INCH (915mm)

PARTS LIST

- Two Sided Full Assembly #9460
- 01 - Transition 36" Concrete Straight Connection #9464
- 02 - Transition Concrete Spanner Brace #9469
- 03 - Transition Concrete #1 Tapered Spanner Brace #9470



PLAN VIEW



SIDE VIEW

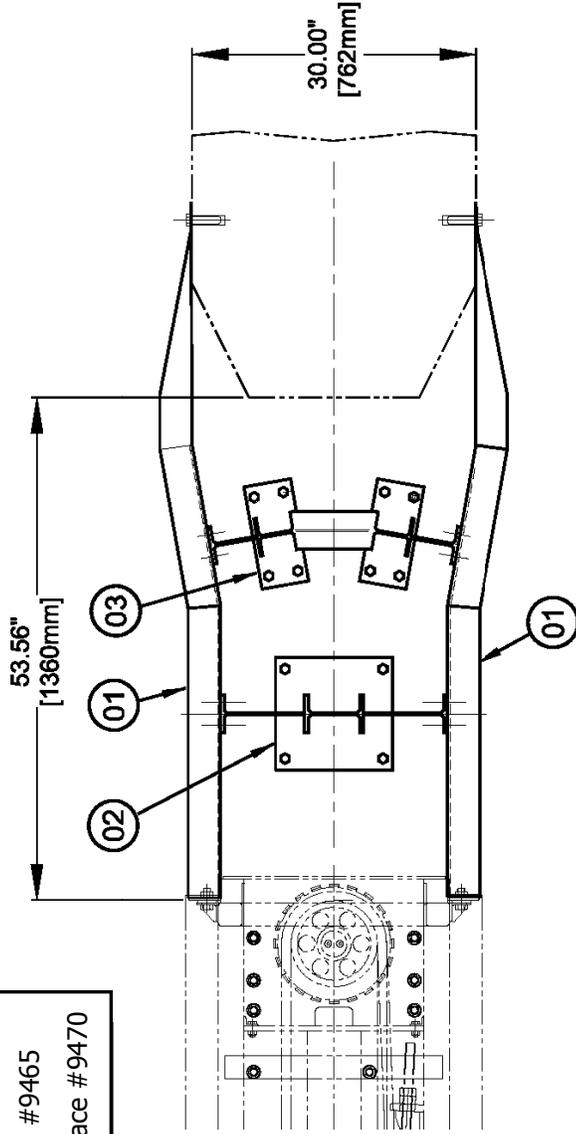
USED FOR:

- 1. Unchamfered Concrete Block ***
 - 2. Chamfered Concrete Block ***
- *** Chamfer limited to <4"

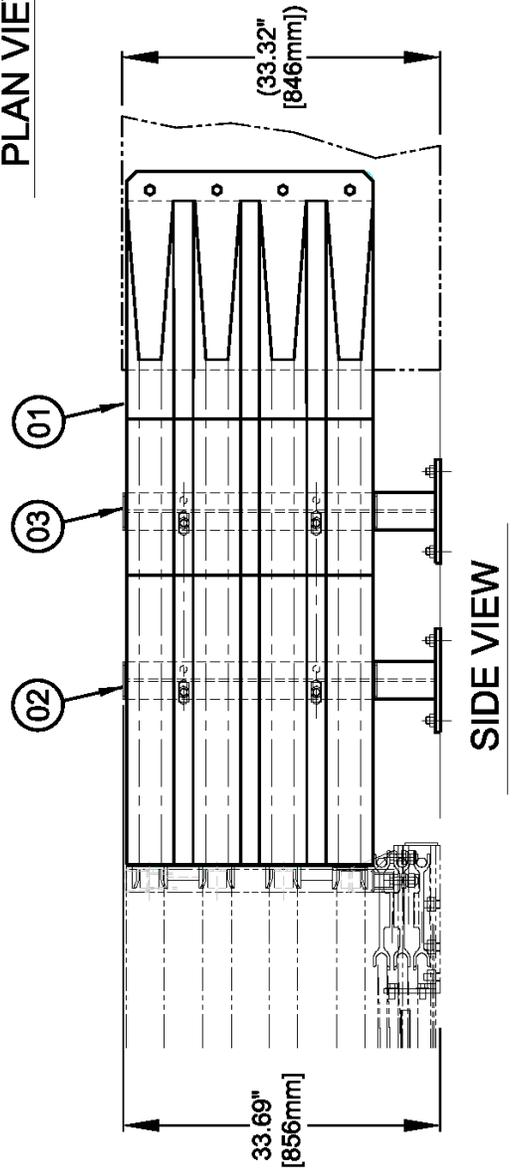
APPENDIX K - TRANSITION, CONCRETE BLOCK, 30 INCH (762mm) FLARED

PARTS LIST

- Two Sided Full Assembly #9461
- 01 - Transition 30" Concrete Outside Connection #9465
- 02 - Transition Concrete Spanner Brace #9469
- 03 - Transition Concrete #1 Tapered Spanner Brace #9470



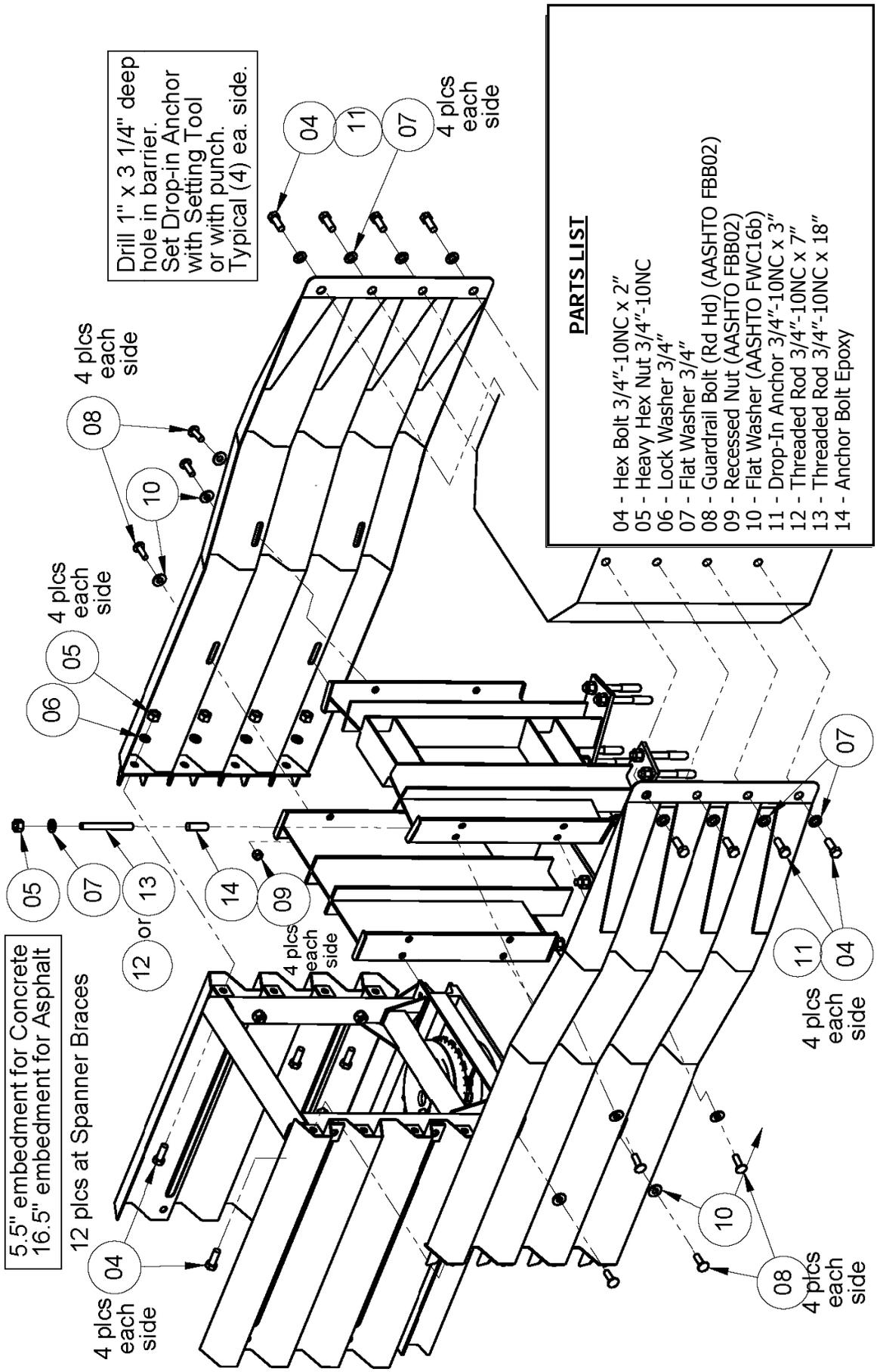
PLAN VIEW



SIDE VIEW

USED FOR:
 1. Unchamfered Concrete Block ***
 2. Chamfered Concrete Block ***
 *** Chamfer limited to <4"

APPENDIX K(2) - TRANSITION, CONCRETE BLOCK, 30 INCH (762mm) FLARED



5.5" embedment for Concrete
16.5" embedment for Asphalt

12 pcs at Spanner Braces

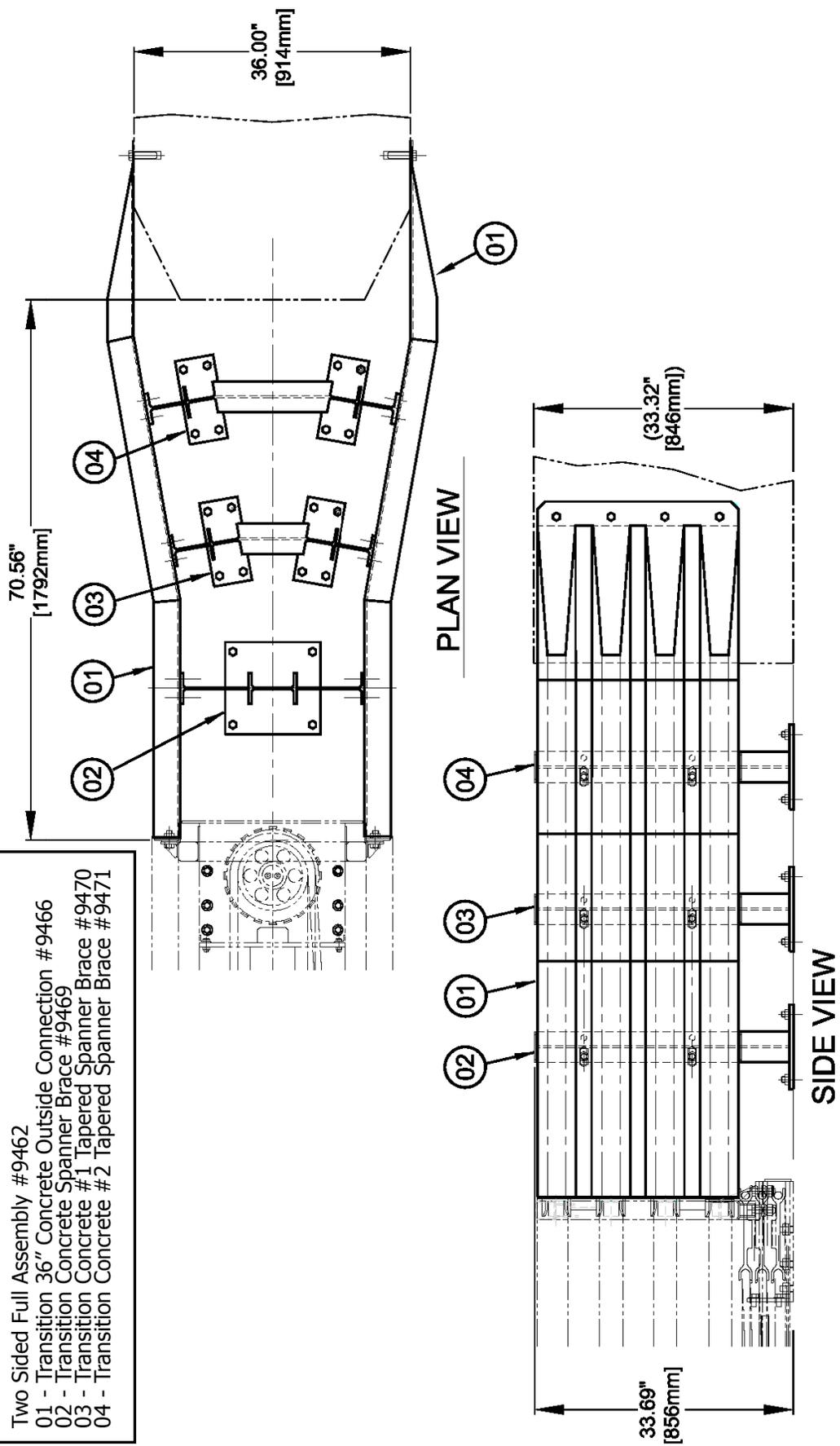
4 pcs each side

Drill 1" x 3 1/4" deep hole in barrier. Set Drop-in Anchor with Setting Tool or with punch. Typical (4) ea. side.

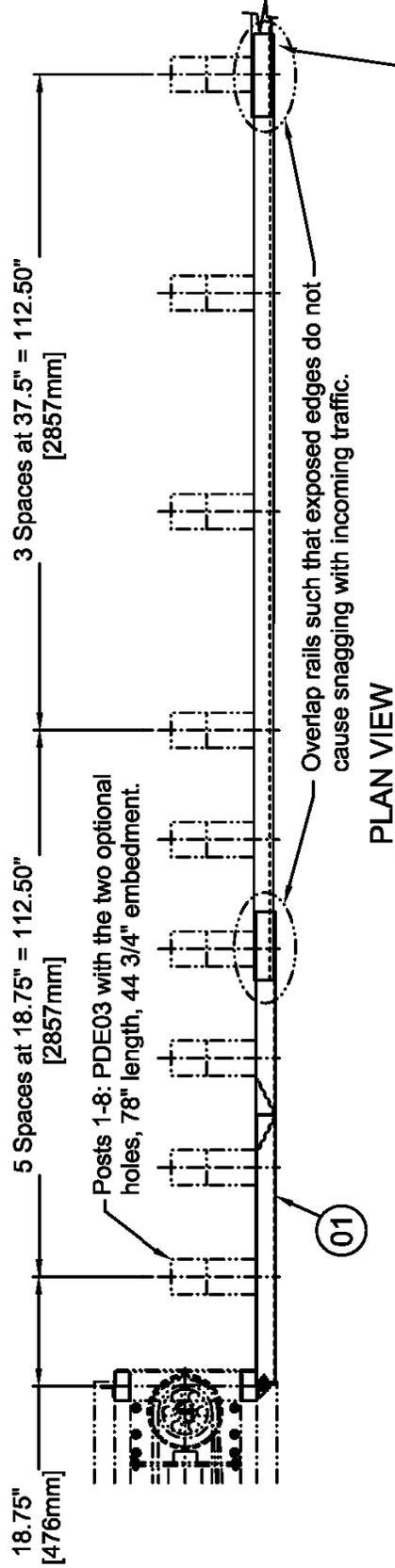
- PARTS LIST**
- 04 - Hex Bolt 3/4"-10NC x 2"
 - 05 - Heavy Hex Nut 3/4"-10NC
 - 06 - Lock Washer 3/4"
 - 07 - Flat Washer 3/4"
 - 08 - Guardrail Bolt (Rd Hd) (AASHTO FBB02)
 - 09 - Recessed Nut (AASHTO FBB02)
 - 10 - Flat Washer (AASHTO FWC16b)
 - 11 - Drop-In Anchor 3/4"-10NC x 3"
 - 12 - Threaded Rod 3/4"-10NC x 7"
 - 13 - Threaded Rod 3/4"-10NC x 18"
 - 14 - Anchor Bolt Epoxy

APPENDIX L - TRANSITION, CONCRETE BLOCK, 36 INCH (915mm) FLARED

- PARTS LIST**
- Two Sided Full Assembly #9462
 - 01 - Transition 36" Concrete Outside Connection #9466
 - 02 - Transition Concrete Spanner Brace #9469
 - 03 - Transition Concrete #1 Tapered Spanner Brace #9470
 - 04 - Transition Concrete #2 Tapered Spanner Brace #9471

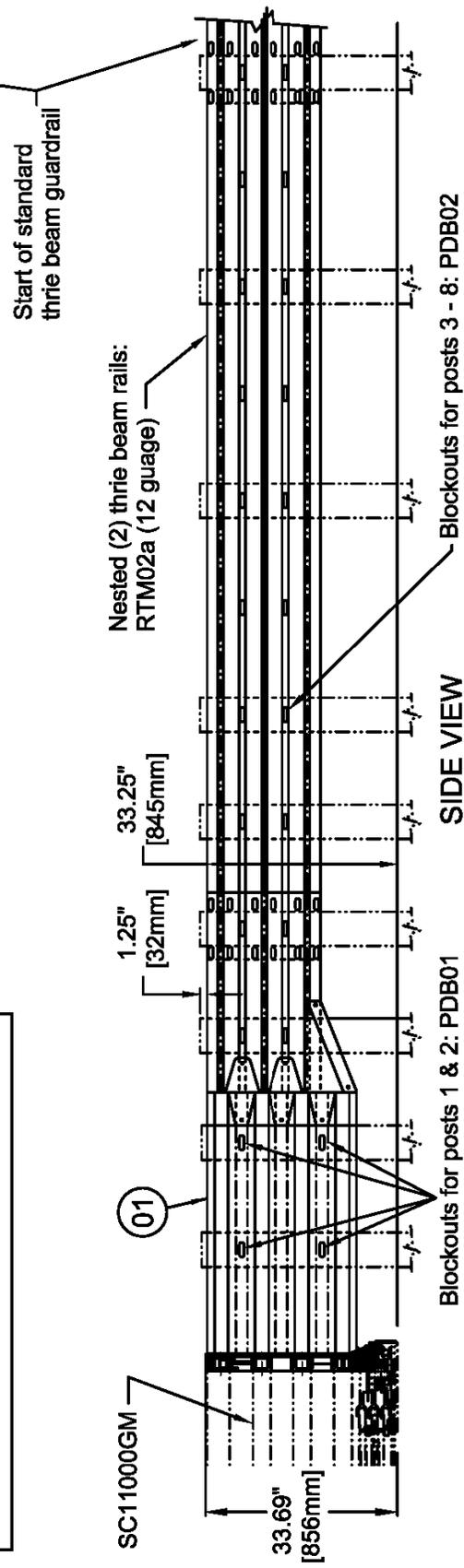


APPENDIX M - TRANSITION, THRIE BEAM



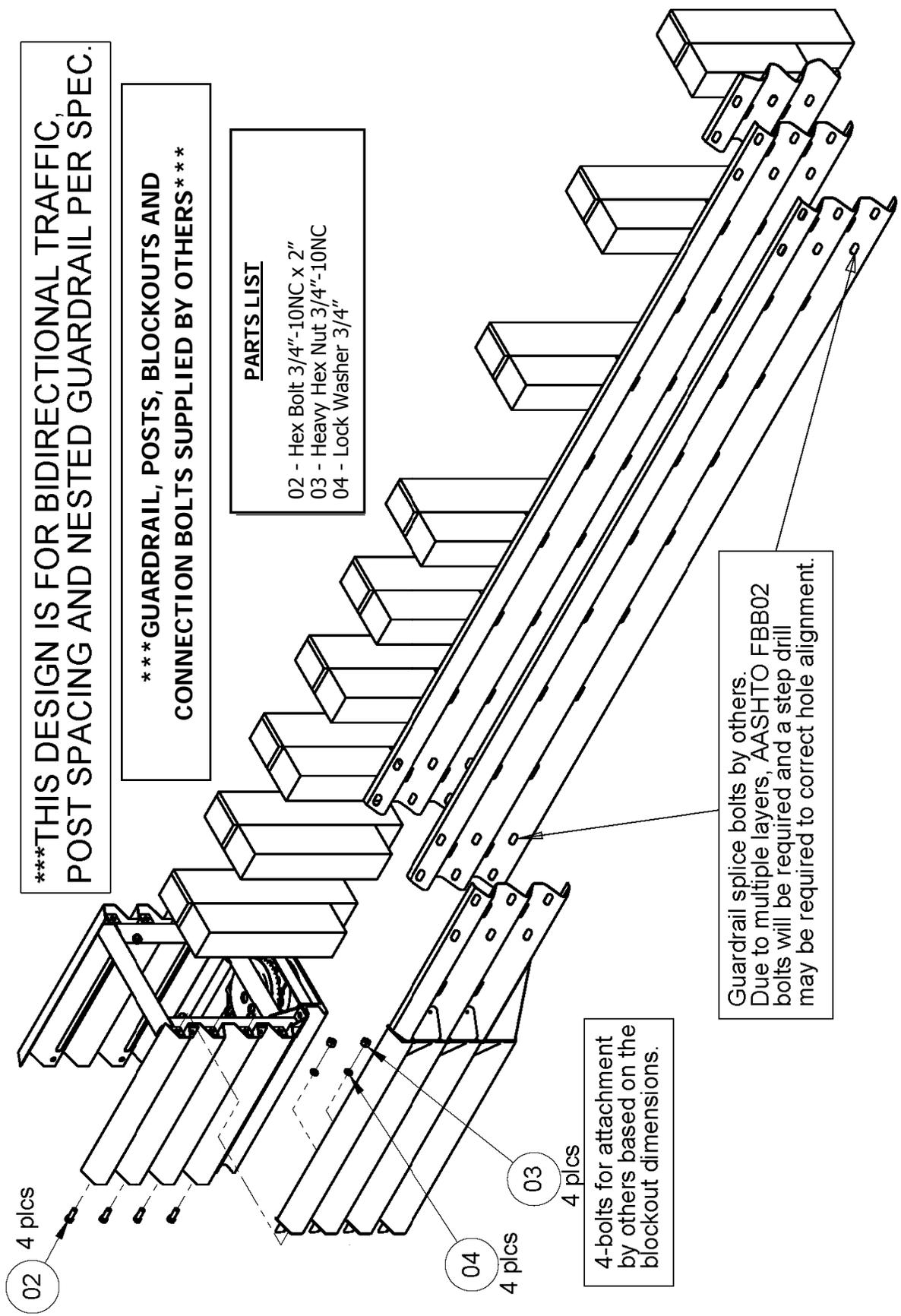
***** GUARDRAIL, POSTS, BLOCKOUTS AND CONNECTION BOLTS SUPPLIED BY OTHERS *****

PARTS LIST
 01 - Transition Thrie & W Beam - Right #9437
 01 - Transition Thrie & W Beam - Left #9438



Blockouts for posts 1 & 2: PDB01 (two per post), or use similar to Part 15 (figure 7) in original design.

APPENDIX M(2) - TRANSITION, THRIE BEAM



*****THIS DESIGN IS FOR BIDIRECTIONAL TRAFFIC, POST SPACING AND NESTED GUARDRAIL PER SPEC.**

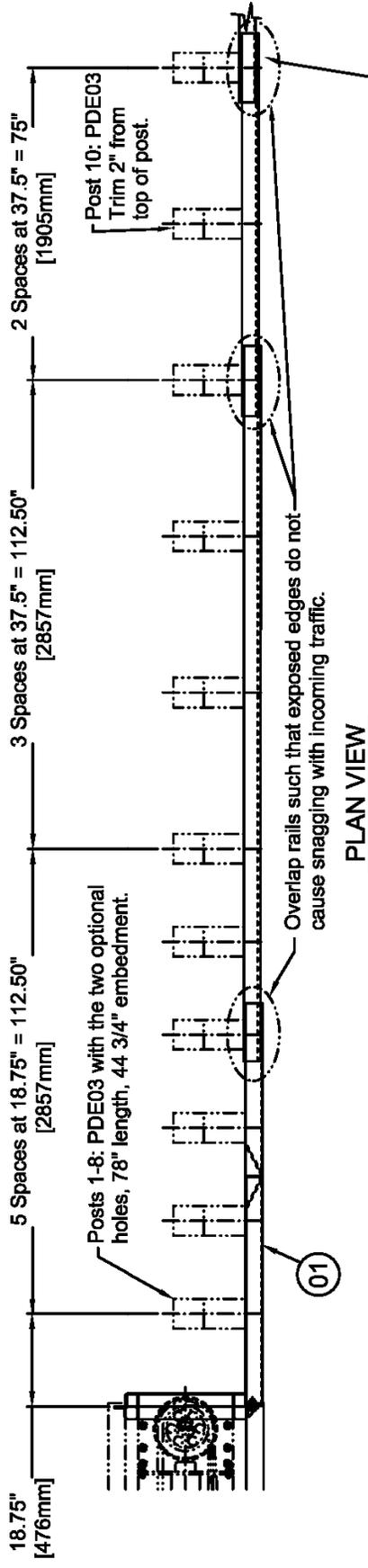
***** GUARDRAIL, POSTS, BLOCKOUTS AND CONNECTION BOLTS SUPPLIED BY OTHERS *****

PARTS LIST
 02 - Hex Bolt 3/4"-10NC x 2"
 03 - Heavy Hex Nut 3/4"-10NC
 04 - Lock Washer 3/4"

Guardrail splice bolts by others. Due to multiple layers, AASHTO FBB02 bolts will be required and a step drill may be required to correct hole alignment.

4-bolts for attachment by others based on the blockout dimensions.

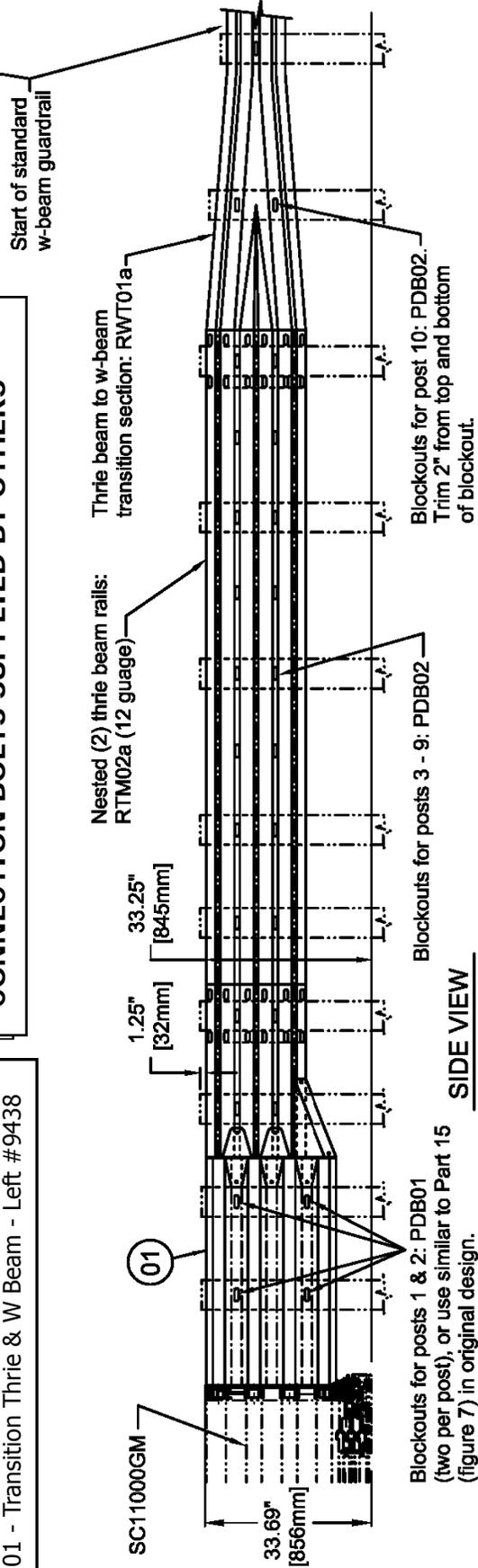
APPENDIX N - TRANSITION, W BEAM
*****FOR USE WITH REVERSE DIRECTION TRAFFIC*****



PLAN VIEW

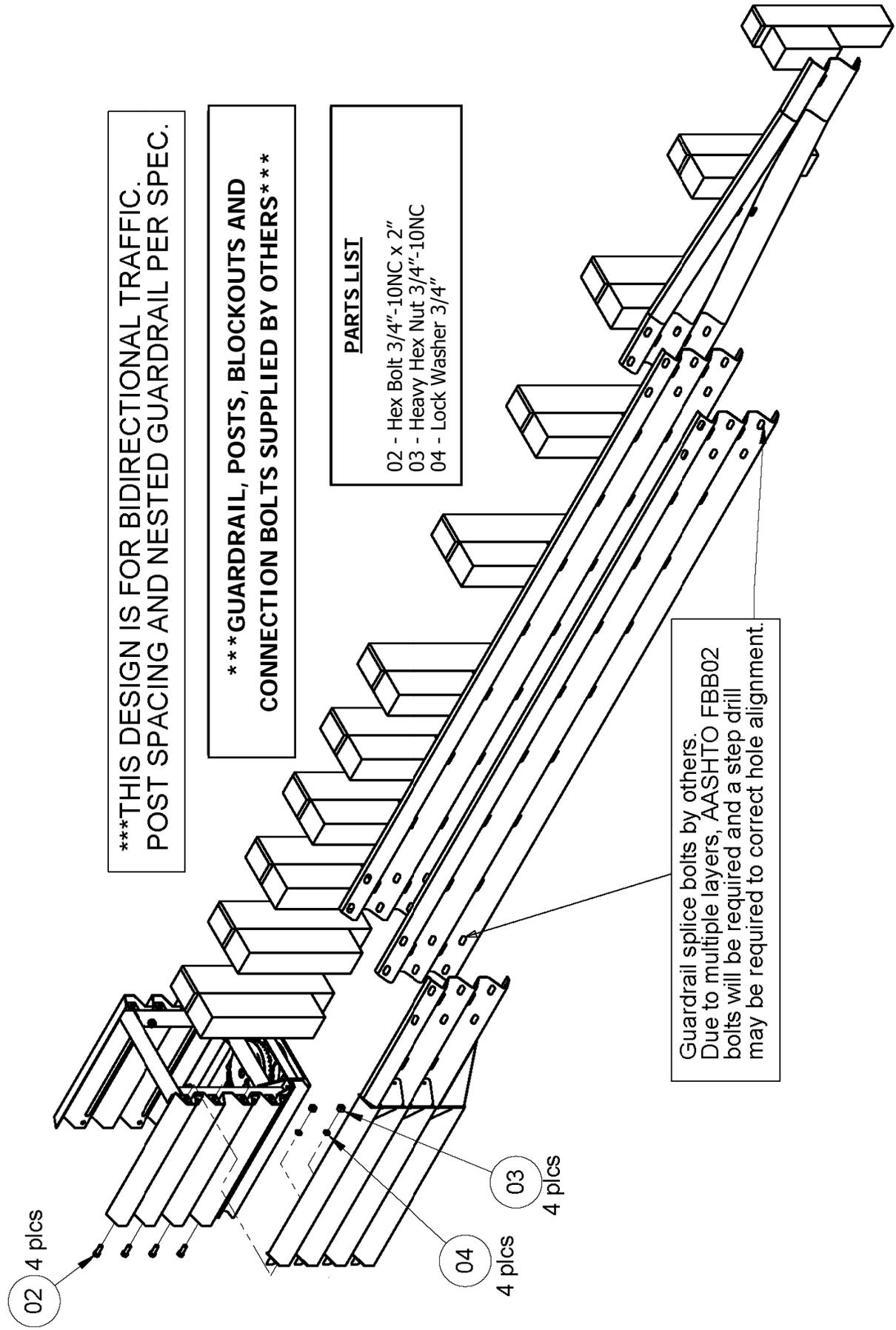
***** GUARDRAIL, POSTS, BLOCKOUTS AND CONNECTION BOLTS SUPPLIED BY OTHERS *****

- PARTS LIST**
- 01 - Transition Thrie & W Beam - Right #9437
 - 01 - Transition Thrie & W Beam - Left #9438



SIDE VIEW

APPENDIX N(2) - TRANSITION, W BEAM



*****THIS DESIGN IS FOR BIDIRECTIONAL TRAFFIC. POST SPACING AND NESTED GUARDRAIL PER SPEC.**

*****GUARDRAIL, POSTS, BLOCKOUTS AND CONNECTION BOLTS SUPPLIED BY OTHERS*****

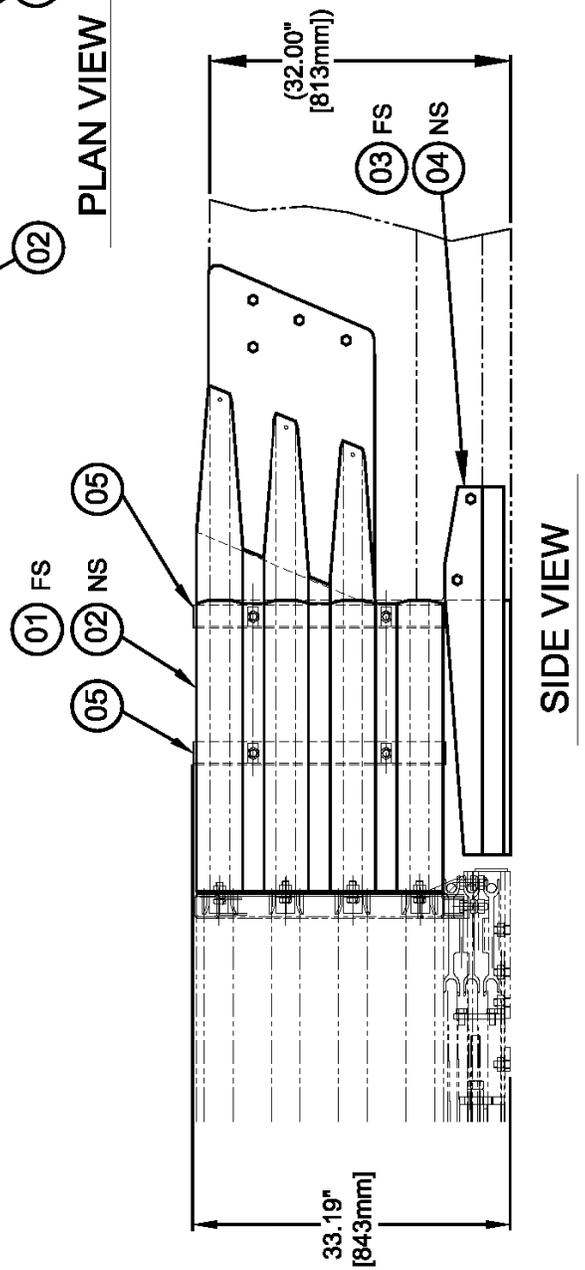
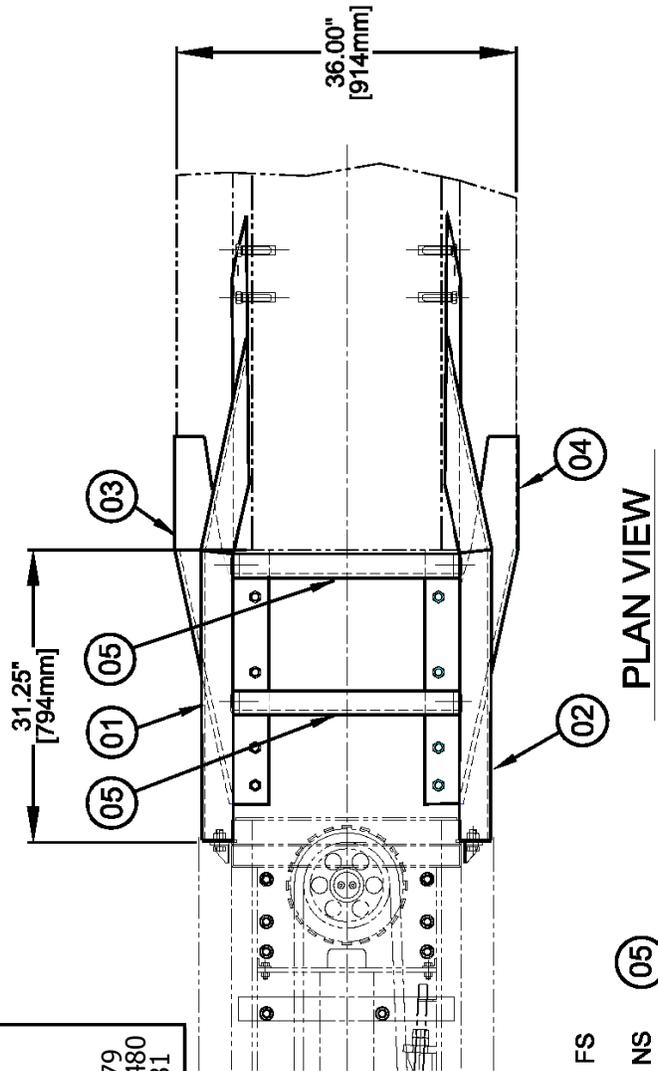
- PARTS LIST**
- 02 - Hex Bolt 3/4"-10NC x 2"
 - 03 - Heavy Hex Nut 3/4"-10NC
 - 04 - Lock Washer 3/4"

Guardrail splice bolts by others. Due to multiple layers, AASHTO FBB02 bolts will be required and a step drill may be required to correct hole alignment.

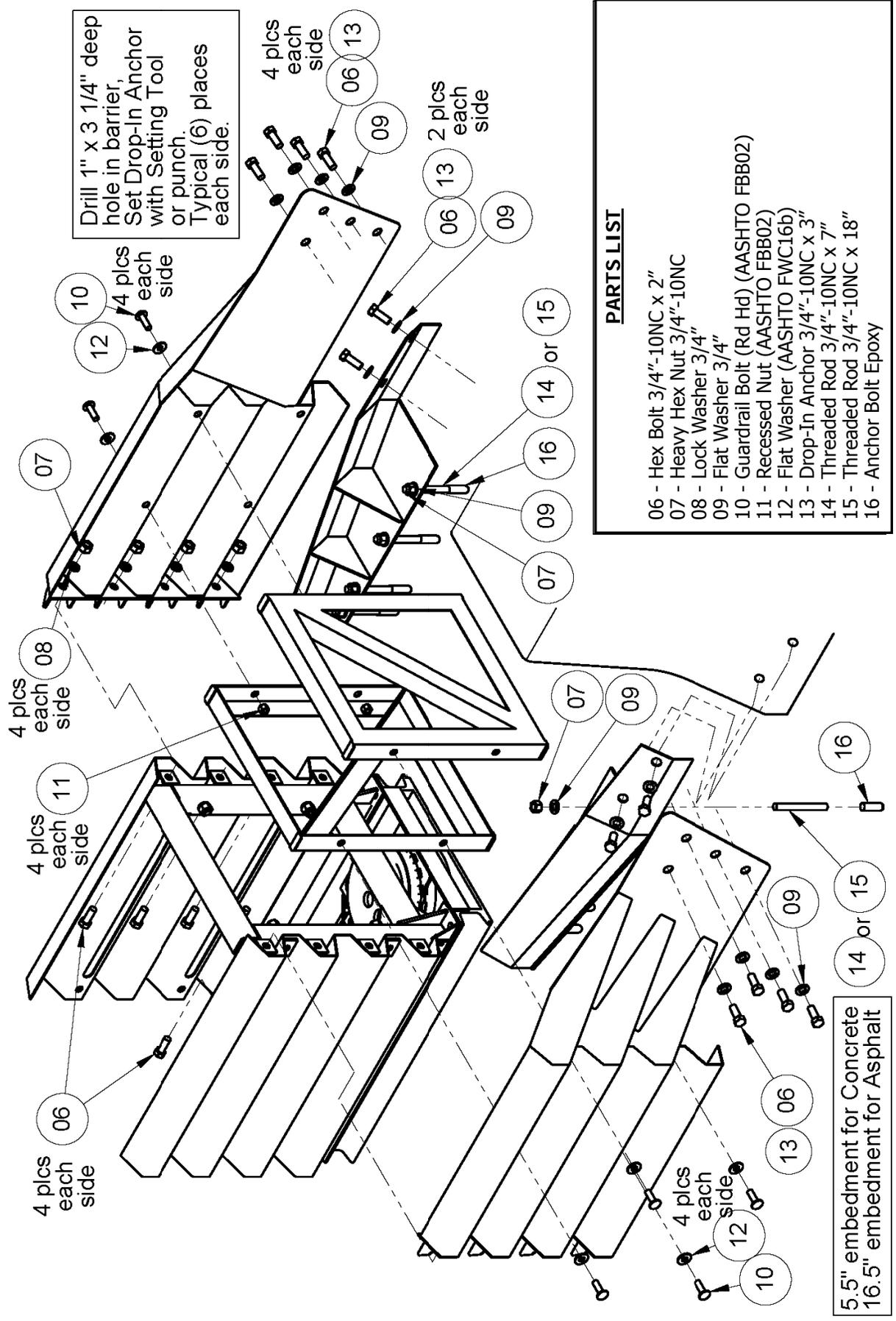
APPENDIX O - TRANSITION, JERSEY/F SHAPE BARRIER - 36 INCH (915mm) BASE X 32 INCH (813mm) TALL

- PARTS LIST**
- Double Sided Median Barrier 36" Base:
 - Two Sided Full Assembly #9492
 - 02 - Transition Median Barrier - Right #9493
 - 01 - Transition Median Barrier - Left #9494
 - 05 - Transition Spanner Brace Median Barrier #9479
 - 04 - Transition Rub Rail Median Barrier - Right #9480
 - 03 - Transition Rub Rail Median Barrier - Left #9481

Barrier width at top can have a variance from 19" - 21"



APPENDIX O(2) - TRANSITION, JERSEY/ F SHAPE BARRIER - 36 INCH (915mm) BASE X 32 INCH (813mm) TALL



- PARTS LIST**
- 06 - Hex Bolt 3/4"-10NC x 2"
 - 07 - Heavy Hex Nut 3/4"-10NC
 - 08 - Lock Washer 3/4"
 - 09 - Flat Washer 3/4"
 - 10 - Guardrail Bolt (Rd Hd) (AASHTO FBB02)
 - 11 - Recessed Nut (AASHTO FBB02)
 - 12 - Flat Washer (AASHTO FWC16b)
 - 13 - Drop-In Anchor 3/4"-10NC x 3"
 - 14 - Threaded Rod 3/4"-10NC x 7"
 - 15 - Threaded Rod 3/4"-10NC x 18"
 - 16 - Anchor Bolt Epoxy

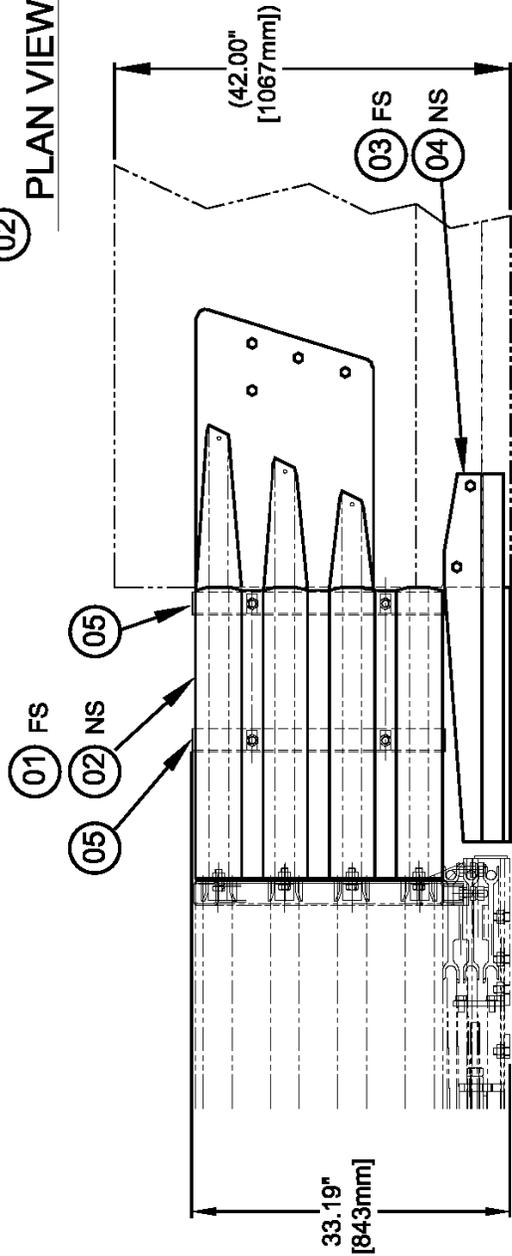
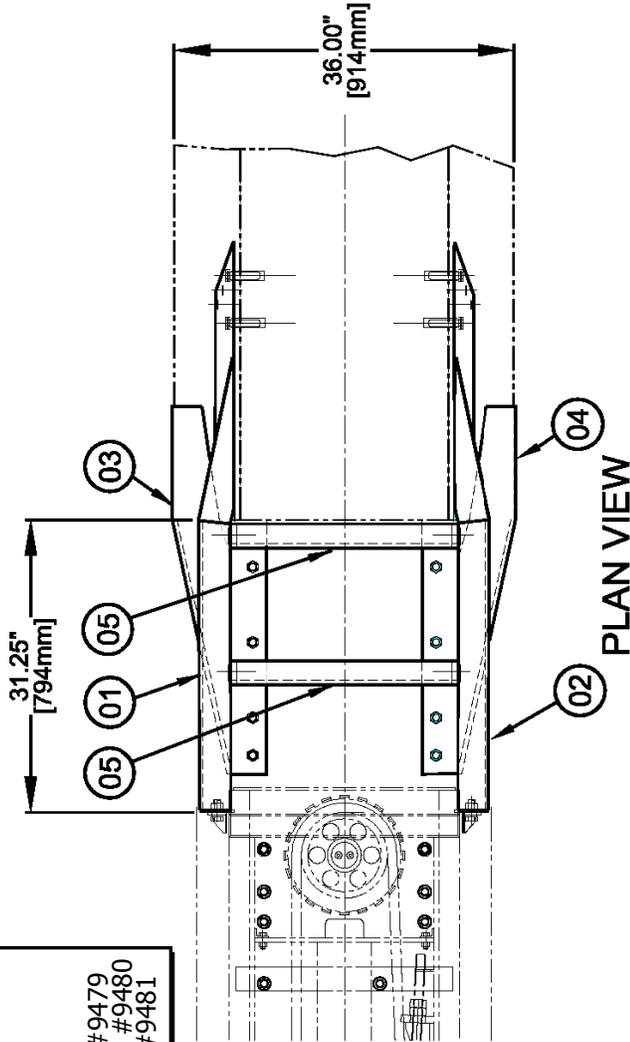
5.5" embedment for Concrete
16.5" embedment for Asphalt

APPENDIX P - TRANSITION, JERSEY/F SHAPE BARRIER - 36 INCH (915mm) BASE X 42 INCH (1067mm) TALL

PARTS LIST

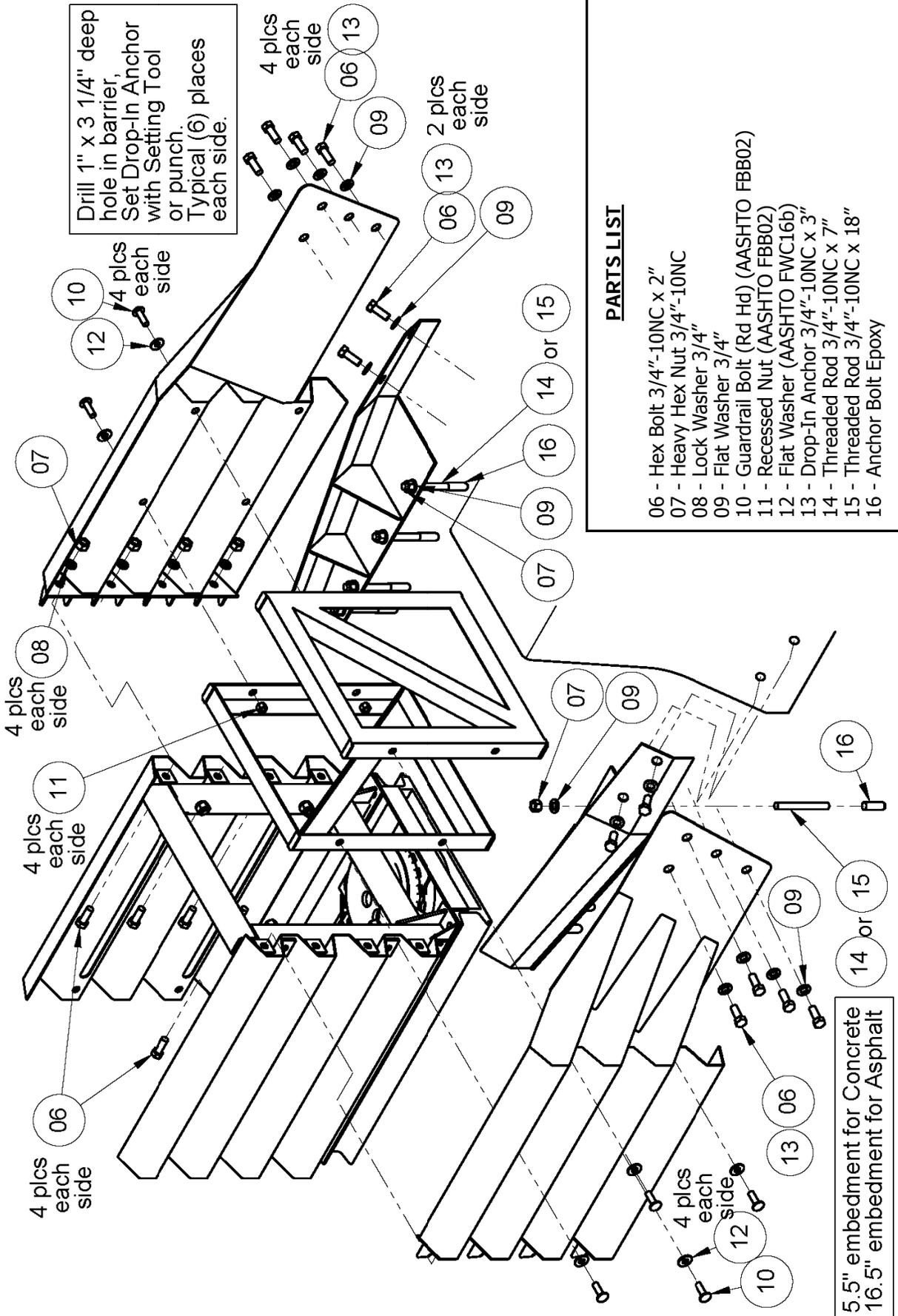
- Double Sided Median Barrier 36" Base:
- Two Sided Full Assembly #9476
- 02 - Transition Median Barrier - Right #9477
- 01 - Transition Median Barrier - Left #9478
- 05 - Transition Spanner Brace Median Barrier #9479
- 04 - Transition Rub Rail Median Barrier - Right #9480
- 03 - Transition Rub Rail Median Barrier - Left #9481

Barrier width at top can have a variance from 19" - 21"



SIDE VIEW

APPENDIX P(2) - TRANSITION, JERSEY/F SHAPE BARRIER - 36 INCH (915mm) BASE X 42 INCH (1067mm) TALL



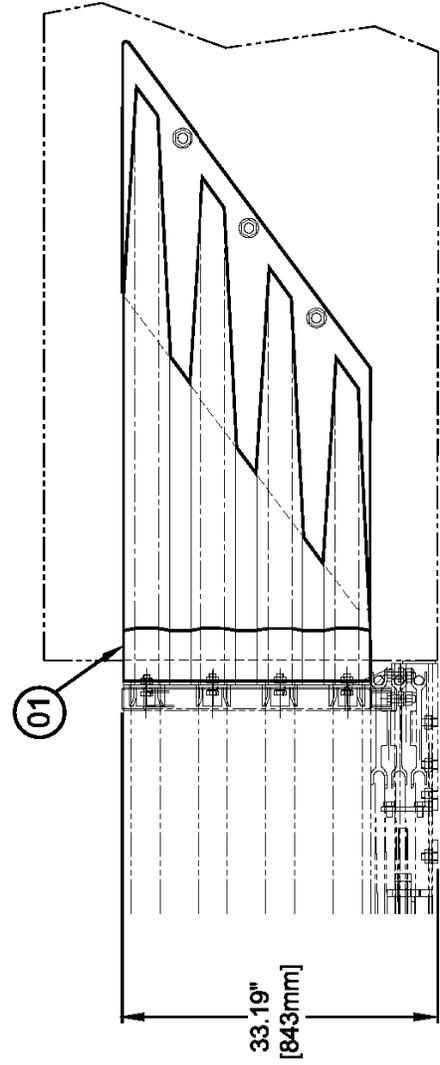
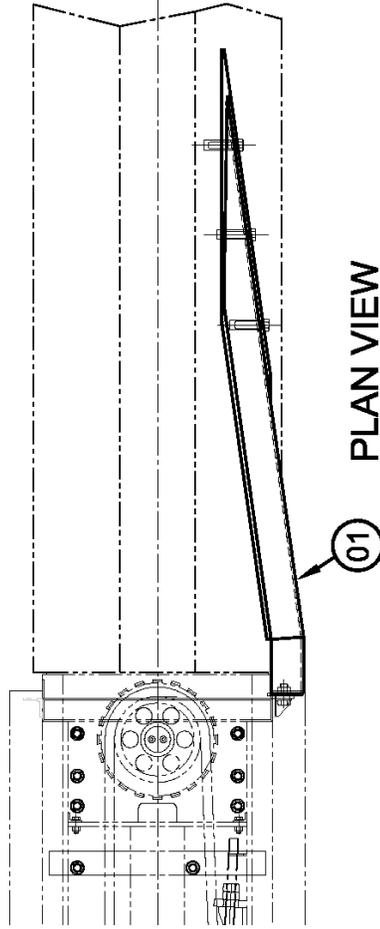
PARTS LIST

- 06 - Hex Bolt 3/4"-10NC x 2"
- 07 - Heavy Hex Nut 3/4"-10NC
- 08 - Lock Washer 3/4"
- 09 - Flat Washer 3/4"
- 10 - Guardrail Bolt (Rd Hd) (AASHTO FBB02)
- 11 - Recessed Nut (AASHTO FBB02)
- 12 - Flat Washer (AASHTO FWC16b)
- 13 - Drop-In Anchor 3/4"-10NC x 3"
- 14 - Threaded Rod 3/4"-10NC x 7"
- 15 - Threaded Rod 3/4"-10NC x 18"
- 16 - Anchor Bolt Epoxy

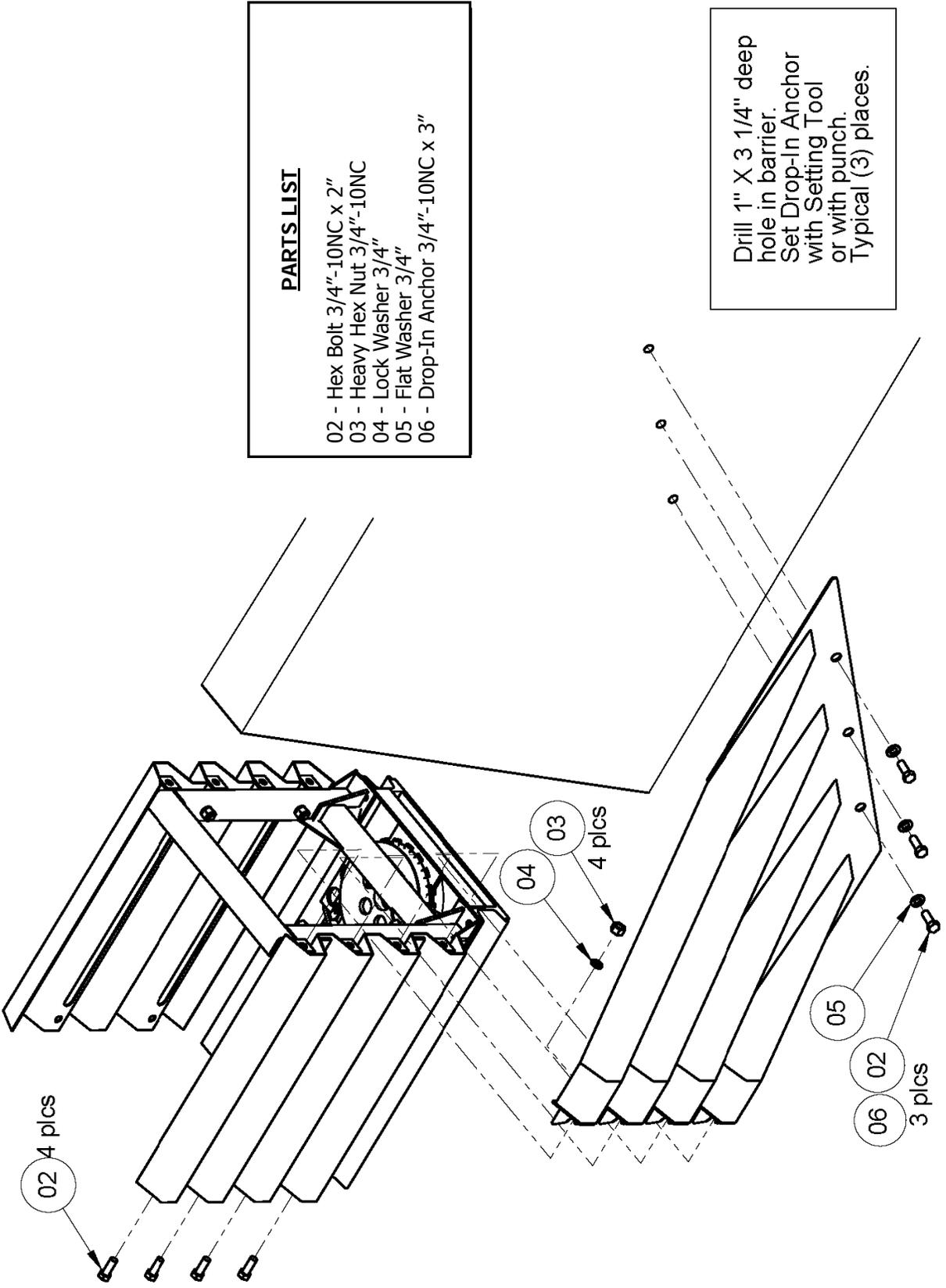
APPENDIX Q - TRANSITION, MEDIAN BARRIER - SINGLE SLOPE

PARTS LIST

- 01 - Transition Single Slope Median Barrier - Right - #9490
- 01 - Transition Single Slope Median Barrier - Left - #9491



APPENDIX Q(2) - TRANSITION, MEDIAN BARRIER - SINGLE SLOPE



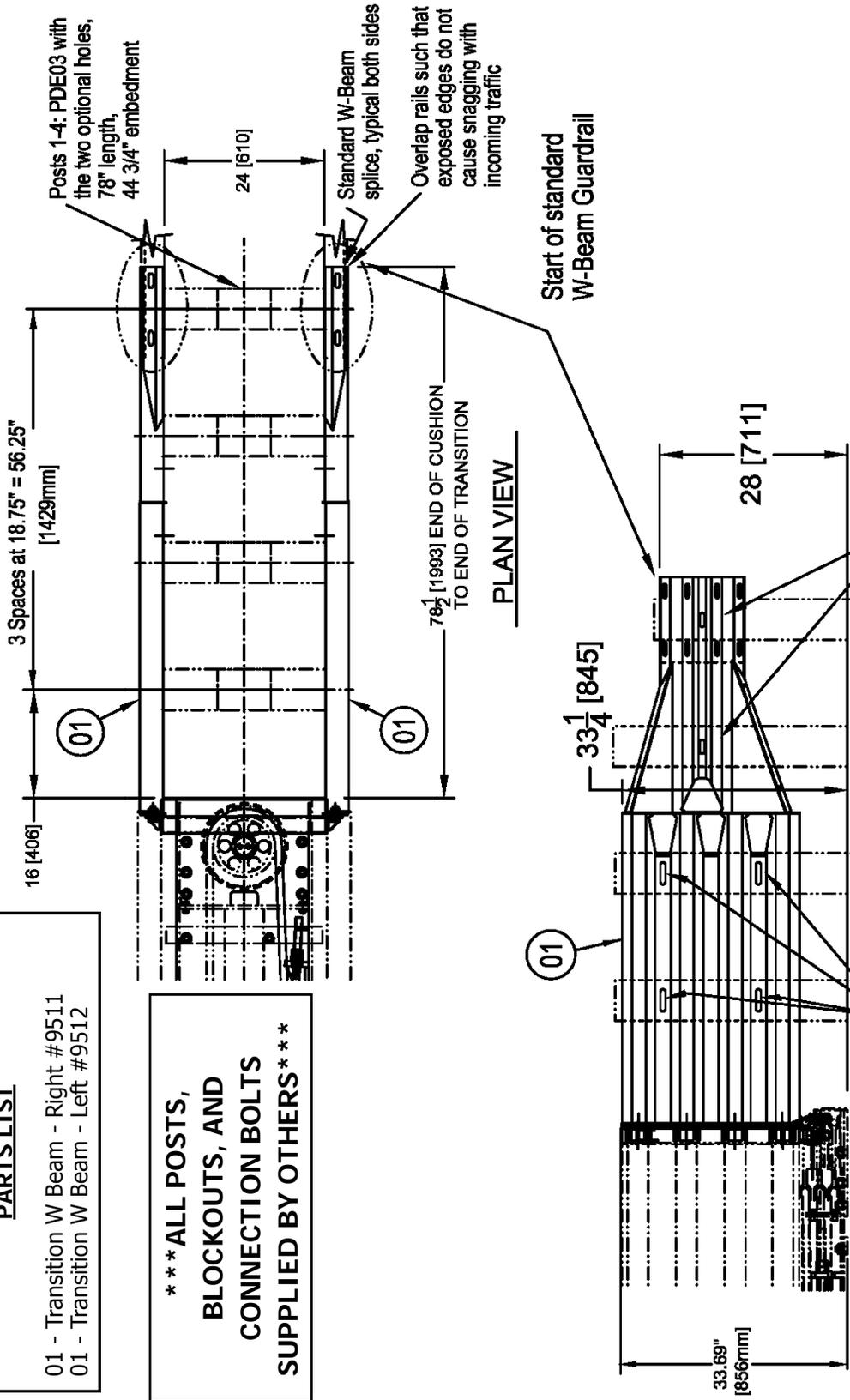
- PARTS LIST**
- 02 - Hex Bolt 3/4"-10NC x 2"
 - 03 - Heavy Hex Nut 3/4"-10NC
 - 04 - Lock Washer 3/4"
 - 05 - Flat Washer 3/4"
 - 06 - Drop-In Anchor 3/4"-10NC x 3"

Drill 1" X 3 1/4" deep hole in barrier. Set Drop-In Anchor with Setting Tool or with punch. Typical (3) places.

APPENDIX R - TRANSITION, W-BEAM 28" HIGH
*****FOR USE WITH NO REVERSE DIRECTION TRAFFIC*****

PARTS LIST
 01 - Transition W Beam - Right #9511
 01 - Transition W Beam - Left #9512

***** ALL POSTS,
 BLOCKOUTS, AND
 CONNECTION BOLTS
 SUPPLIED BY OTHERS *****

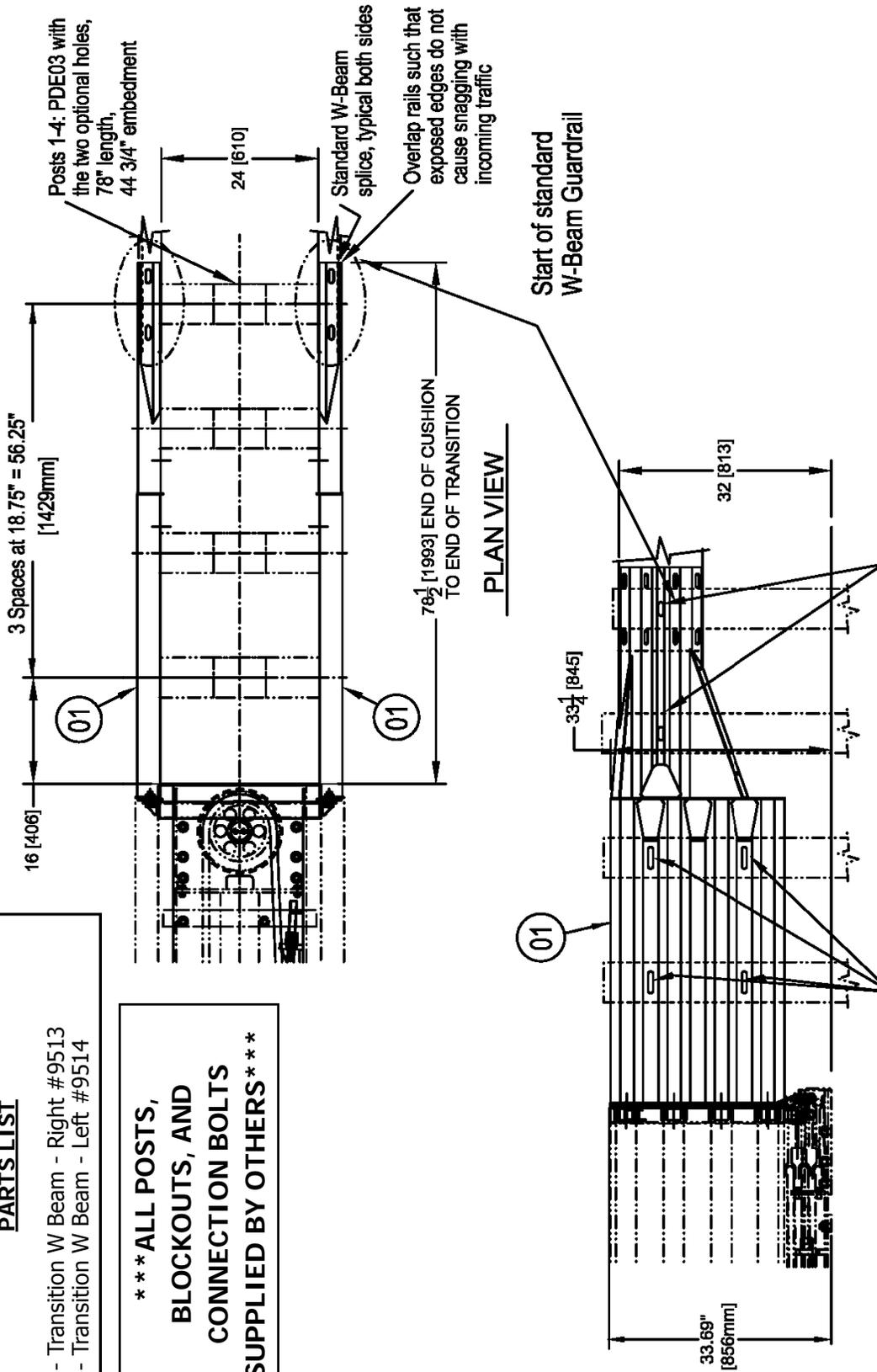


**APPENDIX S - TRANSITION, W-BEAM 32" HIGH
 *** FOR USE WITH NO REVERSE DIRECTION TRAFFIC *****

PARTS LIST

- 01 - Transition W Beam - Right #9513
- 01 - Transition W Beam - Left #9514

***** ALL POSTS,
 BLOCKOUTS, AND
 CONNECTION BOLTS
 SUPPLIED BY OTHERS *****

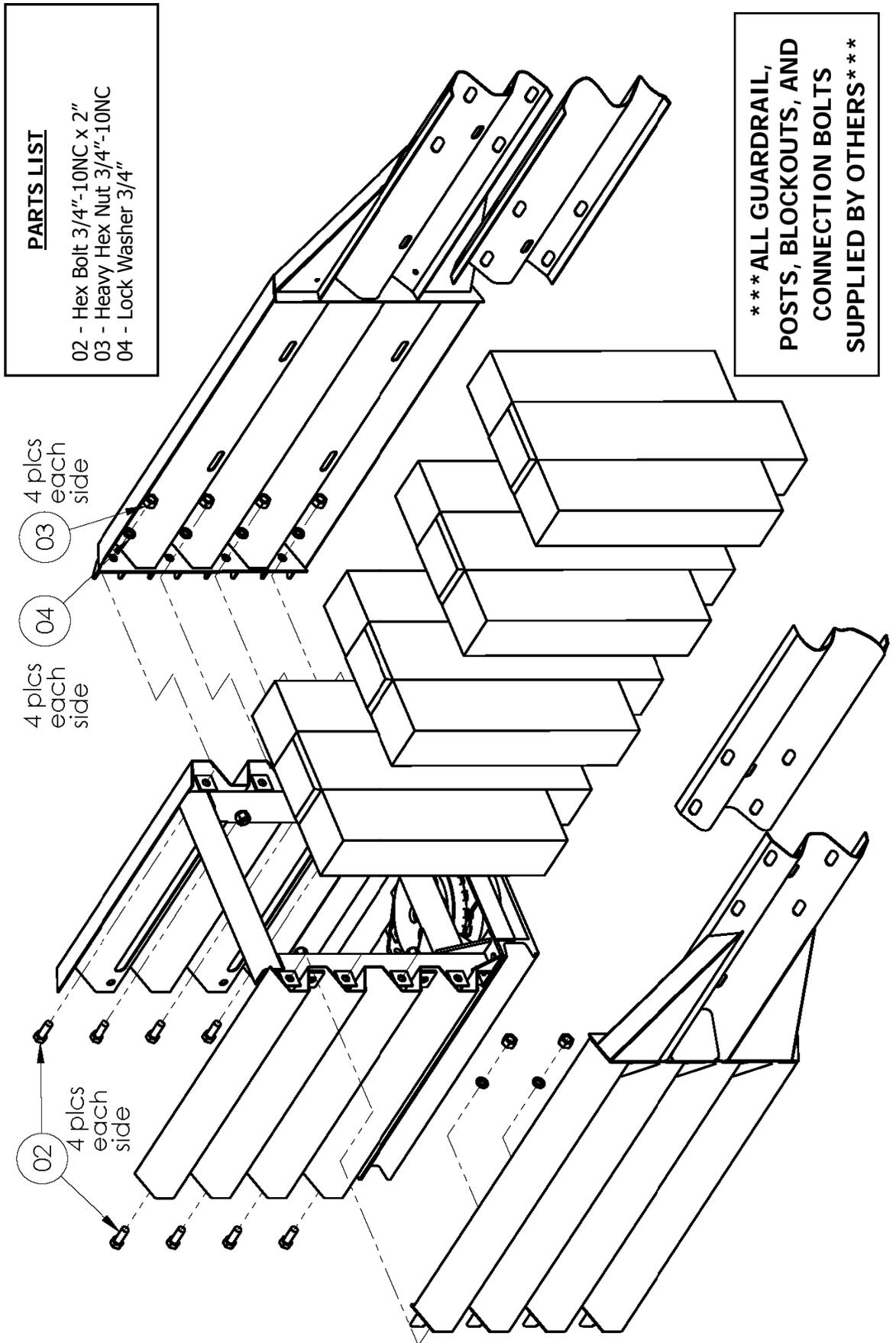


Blockouts for posts 1&2: PDB01 (two per post, ea. side), or use similar to Part 15 (figure 7) in original design.

SIDE VIEW

PLAN VIEW

APPENDIX R(2) & S(2) - TRANSITION, W-BEAM 28" & 32" HIGH





SCI Products Inc.

SCI70/100GM CRASH CUSHION COMMERCIAL 1-YEAR WARRANTY

SCI PRODUCTS INC. warrants this product to be free from defects in material and workmanship under normal use and service for a period of one (1) year beginning on the date of installation. SCI PRODUCTS INC. will repair or replace without charge to the original customer any defective component. This is the sole and exclusive remedy.

This warranty is contingent upon proper use of the System and does not cover Systems that have been modified (including the addition of parts) without the approval of SCI PRODUCTS INC. or which are in need of repair due to damage from external cause, including accident, collision, improper handling, improper transporting, failure to properly maintain the System as recommended by SCI PRODUCTS INC., abuse, misuse or which have been damaged by outside parties not employed by SCI PRODUCTS INC., whether in installation or otherwise.

THIS IS A LIMITED WARRANTY AND IT IS THE ONLY WARRANTY MADE BY SCI PRODUCTS INC. SCI PRODUCTS INC. MAKES, AND CUSTOMER RECEIVES, NO OTHER WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. SCI PRODUCTS INC. SHALL HAVE NO LIABILITY WITH RESPECT TO ITS OBLIGATIONS UNDER THIS WARRANTY FOR CONSEQUENTIAL, EXEMPLARY OR INCIDENTAL DAMAGES EVEN IF IT HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THIS DOCUMENT WITH RESPECT TO THE PRODUCT INDICATED ABOVE. BUYER ACKNOWLEDGES THAT ANY STATEMENTS MADE WHICH ARE NOT FOUND IN THIS DOCUMENT ARE NOT PROMISES TO BE RELIED UPON.

THE BUYER AGREES TO INSPECT THE PRODUCT ON RECEIPT AS FULLY AS THE BUYER DESIRES AND TO NOTIFY SCI PRODUCTS INC. OF ANY REVEALED DEFECT.



Work Area Protection

QuadGuard® Elite



*An Ideal Crash Cushion for Rigid Hazards
in High Frequency Impact Areas*



Corporate Offices:
35 East Wacker Dr., 11th Floor
Chicago, IL 60601-2076
Telephone: (312) 467-6750
FAX: (312) 467-1356
<http://www.energyabsorption.com/>

Engineering and Manufacturing Facilities:
Rocklin, CA
Pell City, AL

Saving Lives By Design

Installation Manual

QuadGuard® Elite

Table of Contents

Important Introductory Notes	2
System Overview	3
Crash Performance	3
Installation	4
Required Tools	4
How to Determine Left/Right	6
Counting the Number of Bays	6
Measuring The Width	6
QuadGuard® Elite for Narrow Hazards	7
Site Preparation/Foundation	8
Inspect Shipping	9
Installation Procedures	9
QuadGuard® Elite for Wide Hazards	27
Site Preparation/Foundation	28
Inspect Shipping	29
Installation Procedures	29
MP-3® Polyester Anchoring System	46
Vertical Installations	46
Horizontal Installations	48
MP-3® Installation Cautions	49
Maintenance	50
Frequency	50
Visual Drive-By Inspection	50
Walk-Up Inspection	50
Maintenance Checklist	50
Tools Required	52
Post-Impact Instructions	52
Restoring Collapsed Systems	54
Parts Ordering Procedure	55
Maintenance Flow Chart	58
Limitations and Warnings	61

Important Introductory Notes

The purpose of this manual is to provide assembly, installation and maintenance instructions for the QuadGuard Elite. Please acquire the proper installation drawings from the manufacturer to use in conjunction with this manual prior to installing a QuadGuard Elite.

Proper installation of the QuadGuard Elite is essential to assure maximum performance. Take the time to review this manual including “Limitations and Warnings” on page 61 thoroughly before performing the necessary work. **Do not attempt to install the QuadGuard Elite without the proper plans and a thorough review of this installation manual.**

If you need additional information, or have questions about the QuadGuard Elite, please call: Energy Absorption Systems, Inc. Customer Service Department at (888) 323-6374 or your local Energy Absorption Systems distributor.

When reading this manual, please note the following:

WARNING!

Indicates a situation that **will** cause physical and/or property damage.

Caution: Indicates a situation that **could** possibly cause physical and/or property damage.

Note: Indicates a matter of interest or clarification.

QuadGuard® Elite

System Overview

The QuadGuard Elite is a highly efficient, reusable, redirective, non-gating crash cushion for hazards ranging in width from 610 mm to 2285 mm (24" to 90"). It consists of high molecular weight, high density polyethylene (HMW/HDPE), energy-absorbing cylinders surrounded by a framework of Quad-Beam™ panels.

The QuadGuard Elite utilizes three types of cylinders in a "staged" configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the System length to be tailored to the design speed of a site.

Crash Performance

The 5 bay and 7 bay EC QuadGuard Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 2 tests with both the light car and pickup at speeds of up to 70 km/h [43 m.p.h.] at angles up to 15 degrees.

The EC designation on the 7 bay system stands for "Extra Capacity". This System has additional energy absorbing capacity compared to the 5 bay system.

The 8 bay and 11 bay EC QuadGuard Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 m.p.h.] at angles up to 15 degrees.

The EC designation on the 11 bay system stands for "Extra Capacity". This system has additional energy absorbing capacity compared to the 8 bay EC system.

The 14 bay 24", 30" and 36" wide QuadGuard Elite have successfully been tested with the pickup at speeds up to 115 km/h [70 m.p.h.].

During head-on impacts, the QuadGuard Elite telescopes rearward to absorb the energy of impact. When impacted from the side, it safely redirects the vehicle back toward its original travel path and away from the hazard.

A wise choice...

because most of the QuadGuard Elite is reusable. After a typical design speed, head-on hit, the majority of the System is reusable. The System usually needs only to be pulled back into place. Design speed impacts typically result in no damage to the structural hardware.

because the QuadGuard Elite is available in several widths. It can fit in places where other crash cushions cannot fit. The QuadGuard Elite is available in the following five widths 610 mm [24"], 760 mm [30"], 915 mm [36"], 1755 mm [69"] and 2285 mm [90"].

because the QuadGuard Elite is redirective. It is designed to redirect vehicles that hit the System along the side, rather than allowing them to gate through.

because the QuadGuard Elite is crush efficient. Cylinders offer exceptional energy absorbing efficiency. The QuadGuard Elite is available in three different lengths. Therefore a System length may be chosen which will offer the best size/efficiency ratio of any impact attenuator. Thus, the shortest System possible for a given design speed can be installed. This increases driver decision distance and reduces the likelihood of the System being hit.

QuadGuard® Elite

Installation

Required Tools

Documentation

- Manufacturer's installation manual
- Manufacturer's drawing package

Cutting equipment

- Rebar cutting bit
- Concrete drill bits - 22 mm [7/8"] (*Two Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill motor
- Drill Bits: 1/16" through 7/8"

* Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing the MP-3 anchoring system.

Hammers

- Rotohammer
- Sledgehammer
- Standard hammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/2" drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2" drive Deep sockets: 15/16", 1 1/4"
- 1/2" drive Ratchet and attachments
- 1/2" drive Breaker bar - 24" long
- 1/2" drive Torque wrench: 200 ft-lbs.
- Crescent wrench: 300 mm [12"]
- Allen wrench: 3/8"
- Impact Wrench: 1/2"

Personal protective equipment

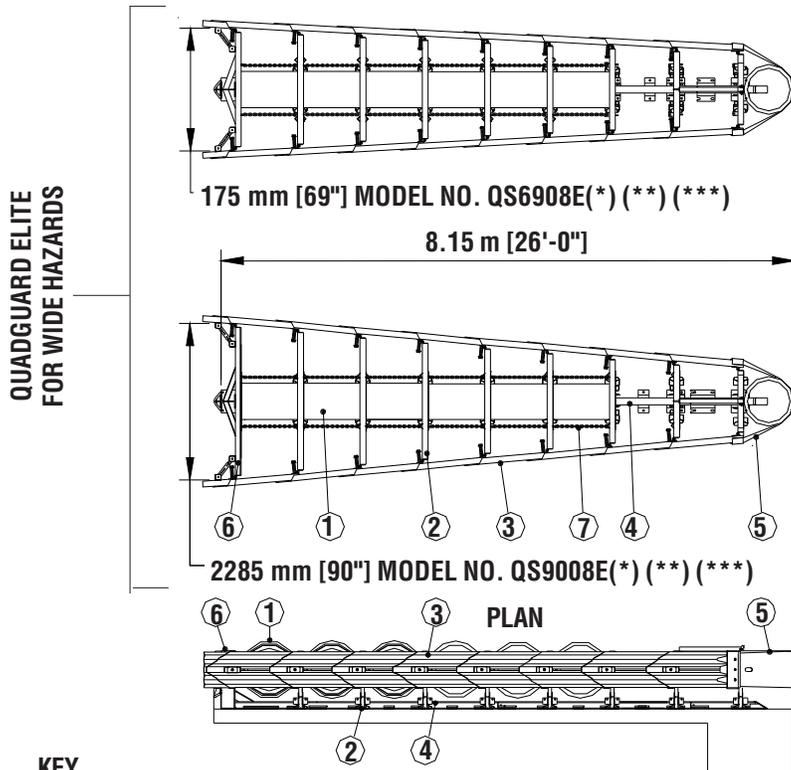
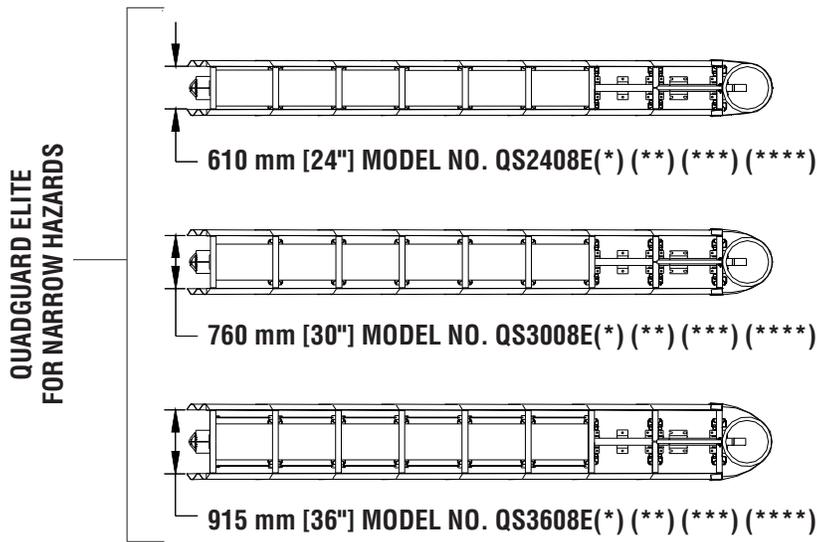
- Safety Glasses
- Gloves

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Compressor (100 psi) and Generator (5 KW)
- Long pry bar
- Drift pin 300 mm [12"]
- Center punch
- Tape measure 7.5 m [25']
- Chalk line
- Concrete marking pencil
- Nylon bottle brush for cleaning 7/8" drilled holes
- Rags, water, and solvent for touch-up
- Chain, 3/8" grade 40, 6 m [20'] with 13 mm [1/2"] hooks
- Acetylene torch

Note: *The above list of tools is a general recommendation. The actual number of tools required will depend on specific site conditions and the complexity of the installation.*

QuadGuard® Elite



KEY

- 1) ENERGY-ABSORBING CYLINDER
- 2) DIAPHRAGM
- 3) QUAD-BEAM™ FENDER PANEL
- 4) MONORAIL
- 5) NOSE COVER
- 6) BACKUP
- 7) CHAIN ASSY

ELEVATION

- * ALSO AVAILABLE IN 5 BAY LENGTHS
- ** ALSO AVAILABLE IN 7 BAY LENGTHS (EC MODEL)
- *** ALSO AVAILABLE IN 11 BAY LENGTHS (EC MODEL)
- **** ALSO AVAILABLE IN 14 BAY LENGTHS

Figure 1
Plan & Elevation

QuadGuard® Elite

Installation (cont'd.)

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the System facing the hazard. Your left is the System's left and your right is the System's right.

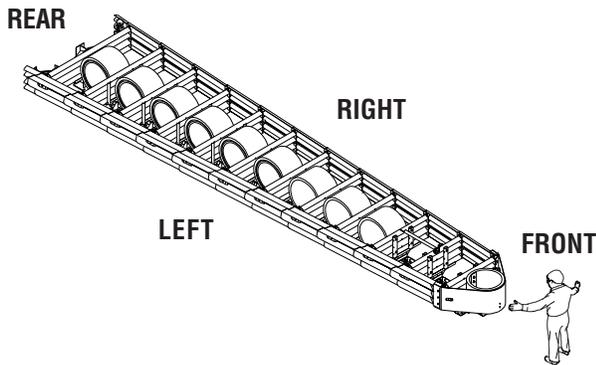


Figure 2
Left/Right

Counting the Number of Bays

One Bay consists of one Diaphragm, two Fender Panels, etc. The Nose section is not considered a Bay (see figure 3).

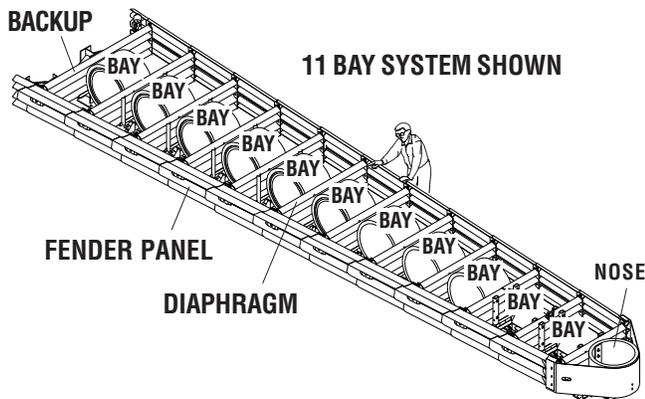


Figure 3
Number of Bays

Measuring The Width

The QuadGuard® Elite System is available in the following sizes.

System Width	5 Bay 70 km/h [43 mph]	7 Bay EC 85 km/h [53 mph]	8 Bay 100 km/h [62 mph]	11 Bay EC 105 km/h [65 mph]	14 Bay 115 km/h [72 mph]
610mm [24"]	QS2405E	QS2407E	QS2408E	QS2411E	QS2414E
760mm [30"]	QS3005E	QS3007E	QS3008E	QS3011E	QS3014E
915mm [36"]	QS3605E	QS3607E	QS3608E	QS3611E	QS3614E
1755mm [69"]	QS6905E	QS6907E	QS6908E	QS6911E	Not Available
2285mm [90"]	QS9005E	QS9007E	QS9008E	QS9011E	Not Available

The nominal width of the Tension Strut backup is the width between side panels behind the backup (see figure 4). The outside width of the System is approximately 150 mm [6"] to 230 mm [9"] wider than this measurement.

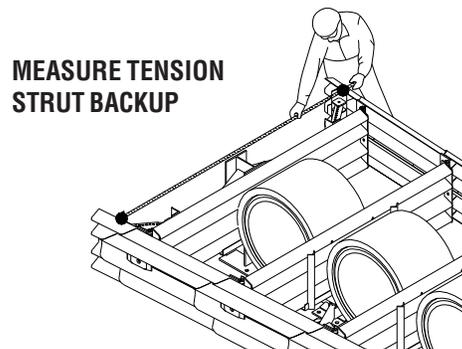
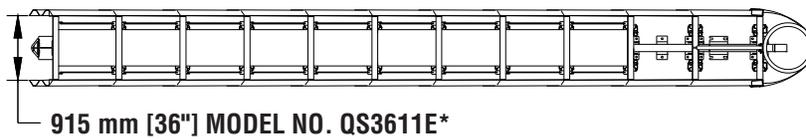
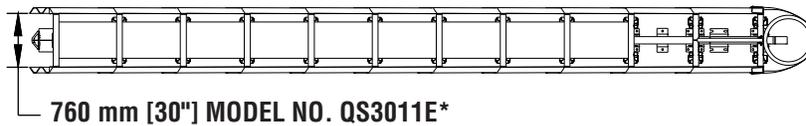
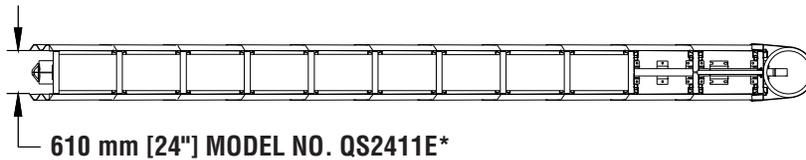


Figure 4
Tension Strut Backup Width

QuadGuard[®] Elite

QuadGuard[®] Elite for Narrow Hazards



* Also available: QS2405E, QS2407E, QS2408E, QS2414E,
QS3005E, QS3007E, QS3008E, QS3014E,
QS3605E, QS3607E, QS3608E, QS3614E

QuadGuard® Elite

Installation for Narrow Hazards

Site Preparation/Foundation

A QuadGuard Elite should be installed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete pads are provided in Energy Absorption Systems, Inc. concrete pad drawing, supplied with the System. The System may be installed on a non-reinforced concrete roadway (minimum 200 mm [8"] thick). Installation cross slope shall not exceed 8% and should not twist more than 2% over the length of the System; the pad surface shall have a light broom finish.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

WARNING!

Location of the backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the fender panels telescope toward and extend beyond the rigid backup as much as 635 mm [25"] from their pre-impact location. Position the backup so that the rear ends of the last fender panels are a minimum of 635 mm [25"] forward of objects that would otherwise interfere with movement of the panels. Failure to comply with this requirement may result in impaired system performance offering motorists less protection and causing component damage.

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

Inspect Shipping

Before installing the QuadGuard Elite, check the received parts against the shipping list supplied with the System. Make sure all parts have been received.

Installation Procedures

Note: The Drawing Package supplied with the QuadGuard Elite must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup & Transition Type

The QuadGuard Elite uses a Tension Strut Backup.

A transition panel or side panel must be used on each side of the backup. A side panel is not needed when a transition panel is used. Several types of transitions are available for use with the QuadGuard Elite. Refer to Figures 7 through 11 and the drawing package to determine which type of panel to install.

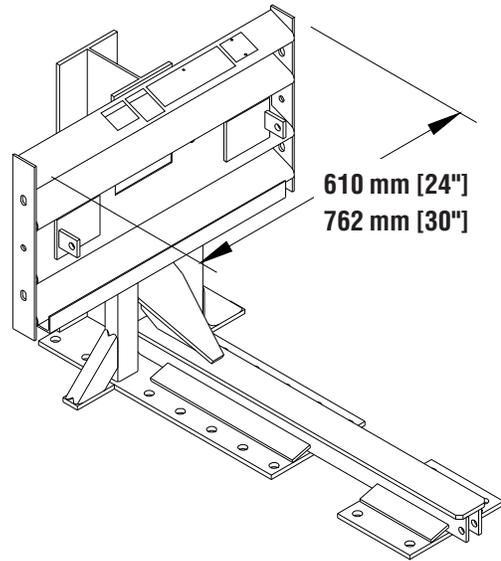


Figure 5
Tension Strut Backup

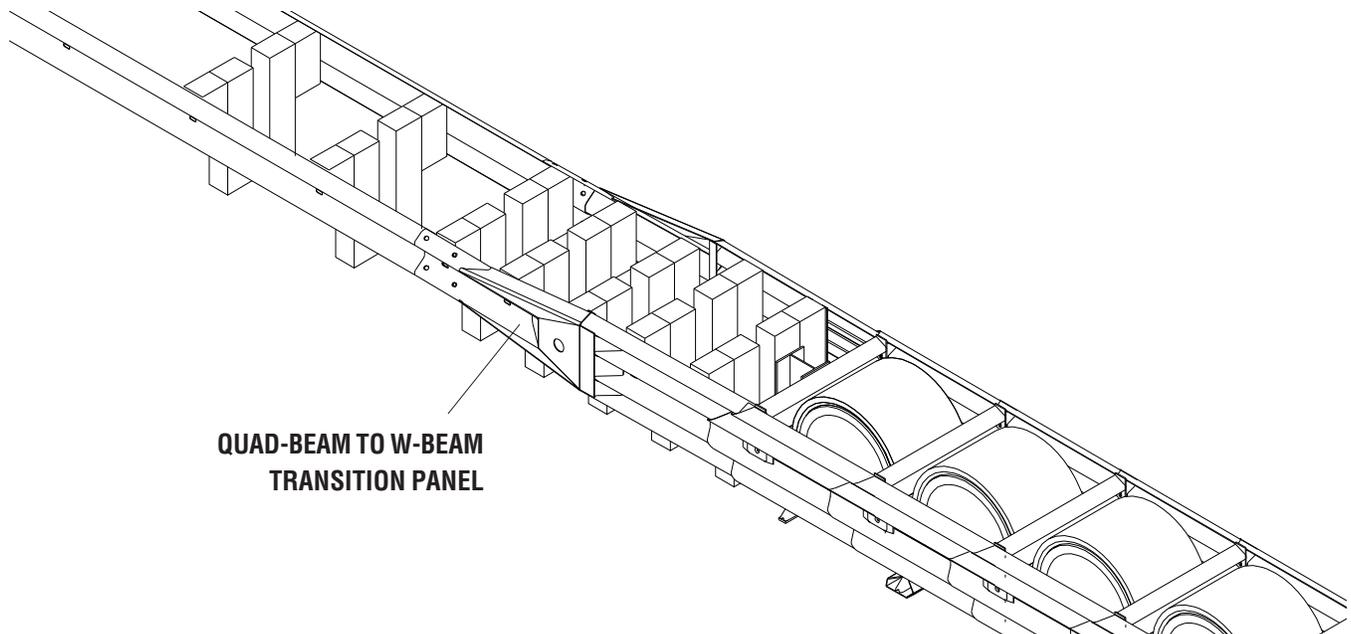


Figure 6
Transitioning the QuadGuard® Elite

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)



Figure 7
Side Panel

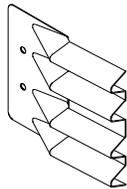


Figure 8
Quad-Beam™ End Shoe

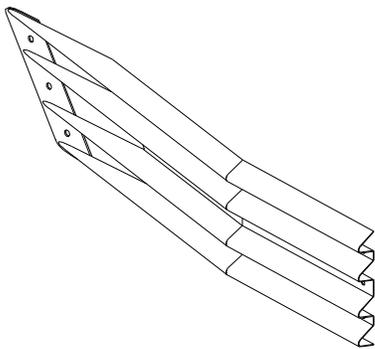


Figure 9
Quad-Beam to Safety Shape Barrier Transition Panel

Transition and Side Panel Types

Note: The proper transition or side panel must be used for optimum impact performance of the System. The correct panel to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard® Elite is shielding. Contact the Customer Service Department prior to installation if you have any questions.

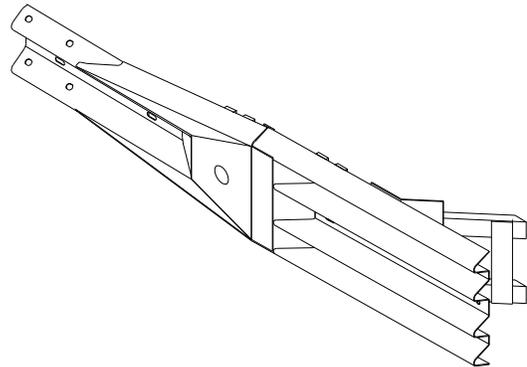


Figure 10
Quad-Beam to W-Beam Transition Panel

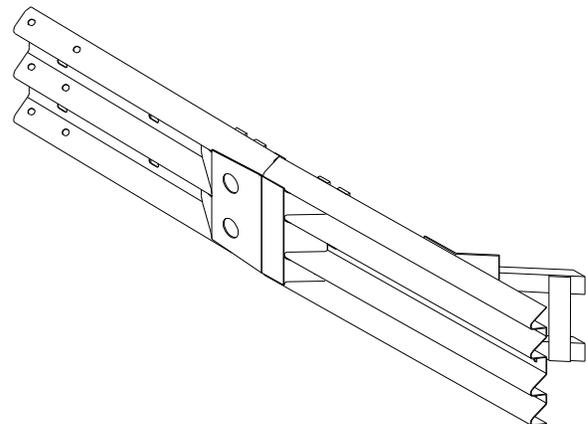


Figure 11
Quad-Beam to Thrie-Beam Transition Panel

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

2) Mark System Location

Locate the centerline of the System by measuring the proper offset from the hazard. Refer to the drawing package supplied with the System. Place chalk line to mark the centerline of the System. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 12. The edge of the monorail will be placed on this line.

Note: The concrete pad should be installed per the project plans supplied with the System.

WARNING!

Location of System with respect to the hazard is critical and dependent on the type of transition panel used. See the project plans supplied with the System for details.

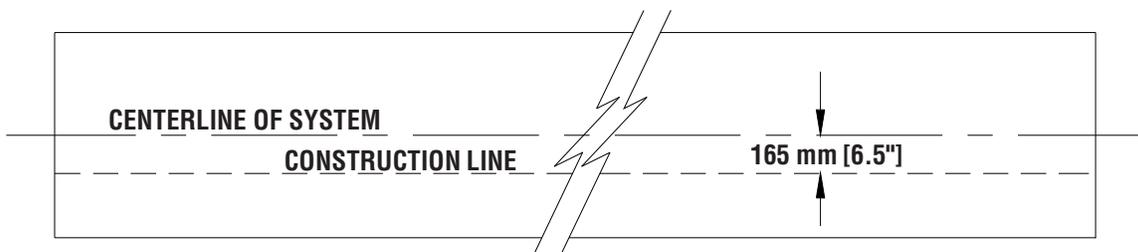


Figure 12
(Top view of concrete pad)
Locating Construction Line

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

3) Anchor the Backup and monorail

Refer to Figure 13 (showing backup assembly) and Figure 14 (showing monorail installation). Also refer to the drawing package, and the MP-3® Polyester Anchoring System Instructions included with this manual.

A) Tension Strut Backup Installation (Figure 13)

Locate the backup and monorail on the pad with the side of the monorail on the construction line (Figure 15). Verify that applicable transition panels fit properly before anchoring the backup. Drill 140 mm [5 1/2"] deep anchor holes in the pad using the backup as a template. Do not drill through pad. Anchor the backup to the concrete pad using the MP-3® vertical kits provided. See "MP-3 Polyester Anchoring System", page 46.

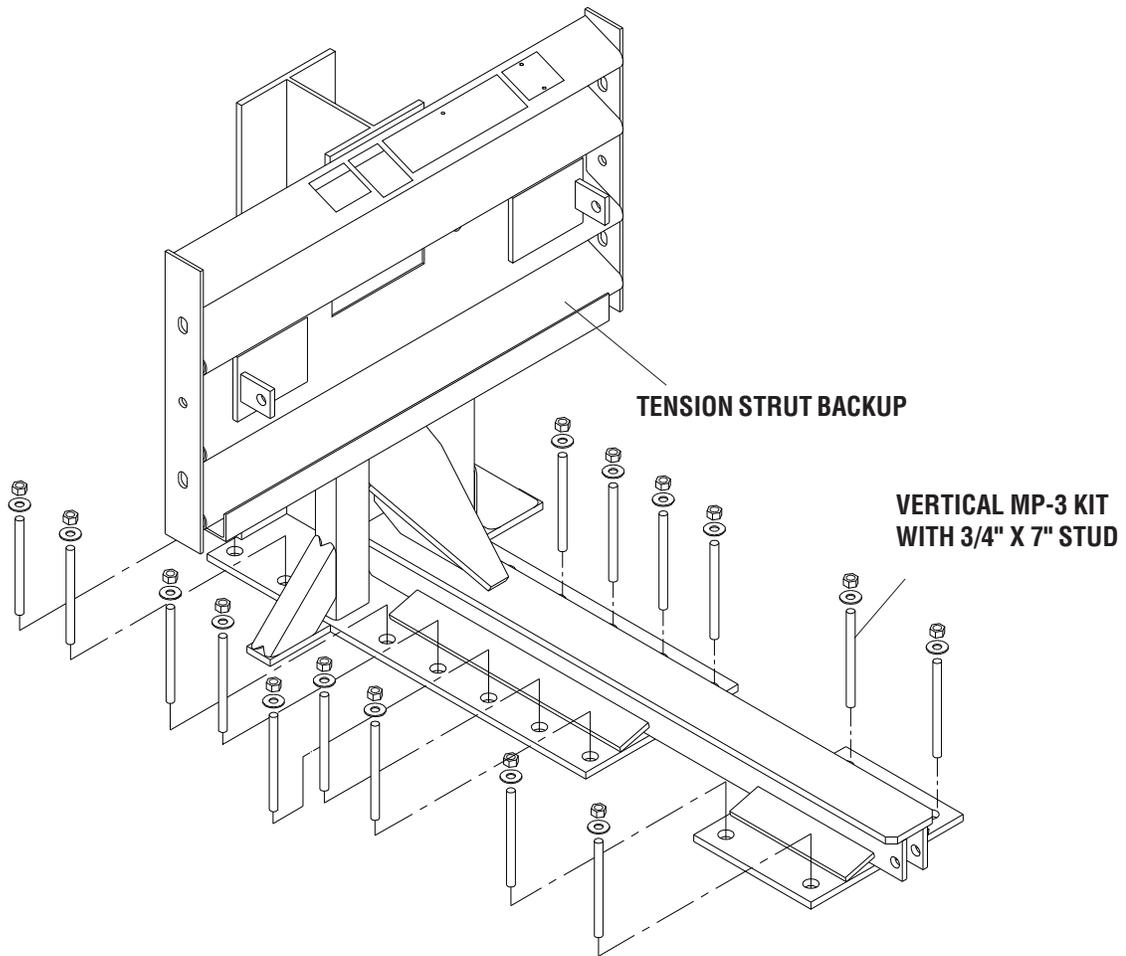


Figure 13

Anchoring Tension Strut Backup to Foundation

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

B. Monorail installation

Locate the monorail on the construction line as shown in the monorail assembly drawings. Drill 140 mm [5 1/2"] deep anchor holes using the monorail as a template (see figure 15). Do not drill through pad. Anchor each monorail section using the MP-3 vertical kits provided. Refer to Figure 15 and the MP-3 Polyester Anchoring System Instructions included with this manual. **It is important to install each segment of monorail in alignment from the back to the front of the System (+/- 6 mm [1/4"])**.

WARNING!

Improper alignment at the monorail splice joints will prevent proper System collapse during an impact.

WARNING!

Every hole and slot in backup and monorail must have an MP-3 stud anchoring it.

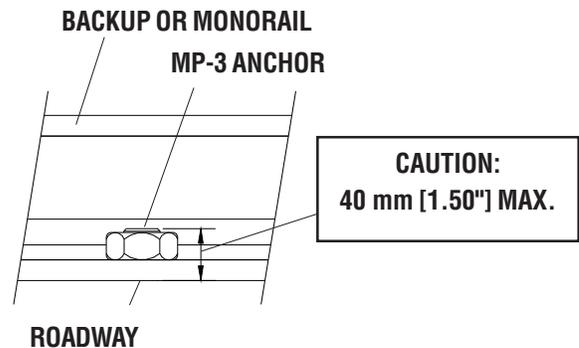


Figure 14
Proper Stud Height

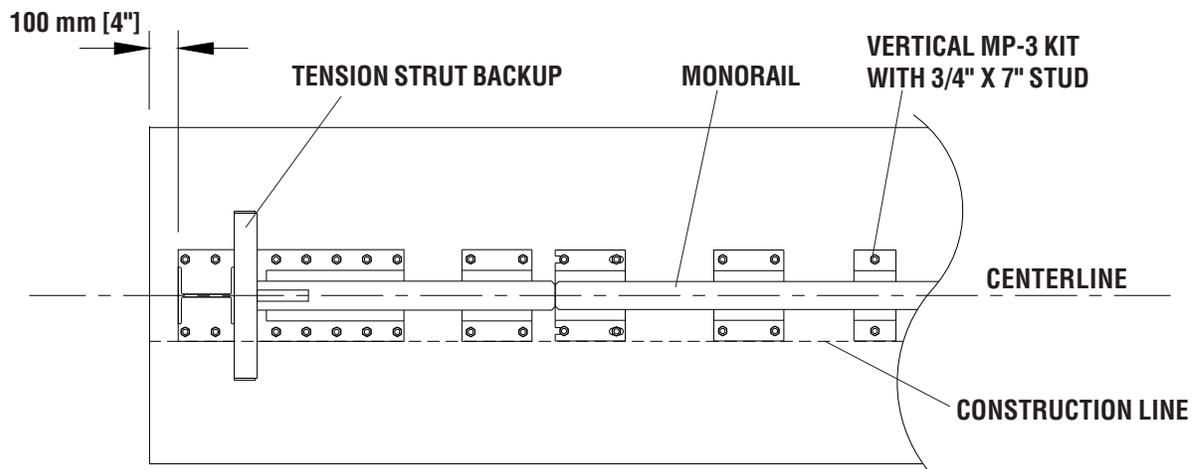


Figure 15
Backup and Monorail Location
for Tension Strut Backup

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

4) Install Side Panels / Transition Panels to Backup Assembly

Attach the transition panel or side panel as appropriate to each side of the backup. Refer to Figure 16 and the drawing package for more information.

Note: A side panel is not needed when a transition panel is used.

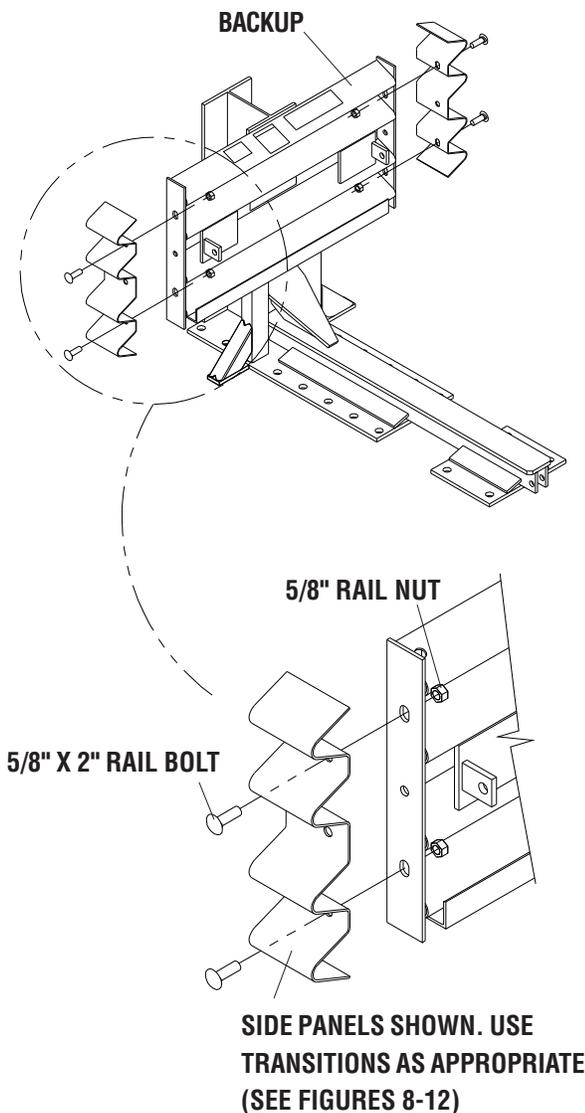


Figure 16

Side Panel/Transition Panel Assembly

5) Attach Monorail Guides

Attach monorail guides to diaphragms as shown in Figure 17, and the diaphragm assembly drawing.

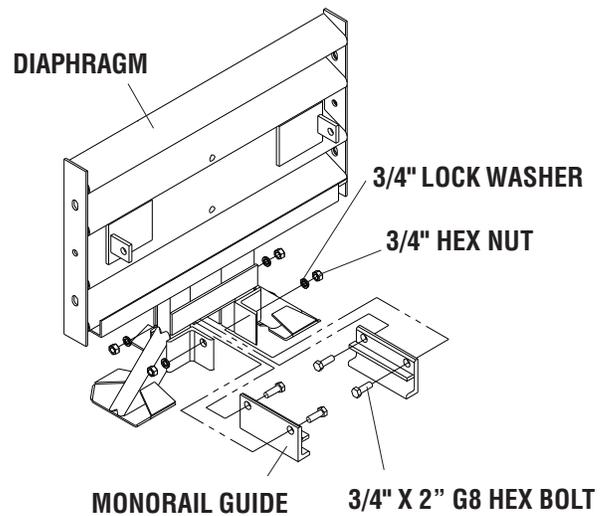


Figure 17

Monorail Guide Attachment

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

6) Install Diaphragms

Orient a diaphragm so that the front face of the Quad-Beam shape faces toward the nose of the System as shown in Figure 18. Slide one diaphragm all the way to the backup to ensure the System is able to collapse properly during impact. Once this has been verified, slide the diaphragm forward to approximately 915 mm [36"] in front of the backup. Orient and slide all other diaphragms (except the first three) onto monorail and position each approximately as shown in Figure 19.

Diaphragms 1, 2 & 3 each have bumpers attached to them. Orient diaphragms 3, 2 & 1 with the bumpers as shown in Figure 19 and the front face of the Quad-Beam shape facing toward the nose of the System as shown in Figures 18 and 19.

Slide diaphragms 3, 2 & 1 onto the monorail and space as shown in Figure 19.

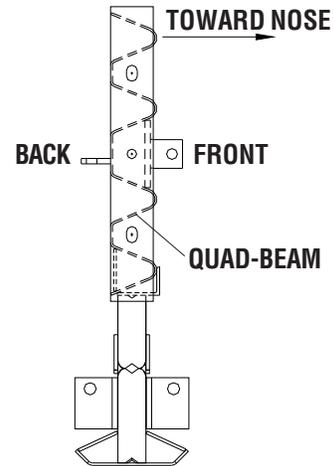


Figure 18
Diaphragm Orientation

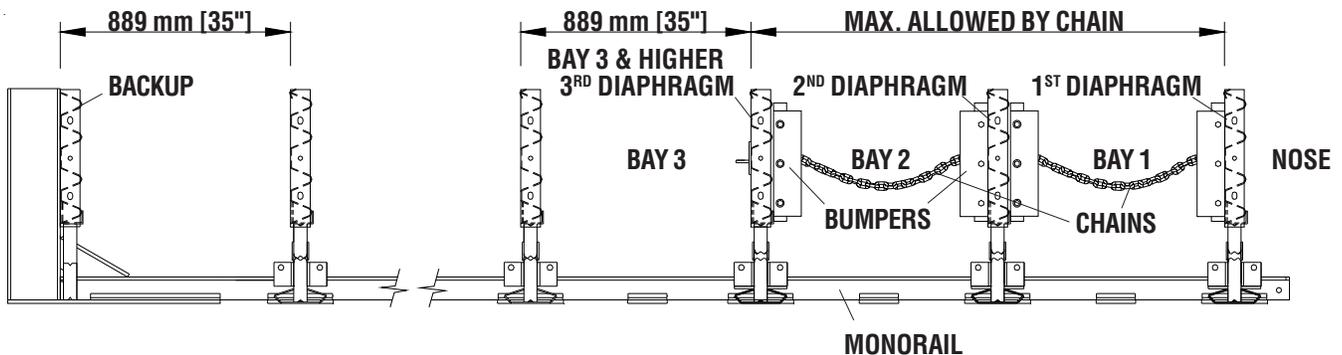


Figure 19
Diaphragm spacing

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

7) Cylinder Installation

All QuadGuard Elite Systems utilize the same basic cylinder configuration. Each System is equipped with three different types of cylinders. Bays 1 and 2 are left empty and do not contain any cylinders. Bays 3 through 5 contain a single walled 32" outside diameter cylinder with QE1 stenciled on the outer surface. The remaining bays contain double walled 32" outside diameter cylinders with QE2 stenciled on the outer surface. The nose assembly contains a single walled 28" outside diameter cylinder with QEN stenciled on the surface.

WARNING!

Placing the wrong type cylinder in the nose or any bay may result in unacceptable crash performance as described in NCHRP Report 350.

8) Install Rear-most QE2 Cylinder

Beginning at the backup, locate and position a QE2 cylinder such that it is centered resting on the monorail. Slide the rear-most diaphragm towards the Cylinder such that no gaps exist between the backup, the Cylinder, and the diaphragm. Thread the 1/2" diameter wire rope through the cable support bracket located on the back face of the backup structure, the cable jacketing tube, and the center of the QE2 Cylinder as shown in Figure 20. Attach ends of cable using two 1/2" cable clamps as shown in Figure 21. The cable clamps should be separated by approximately 4" as shown. Take as much slack out of the cable as possible prior to tightening the cable clamps. Draw down the cable clamps evenly and torque nuts to 88 Nm [65 foot-pounds].

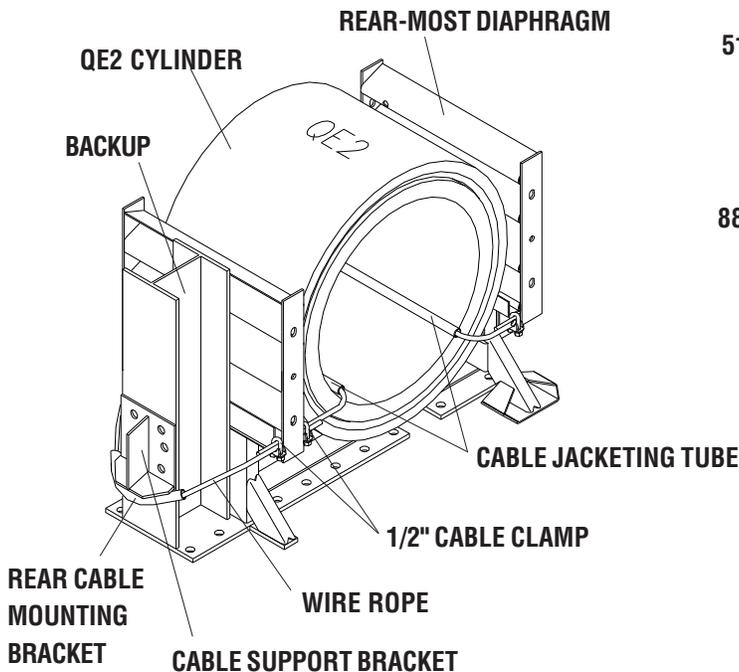


Figure 20
Cylinder Assembly
(Fender panels not shown for clarity)

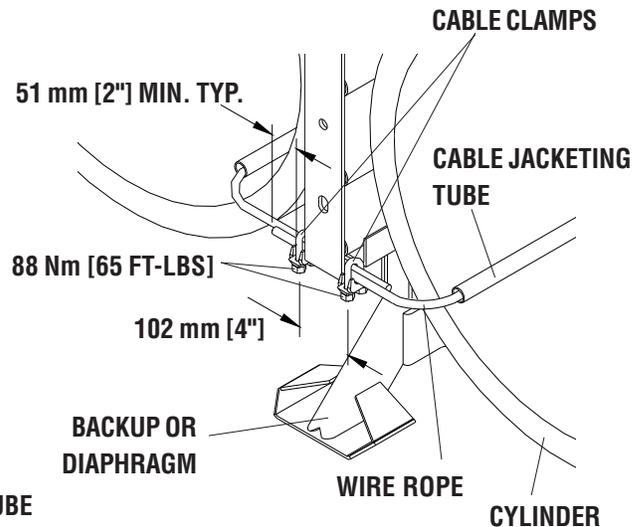


Figure 21
Typical Cable Clamp Installation
(Fender panels not shown for clarity)

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

9) Install The Remaining QE2 Cylinders

Continue attaching the QE2 Cylinders to their common diaphragms using the 1/2" cable, cable clamps, and cable jacketing tube as shown in Figures 21 and 22. Work forward from the backup to diaphragm 6, installing QE2 Cylinders as you proceed forward. Be sure to remove any clearance between the QE2 Cylinders and their adjacent diaphragms prior to removing all the possible cable slack and tightening the cable clamps. Except where otherwise noted, the cable jacketing tube should be centered within the length of the cylinders as shown to prevent the cable from damaging the cylinders.

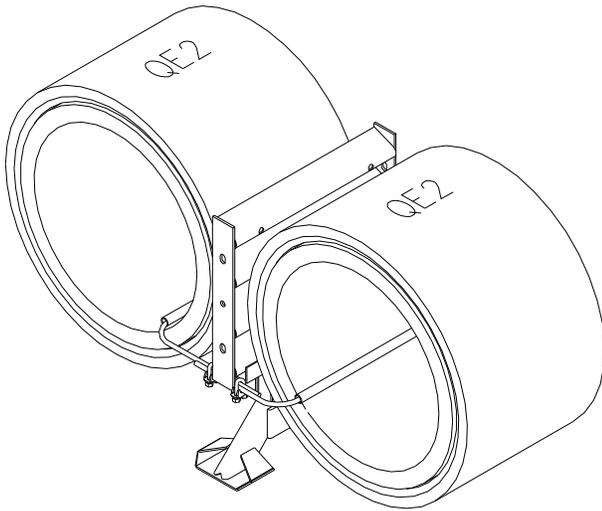


Figure 22
Typical QE2 Cylinder Mounting

10) Install The QE1 Cylinders

Install the three QE1 Cylinders in bays 3 through 5 in the same manner used to install the QE2 Cylinders. Again, it is important that all clearance be removed between the QE1 Cylinders and their adjacent diaphragms before tightening cable. There is no cylinder between diaphragms 2 & 3, therefore the 1/2" diameter cable just wraps around the legs on the front of the third diaphragm as shown in Figure 23.

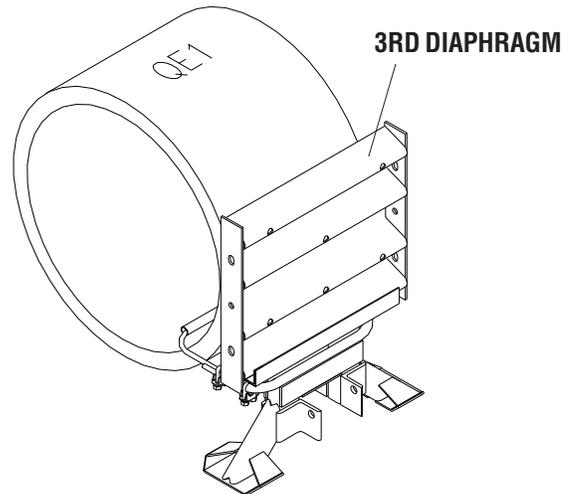


Figure 23
QE1 Cylinder Mounting to 3rd Diaphragm

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

11) Install Nose Belt

Finally, attach the nose belt to the fender panels using 5/8" x 2" long hex head bolts (6), 5/8" flat washers (24) and 5/8" hex nuts (18), through the belt clamps as shown in Figure 25.

The nose of the System may be delineated to comply with local codes (chevron, reflectorized sign, etc.).

WARNING!

Placing the wrong type cylinder in the nose or any bay may result in unacceptable crash performance as described in NCHRP 350.

Adjust the hex nuts so that the face of the flat washers are flush with the outside humps of the fender panels as shown in Figure 24.

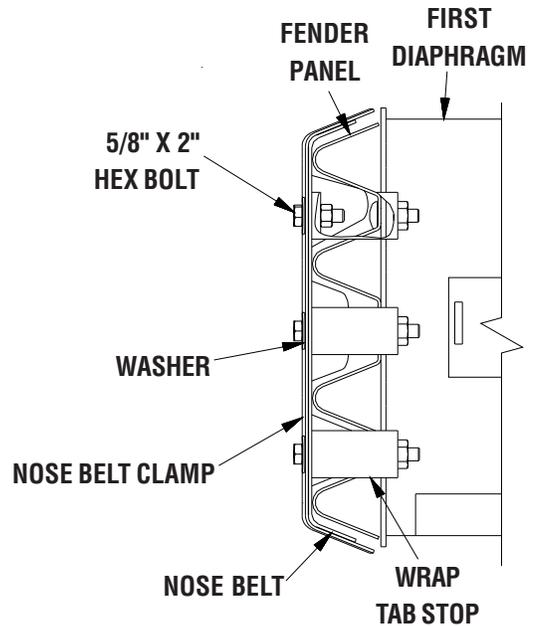


Figure 24

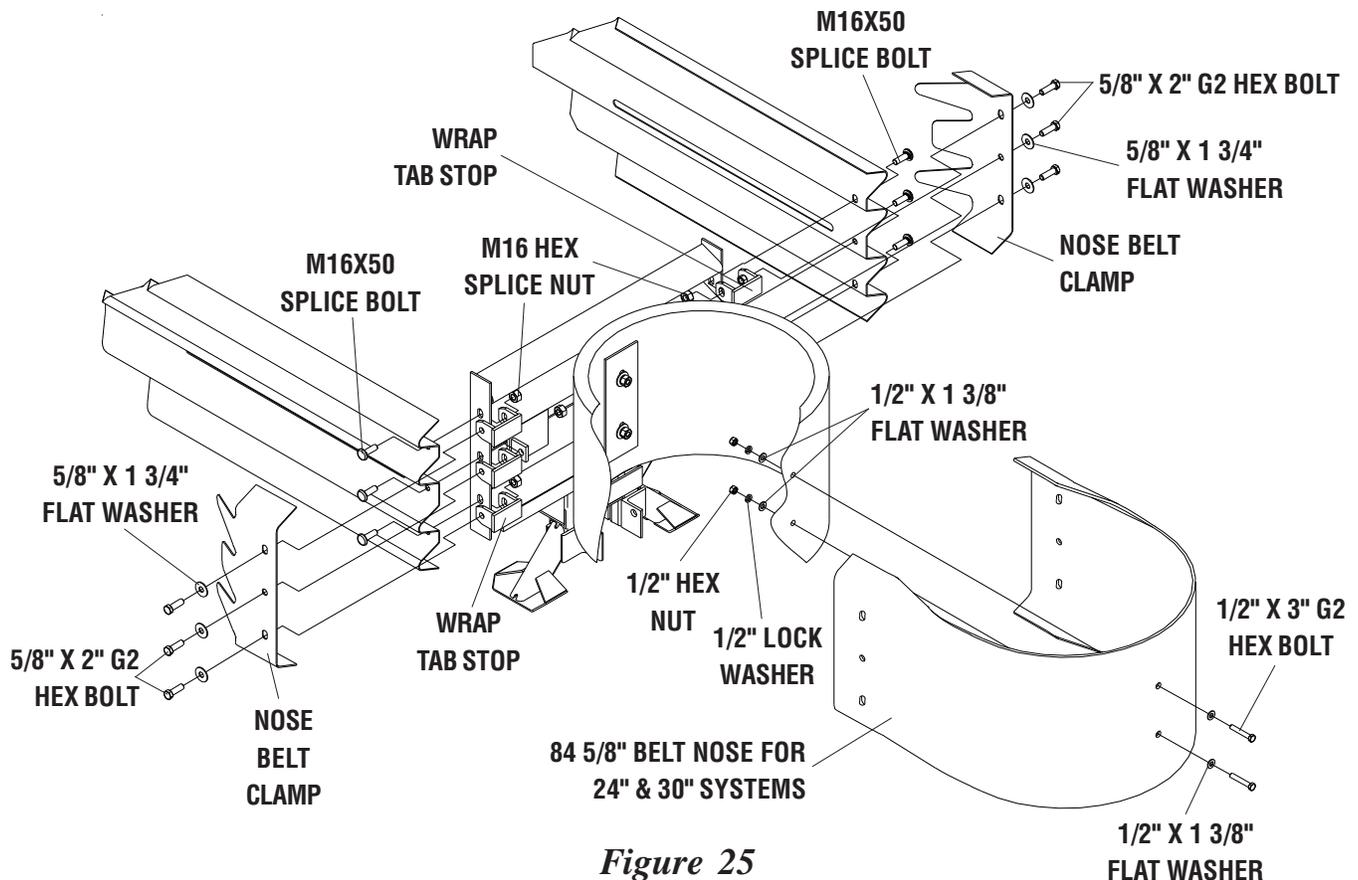
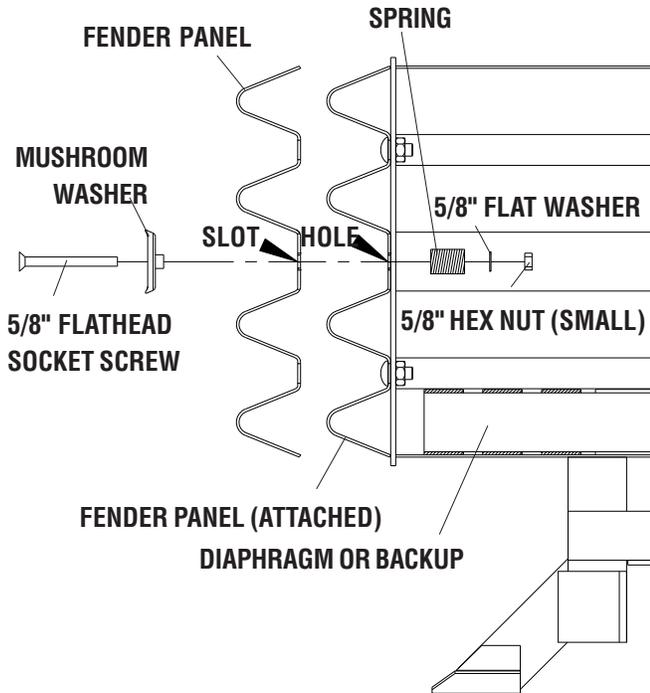


Figure 25

Attach Nose Belt to Fender Panels

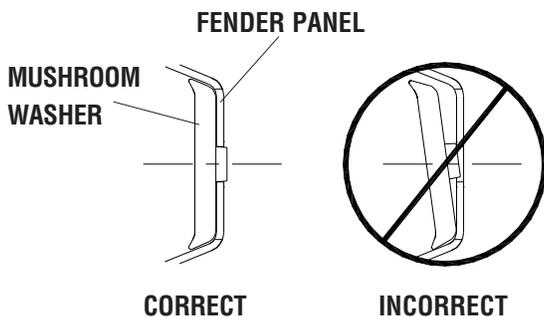
QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)



Detail 26a
Mushroom Washer Attachment

Be sure mushroom washer lays flat against the fender panel as shown in Detail 26b. Standoff on washer must be seated completely through slot.



Detail 26b
Mushroom Washer Orientation

Continue installing fender panels until you reach diaphragm no. 2. Figure 27 shows the location of diaphragm no. 2.

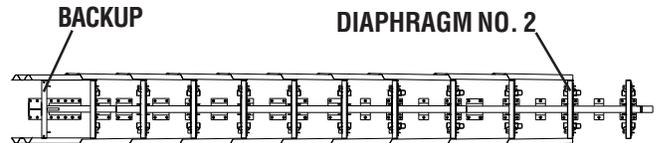


Figure 27
Locate Diaphragm No. 2

12) Install End Cap

Install end cap to the monorail as shown in Figure 28 and the monorail assembly drawing.

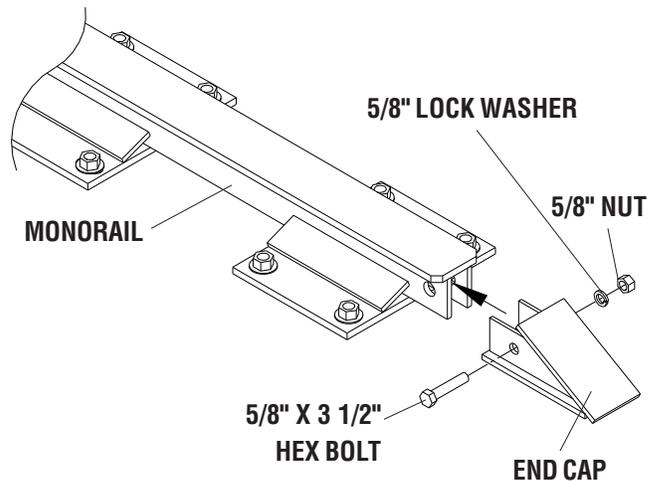


Figure 28
Locate Diaphragm No. 2

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

13) Install Fender Panels

Note: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). See Figure 29.

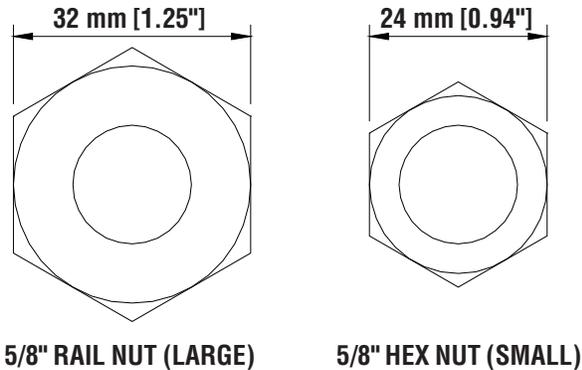


Figure 29
Rail Nuts are Oversize

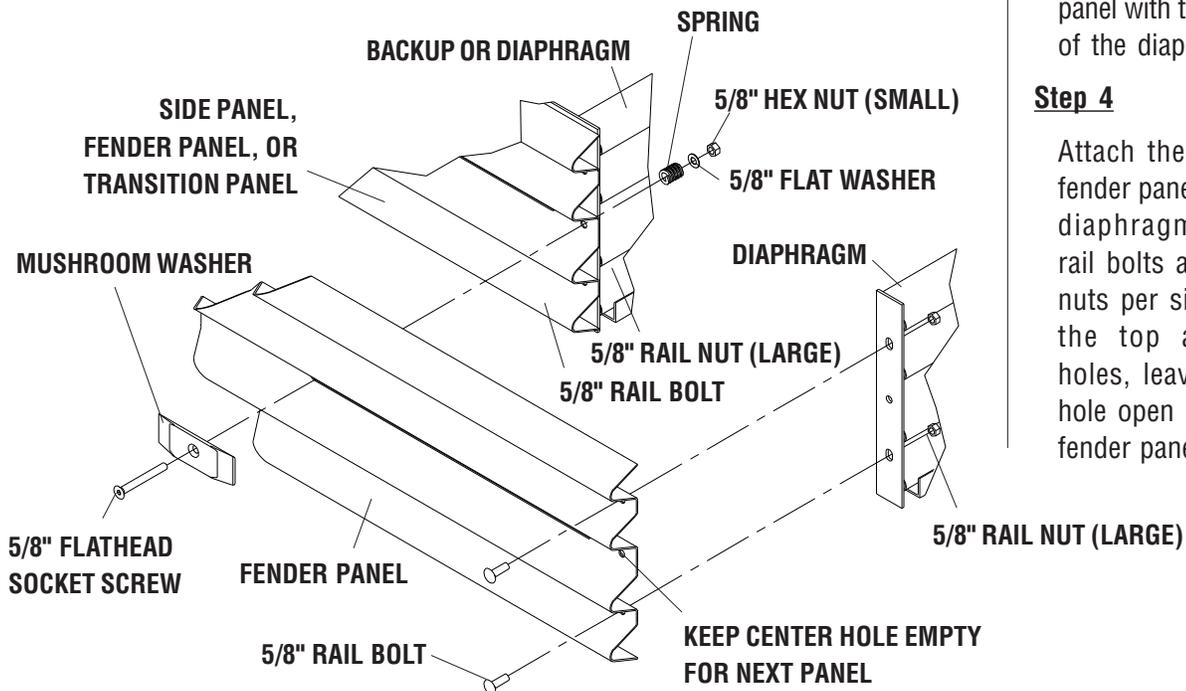


Figure 30
Fender Panel Assembly

Starting at the backup, install left and right fender panels as shown in Figure 28 and fender panel assembly drawing.

Step 1

Place the fender panel so that the center hole of the rearward diaphragm is lined up with the approximate center of the slot in the fender panel.

Attach mushroom washer assembly as shown in Figure 28, but do not torque at this time. (This helps to balance the fender panel.)

Step 2

Slide the fender panel forward until the holes in the fender panel line up with the holes in the forward diaphragm.

Step 3

Use a drift pin to align the center hole of the fender panel with the center hole of the diaphragm.

Step 4

Attach the front of the fender panels to the next diaphragm using two rail bolts and large hex nuts per side. Use only the top and bottom holes, leave the center hole open until the next fender panel is installed.

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

14) Install Nose Cylinder

Attach the nose cylinder using two 5/8" x 7" long threaded rods through the nose cylinder plate, nose cylinder, and diaphragm (see Figure 31). Secure each 5/8" threaded rod with flat washers, nuts and a nose clamp shim and torque to 27 Nm [20 ft-lbs] minimum, 34 Nm [25 ft-lbs] maximum.

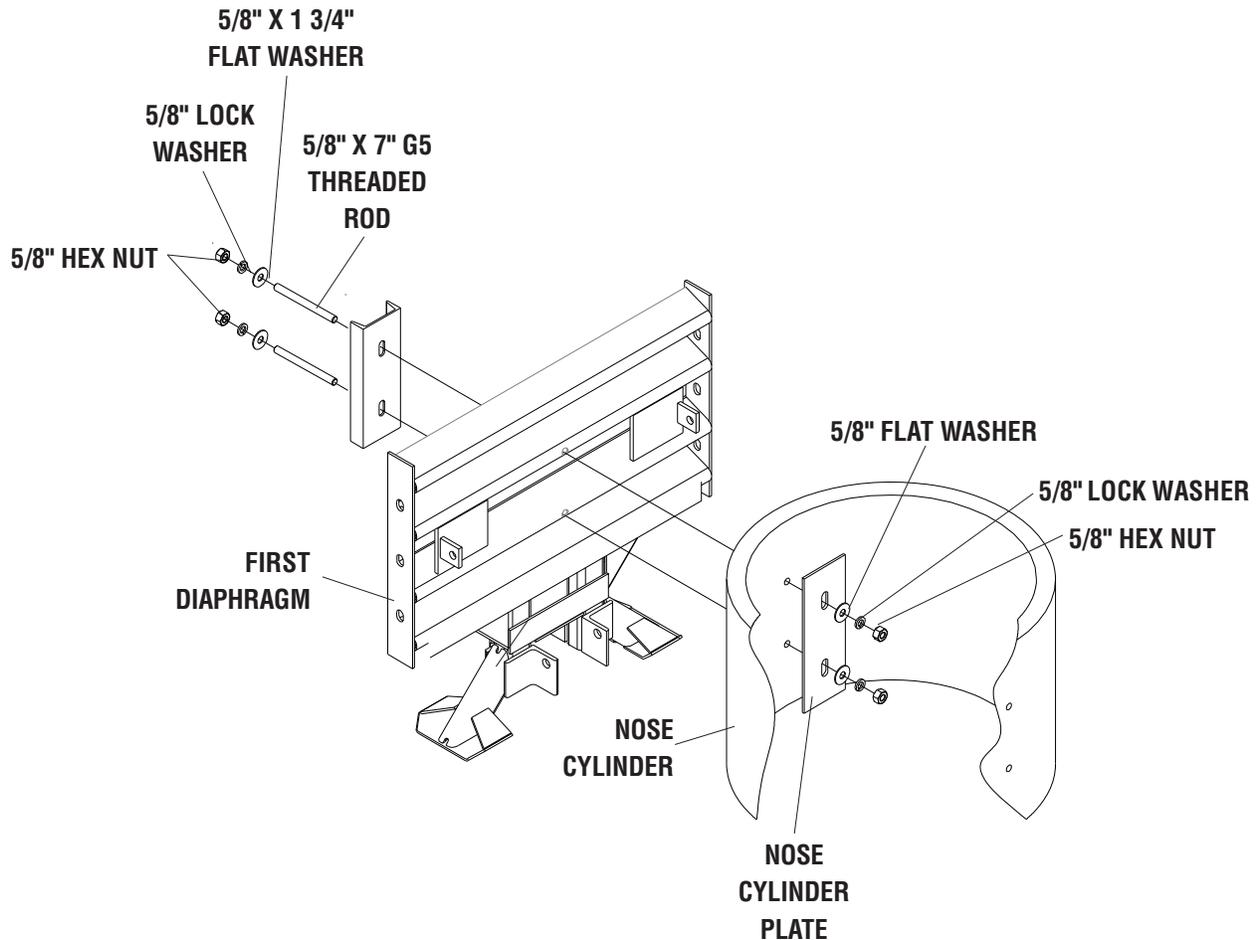


Figure 31

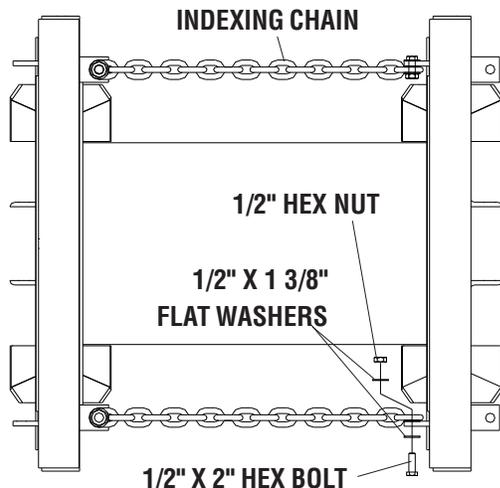
Attach Nose Cylinder To First Diaphragm

QuadGuard® Elite

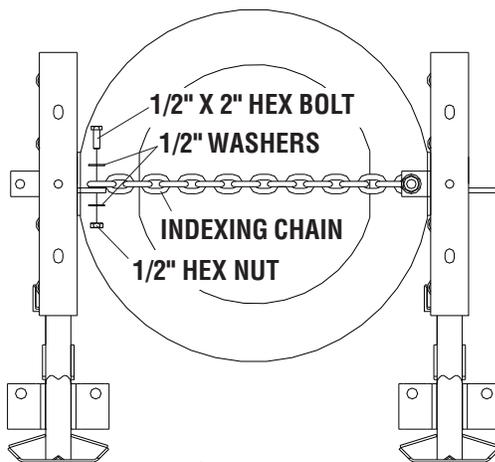
Installation for Narrow Hazards (cont'd.)

15) Install Indexing Chains

For the 36" System, bays 3 and higher to the backup use 2 indexing chains in each bay.



TOP VIEW



SIDE VIEW

Figure 32

Attach Indexing Chains
(Fender panels not shown for clarity)

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

For the 24", 30" & 36" systems bays 1 & 2, use one indexing chain in each bay. Attach indexing chains using 1/2" diameter x 2" long hex head bolts, nuts & washers as shown in Figure 33.

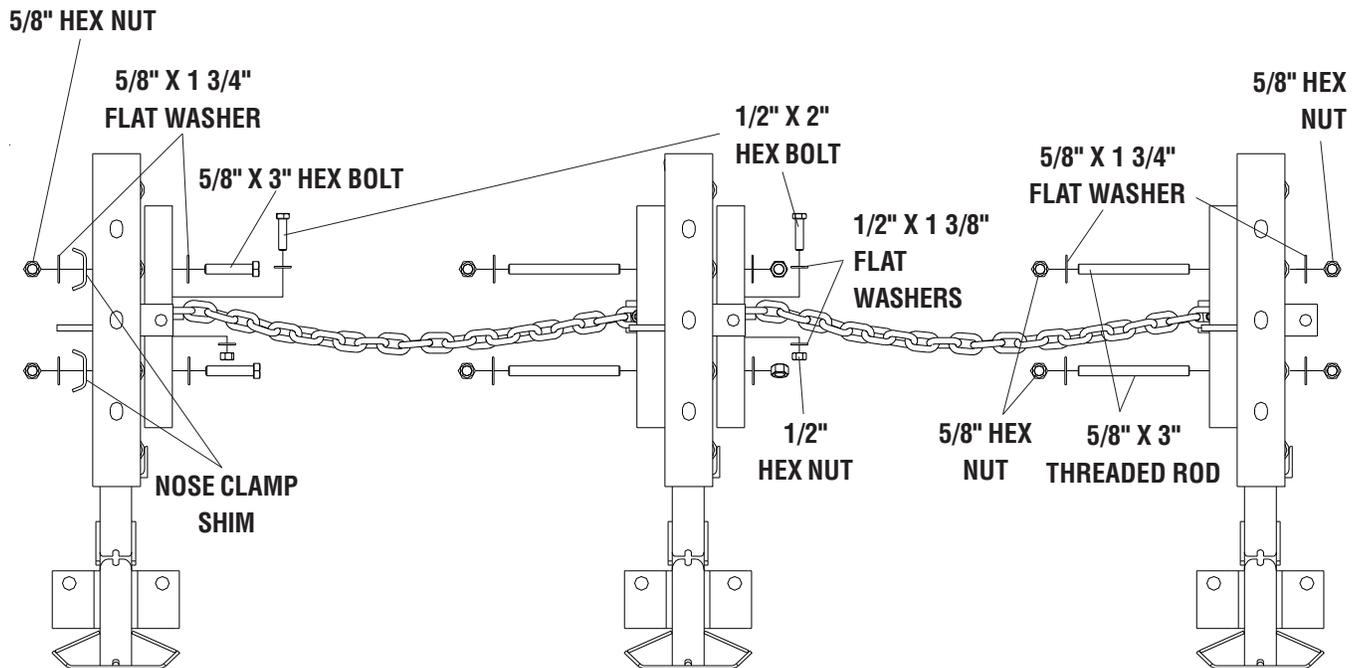


Figure 33

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

16) Assemble Bumper Belt Assemblies

Bays 1 and 2 of the 24", 30" and 36" wide Systems are outfitted with bumper belt assemblies as shown in Figure 34 & Details "A", "B" and "C". Assemble two bumper belt assemblies to the back of the first diaphragm and the front of the third diaphragm. First, orient tube spacers so the larger holes face out as shown in Detail "C" and attach the tube spacers to the diaphragms using the two 1/2" x 2" hex bolts, nuts and 1/2" x 1 3/8" flat wash-

ers. Next, attach one side of the flexible bumper belt to a tube spacer using three 3/8" x 4 1/2" long mounting bolts. Wrap the bumper belt around the tube spacer affixing it's opposite side with the nut/washer combination shown in Details "A" & "C". Torque the mounting bolts to 37 Nm [20 ft-lbs]. The second diaphragm uses 1/2" x 5" Hex Bolts, nuts and washers to attach tube spacers to each side of the diaphragm. Repeat flexible bumper belt assembly for each tube spacer.

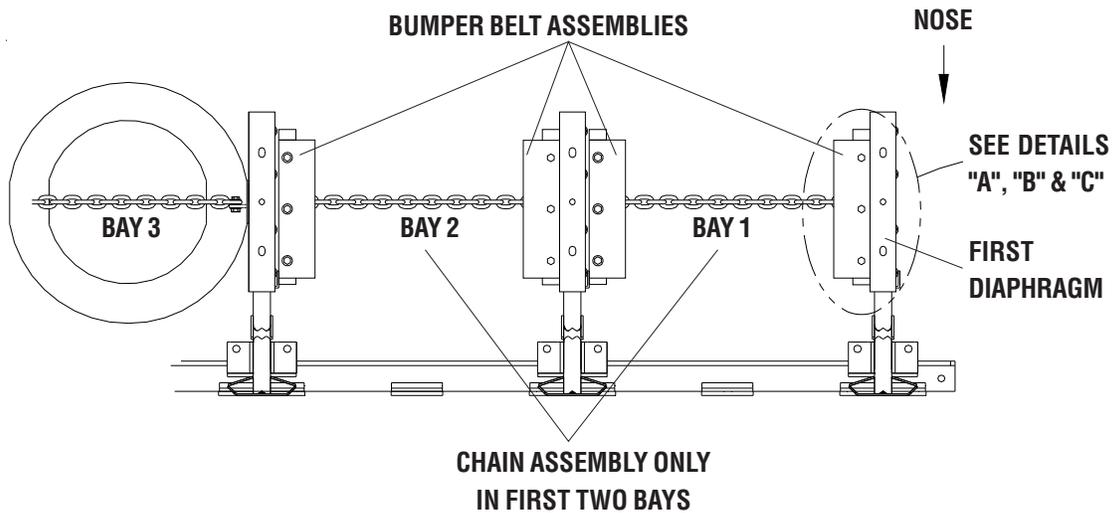
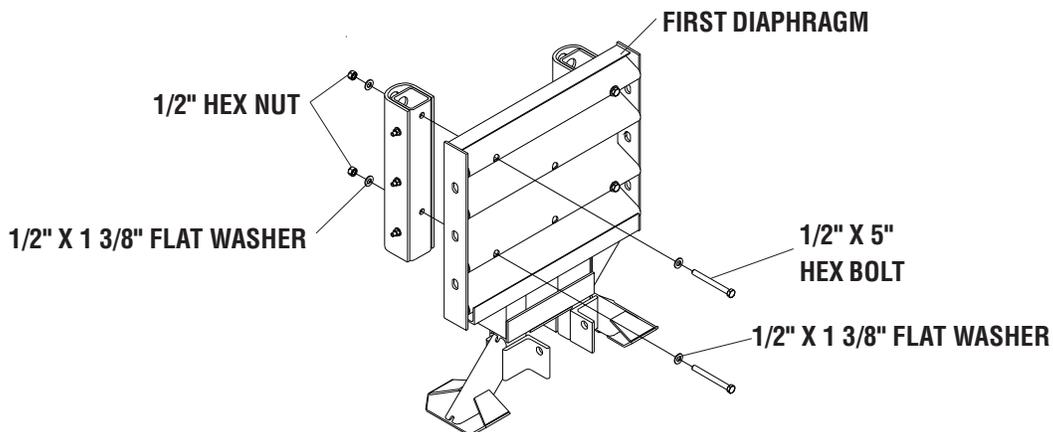


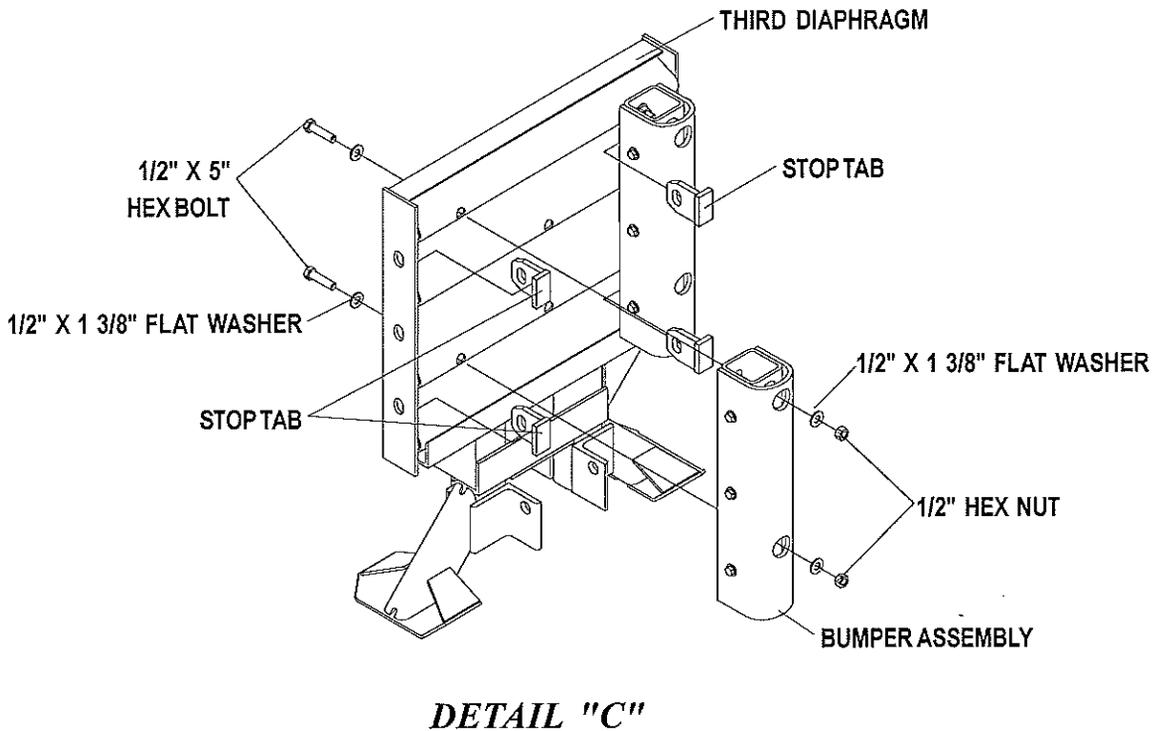
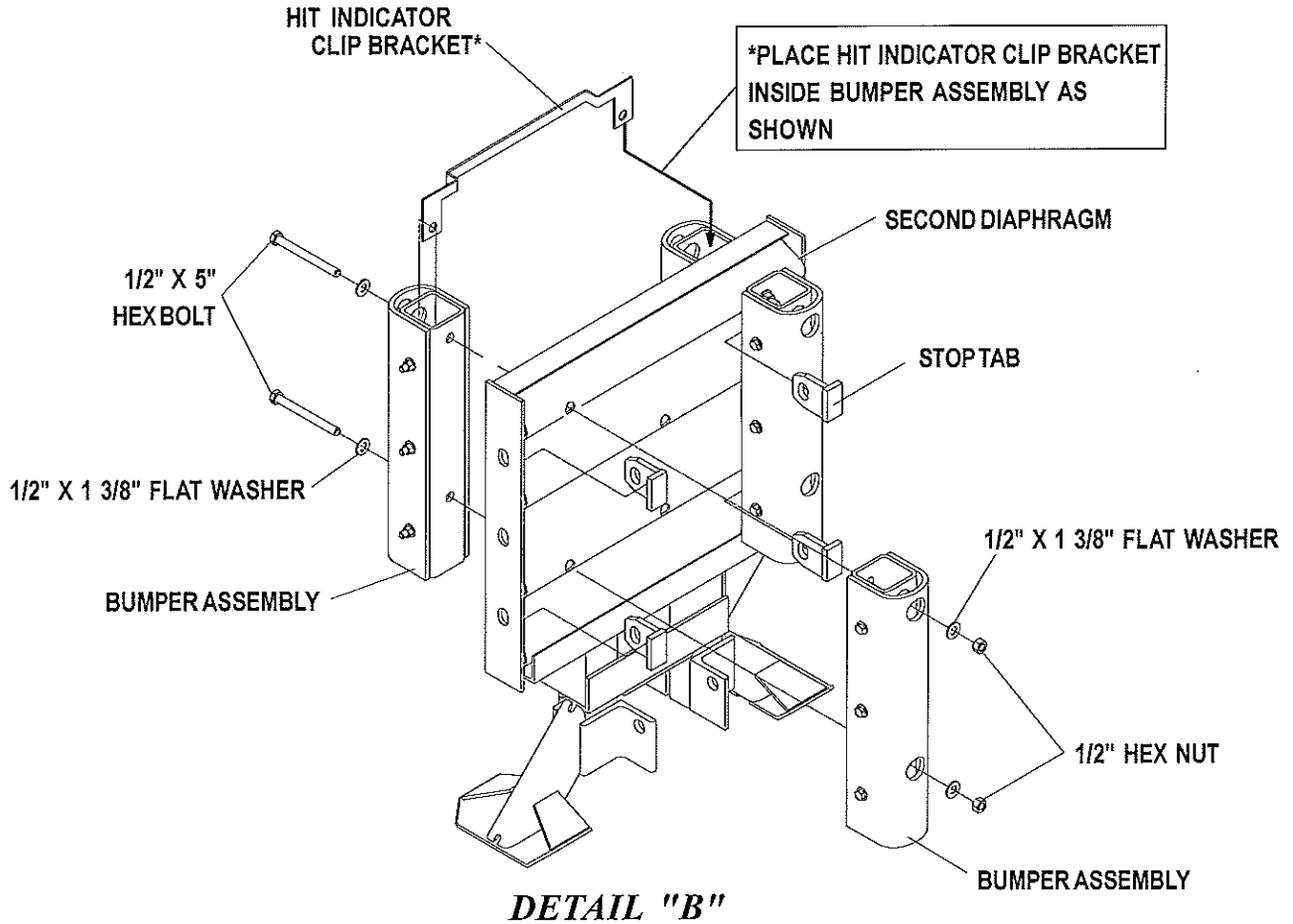
Figure 34
Bumper Belt Assembly



DETAIL "A"

QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)



QuadGuard® Elite

Installation for Narrow Hazards (cont'd.)

17) Install Hit Indicator To Diaphragm No. 1

The Hit Indicator should be the last component installed on the System. Center and bolt the Hit Indicator to the first diaphragm with the hardware provided as shown in Figure 35.

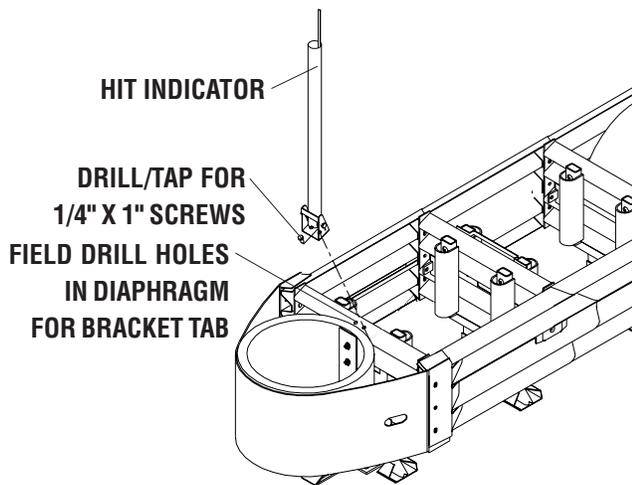


Figure 35
Install Hit Indicator

Rotate the hit indicator to its horizontal position and lock it into position by bending the trigger clip around top of second diaphragm as shown in Figure 36.

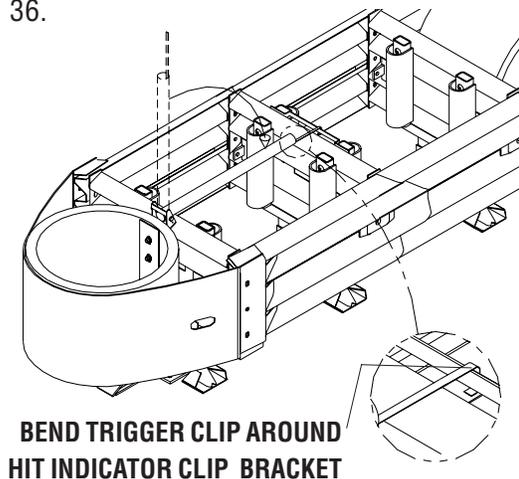


Figure 36
Rotate Hit Indicator/Bend Trigger Clip

18) Checking The System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the System (anchor bolts, etc.). See Table A. Check all fender panels. If they do not fit tightly against the underlying panel, System realignment may be necessary. (See Figure 37). (Critical for wrong way traffic).

Table A
Bolt Torque Specifications

WARNING!

Anchor Studs... Torqued to 165 Nm [120 ft-lbs]
Should NOT protrude above nuts
(see Figure 14)
All Other Bolts... Tightened
Fender Panel.... Maximum gap allowed:
Narrow Systems - 20 mm [0.78"]
Cable Clamps... Torqued to 84 Nm [65 ft-lbs]

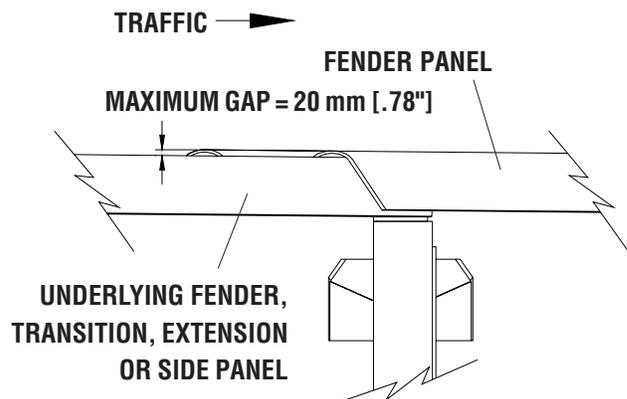


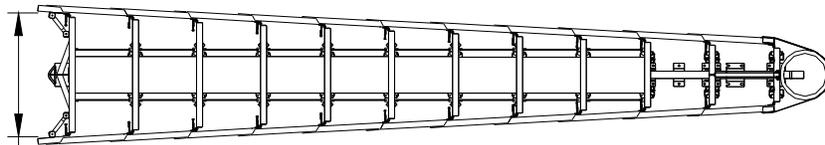
Figure 37
Fender Panel Gap for Narrow Systems

19) Inspect System

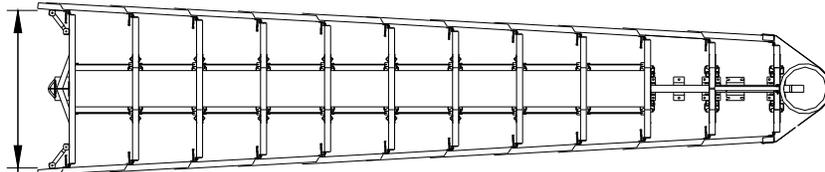
Inspect the System in accordance with the QuadGuard® Elite Maintenance Flow Chart on page 58.

QuadGuard® Elite

QuadGuard® Elite for Wide Hazards



175 mm [69"] MODEL NO. QS6911E*



2285 mm [90"] MODEL NO. QS9011E*

* Also available: QS6905E, QS6907E, QS6908E, QS9005E, QS9007E & QS9008E.

QuadGuard® Elite

Installation for Wide Hazards

Site Preparation/Foundation

A QuadGuard Elite should be installed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete pads are provided in Energy Absorption Systems, Inc. concrete pad drawing, supplied with the System. The System may be installed on a non-reinforced concrete roadway (minimum 200 mm [8"] thick). Installation cross slope shall not exceed 8% and should not twist more than 2% over the length of the System; the pad surface shall have a light broom finish.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

WARNING!

Location of the backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the fender panels telescope toward and extend beyond the rigid backup as much as 635 mm [25"] from their pre-impact location. Position the backup so that the rear ends of the last fender panels are a minimum of 635 mm [25"] forward of objects that would otherwise interfere with movement of the panels. Failure to comply with this requirement can result in impaired system performance offering motorists less protection and causing component damage.

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

Inspect Shipping

Before installing the QuadGuard Elite, check the received parts against the shipping list supplied with the System. Make sure all parts have been received.

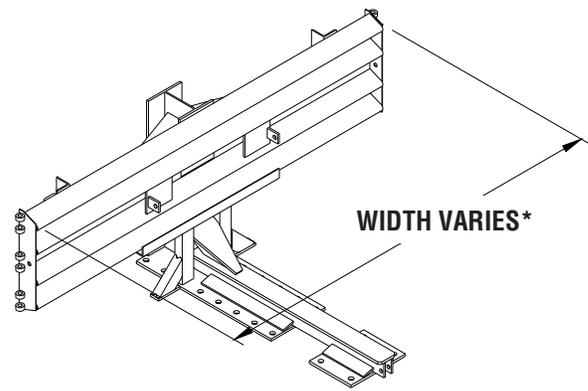
Installation Procedures

Note: The Drawing Package supplied with the QuadGuard Elite must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup & Transition Type

The QuadGuard Elite uses a Tension Strut Backup.

A transition panel or side panel must be used on each side of the backup. A side panel is not needed when a transition panel is used. Several types of transitions are available for use with the QuadGuard 69/90 Elite System. Refer to Figures 40 through 44 and the drawing package to determine which type of panels are being installed.



* 1620 mm [64"] FOR 1755 mm [69"] WIDE SYSTEM
2100 mm [83"] FOR 2285 mm [90"] WIDE SYSTEM

Figure 38
Tension Strut Backup

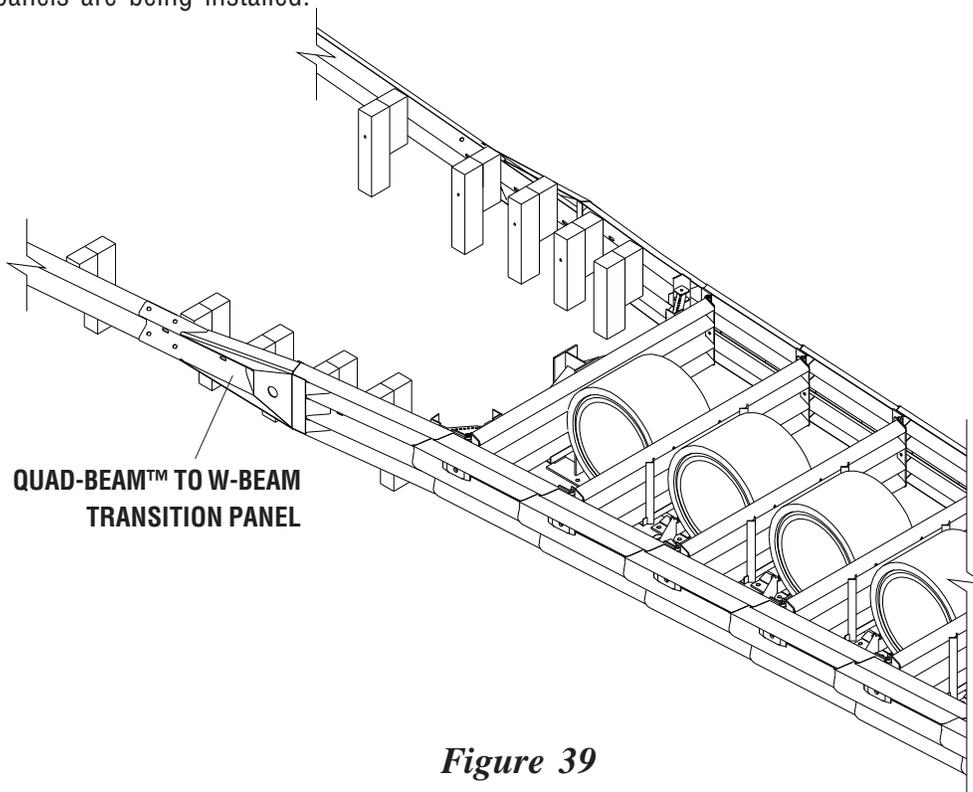


Figure 39
Transitioning the QuadGuard® Elite

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)



Figure 40
Side Panel

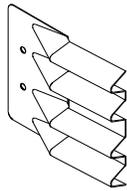


Figure 41
Quad-Beam™ End Shoe

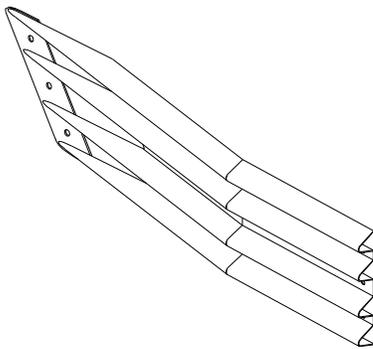


Figure 42
Quad-Beam to Safety Shape Barrier Transition Panel

Transition and Side Panel Types

Note: The proper transition or side panel must be used for optimum impact performance of the System. The correct panel to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard Elite is shielding. Contact the Customer Service Department prior to installation if you have any questions.

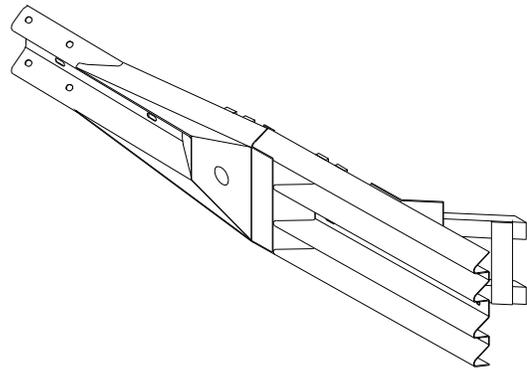


Figure 43
Quad-Beam to W-Beam Transition Panel

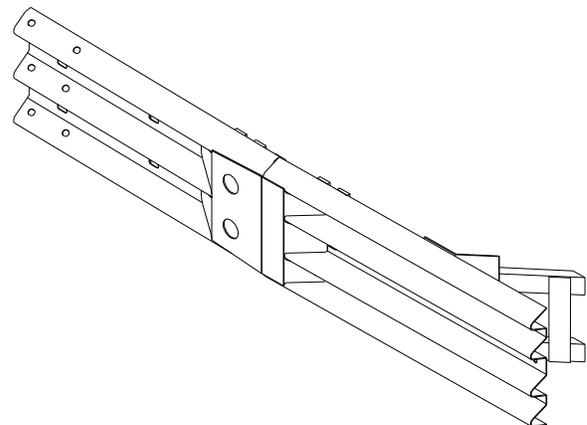


Figure 44
Quad-Beam to Thrie-Beam Transition Panel

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

2) Mark System Location

Locate the centerline of the System by measuring the proper offset from the hazard. Refer to the drawing package supplied with the System. Place chalk line to mark the centerline of the System. Mark a construction line parallel to the center line and offset 165 mm [6.5"] to one side as shown in Figure 45. The edge of the monorail will be placed on this line.

Note: The concrete pad should be installed per the project plans supplied with the System.

WARNING!

Location of System with respect to the hazard is critical and dependent on the type of transition panel used. See the project plans supplied with the System for details.

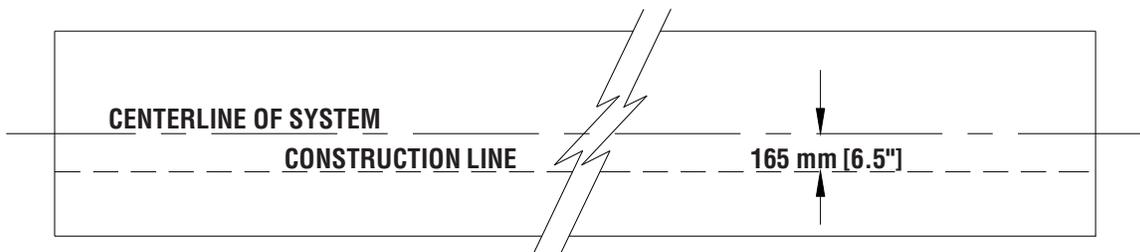


Figure 45
*(Top view of Concrete Pad)
Locating Construction Line*

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

3) Anchor the Backup and monorail

Refer to Figure 46 (showing backup assembly) and Figure 47 (showing monorail installation). Also refer to the drawing package, and the MP-3® Polyester Anchoring System Instructions included with this manual.

A. Tension Strut Backup Installation (Figure 50)

Locate the backup and monorail on the centerline of the pad with the side of the monorail on the construction line (Figure 46). Verify that applicable transition panels fit properly before anchoring the backup. Drill 140 mm [5 1/2"] deep anchor holes in the pad using the backup as a template. Do not drill through pad. Anchor the backup to the concrete pad using the MP-3 vertical kits provided. (See MP-3 anchoring, page 48).

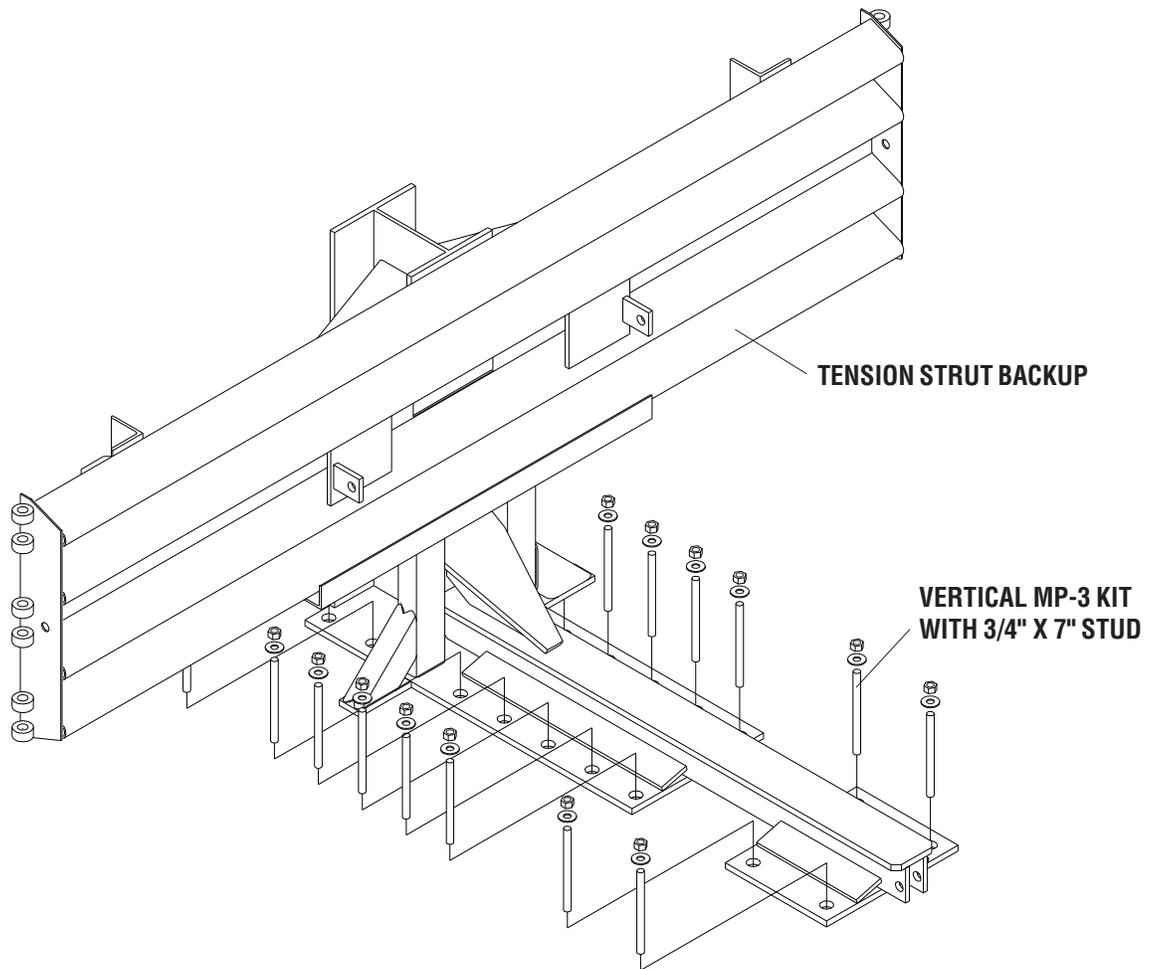


Figure 46
Anchoring Tension Strut Backup to Foundation

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

B. Monorail installation

Locate the monorail on the construction line as shown in the monorail assembly drawings. Drill 140 mm [5 1/2"] deep anchor holes using the monorail as a template (see figure 48). Do not drill through pad. Anchor each monorail section using the MP-3 vertical kits provided. Refer to Figure 47 and the MP-3 Polyester Anchoring System Instructions included with this manual. **It is important to install each segment of monorail in alignment from the back to the front of the System (+/- 6 mm [1/4"])**.

WARNING!

Improper alignment at the monorail splice joints will prevent proper System collapse during an impact.

WARNING!

Every hole and slot in backup and monorail must have an MP-3 stud anchoring it.

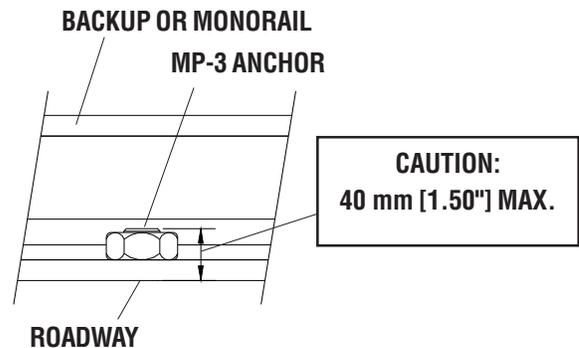


Figure 47
Proper Stud Height

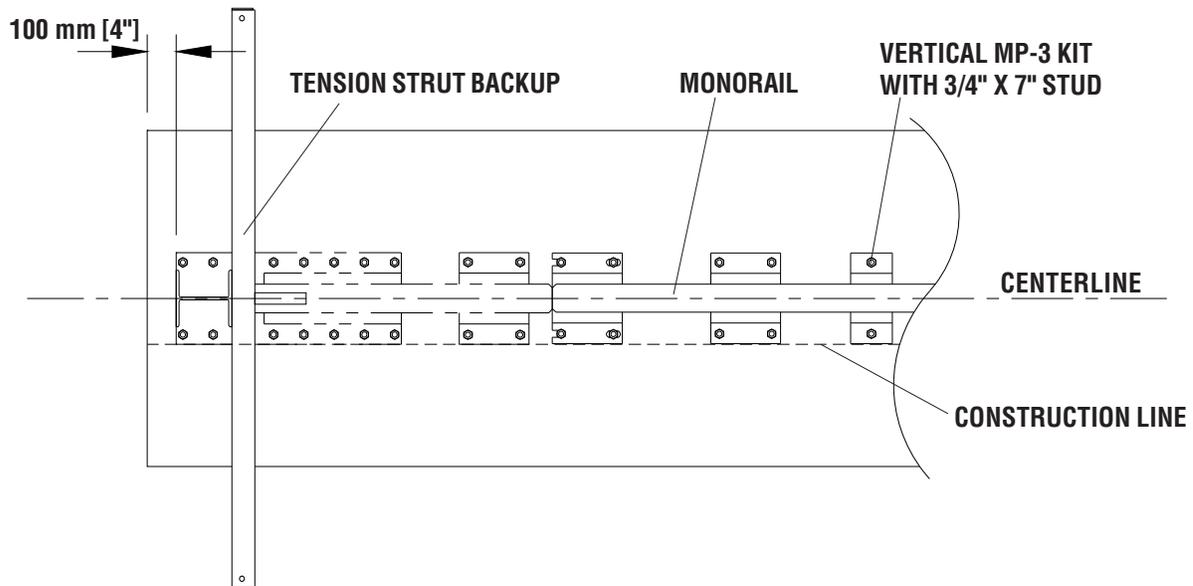


Figure 48
Backup and Monorail Location for Tension Strut Backup

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

4) Install Side Panels / Transition Panels to Backup Assembly

Attach the transition panel or side panel as appropriate to each side of the backup. Refer to Figure 50 and the drawing package for more information.

Note: A side panel is not needed when a transition panel is used.

5) Attach Monorail Guides

Attach monorail guides to diaphragms as shown in Figure 49, and the diaphragm assembly drawing.

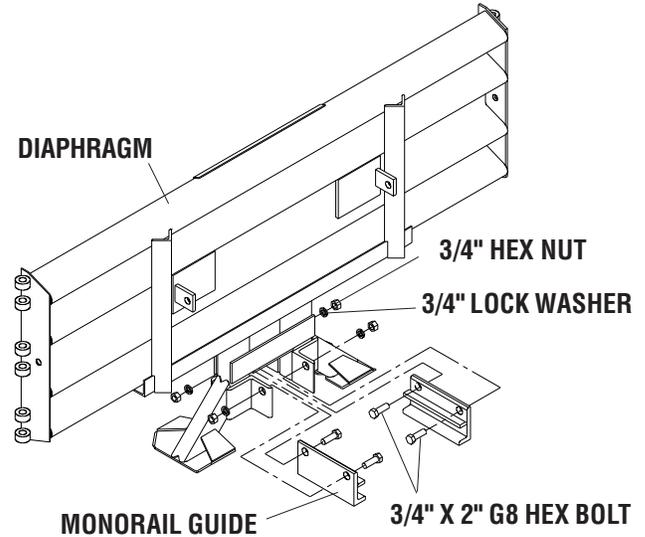


Figure 49
Monorail Guide Attachment

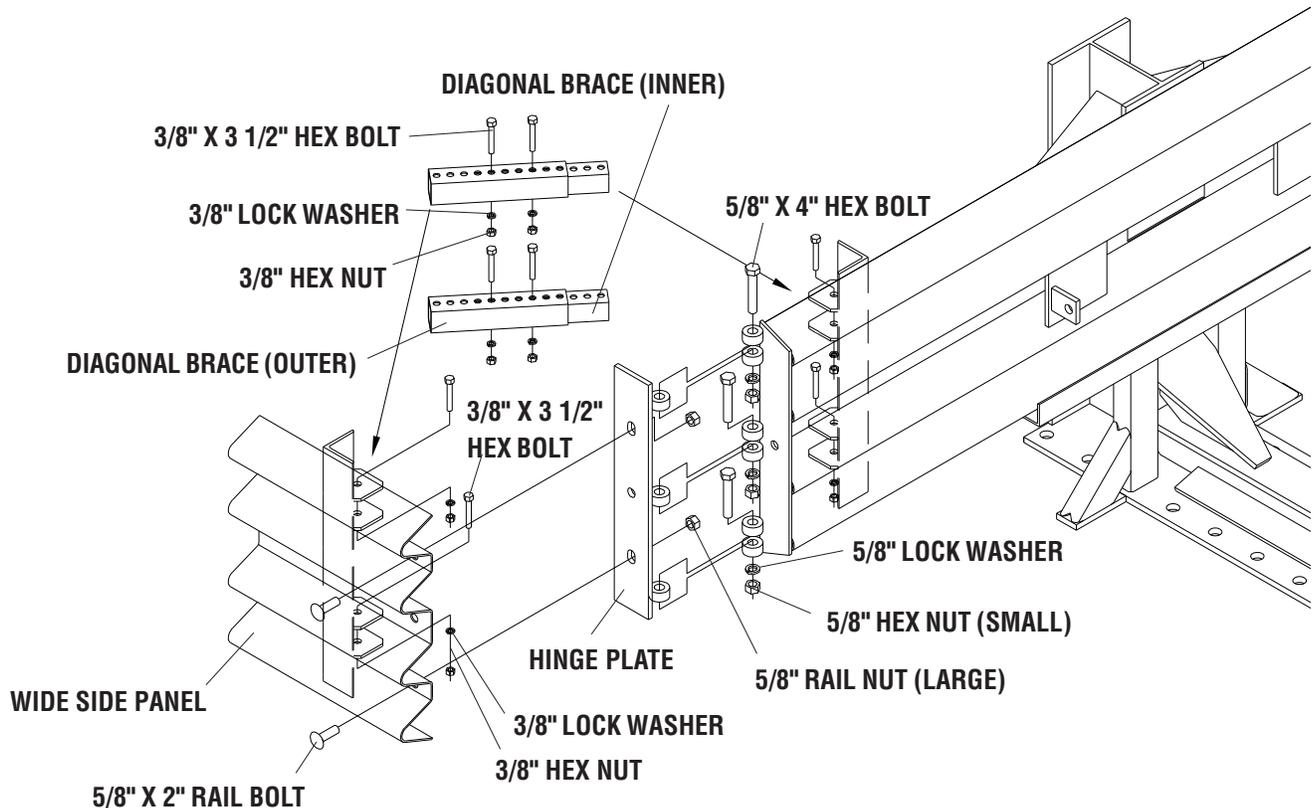


Figure 50
*Side Panel/Transition Panel Installation
for Wide Applications*

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

6) Install Diaphragms

Orient Diaphragms so that the front face of the Quad-beam™ shape faces toward the Nose of the system as shown in Figure 51. **The widest diaphragm must be installed closest to the backup with each subsequent diaphragm being progressively narrower.**

Slide the widest diaphragm onto the monorail and all the way to the backup to ensure system is able to collapse properly during impact. Once this has been verified, slide the diaphragm forward to approximately 889 mm [35"] in front of the backup. Refer to Figure 52 for the proper location.

Orient and slide all other diaphragms (except the first three) onto the monorail and position each as shown in Figure 52. The diaphragm spacing shown in Figure 52 allows the system to be assembled. Once the system is assembled, the diaphragms will be moved to their final locations.

Diaphragms 1, 2 & 3 each have bumpers attached to them. Orient diaphragms 3, 2 & 1 with the bumpers as shown in Figure 58 and the front face of the Quad-Beam shape facing toward the nose of the System as shown in Figures 51 and 52.

Slide diaphragms 3, 2 & 1 onto the monorail and space as shown in Figure 52.

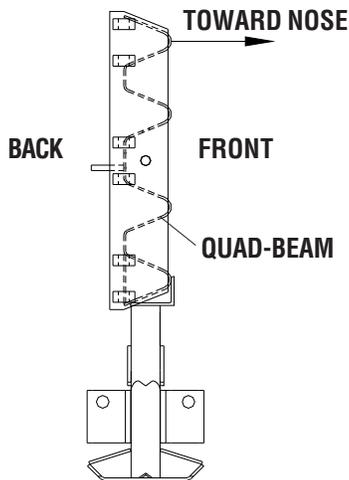


Figure 51
Diaphragm Orientation

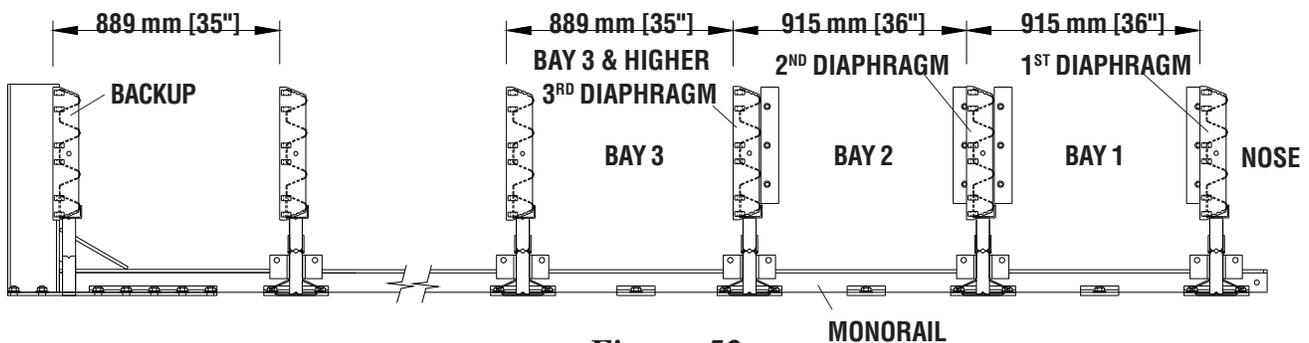


Figure 52
Diaphragm spacing

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

7) Cylinder Installation

All QuadGuard Elite Systems utilize the same basic cylinder configuration. Each System is equipped with three different types of cylinders.

Bays 1, and 2 are left empty, and do not contain any cylinders.

Bays 3 through 5 contain a single walled 32" outside diameter cylinder with QE1 stenciled on the outer surface.

The remaining bays contain double walled 32" outside diameter cylinders with QE2 stenciled on the outer surface.

The nose assembly contains a single walled 28" outside diameter cylinder with QEN stenciled on the outer surface.

WARNING!

Placing the wrong type cylinder in the nose or any bay may result in unacceptable crash performance as described in NCHRP Report 350.

8) Install Rear-most QE2 Cylinder

Beginning at the backup, locate and position a QE2 cylinder so it is centered and resting on the monorail.

Slide the rear-most diaphragm towards the Cylinder so no gaps exist between the backup, the Cylinder, and the diaphragm.

Thread the 1/2" diameter wire rope through the cable support bracket located on the back face of the backup structure, the cable jacketing tube, and the center of the QE2 Cylinder as shown in Figure 53.

Attach ends of the cable using two 1/2" cable clamps as shown in Figure 54. The cable clamps should be separated by approximately 4" as shown.

Take as much slack out of the cable as possible prior to tightening the cable clamps. Draw down the cable clamp evenly and torque nuts to 65 foot-pounds.

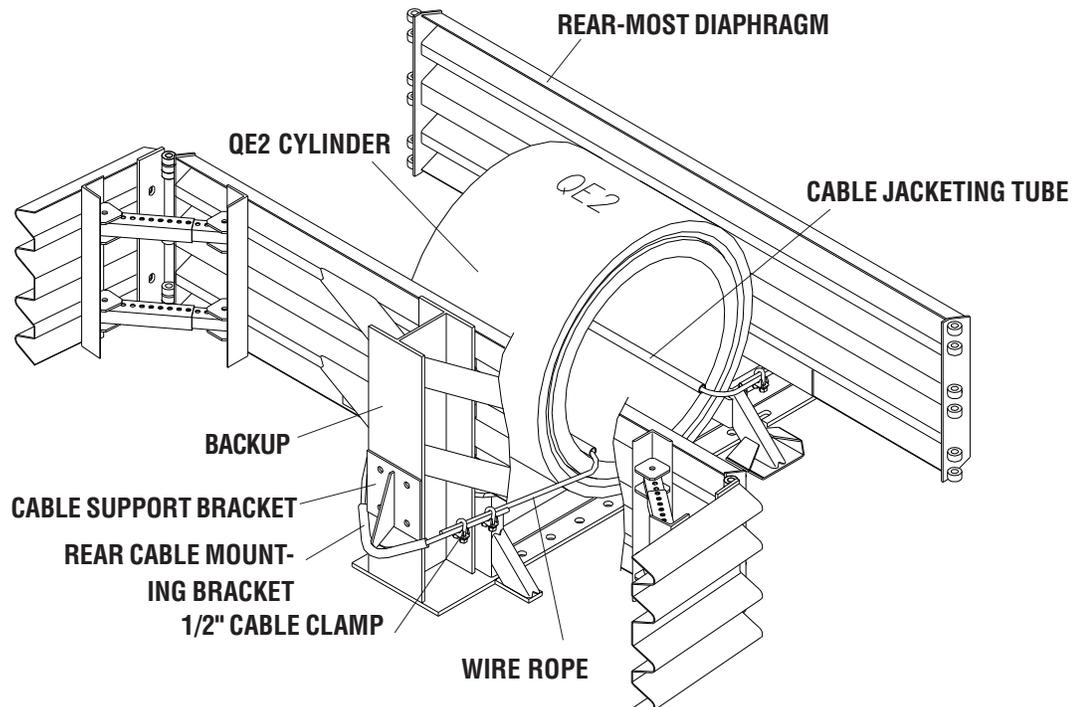


Figure 53
Cylinder Assembly

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

9) Install The Remaining QE2 Cylinders

Continue attaching the QE2 Cylinders to their common diaphragms using the 1/2" cable, cable clamps, and cable jacketing tube as shown in Figures 54 and 55.

Work forward from the backup to diaphragm 6, installing QE2 Cylinders as you proceed forward.

Be sure to remove any clearance between the QE2 Cylinders and their adjacent diaphragms prior to removing all the possible cable slack before tightening the cable clamps.

Except where otherwise noted, the cable jacketing tube should be centered within the length of the cylinders as shown to prevent the cable from damaging the cylinders.

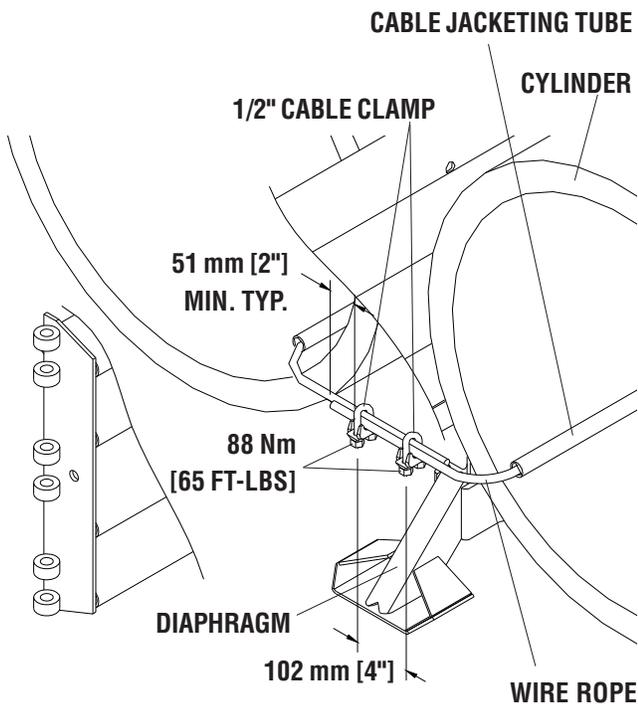


Figure 54
Typical Cable Clamp Installation

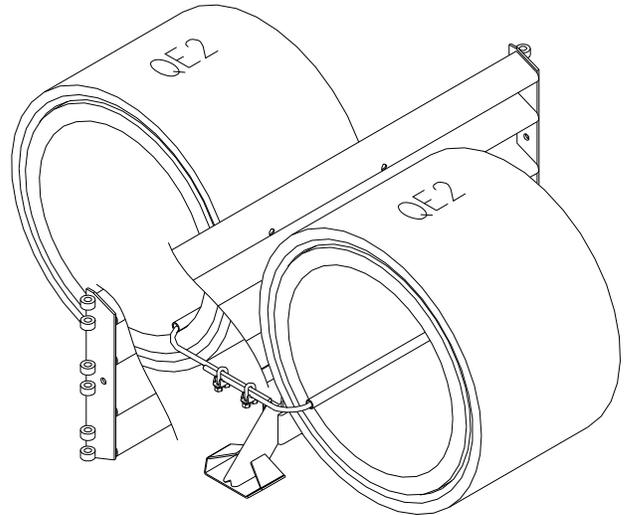


Figure 55
Typical QE2 Cylinder Mounting

10) Install The QE1 Cylinders

Install the three QE1 Cylinders in bays 3 through 5 in the same manner used to install the QE2 Cylinders.

Again, it is important that all clearance be removed between the QE1 Cylinders and their adjacent diaphragms before tightening cable.

There is no cylinder between diaphragms 2 & 3, therefore the 1/2" diameter cable just wraps around the legs on the front of the third diaphragm as shown in Figure 56.

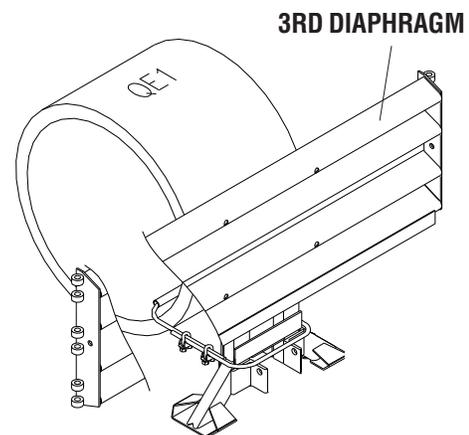


Figure 56
QE1 Cylinder Mounting to 3rd Diaphragm

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

11) Install Indexing Chains

For bays 3 to the backup, use 2 indexing chains in each bay. Attach indexing chains using 1/2" diameter x 2" long hex head bolts, nuts & washers as shown in Figure 57.

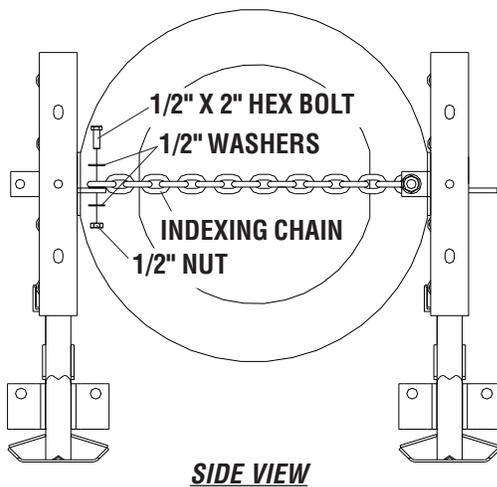
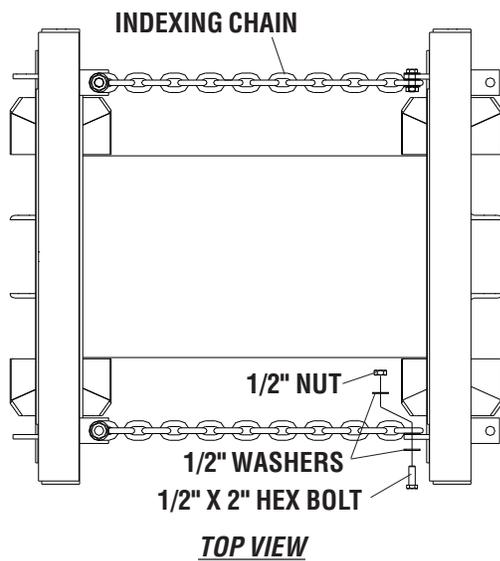


Figure 57

Attach Indexing Chains
(Fender panels not shown for clarity)

12) Install End Cap

Using 5/8" x 3 1/2" G5 hex bolt, 5/8" hex nut and 5/8" lock washer, attach the end cap to the front of the first monorail segment as shown in Figure 58.

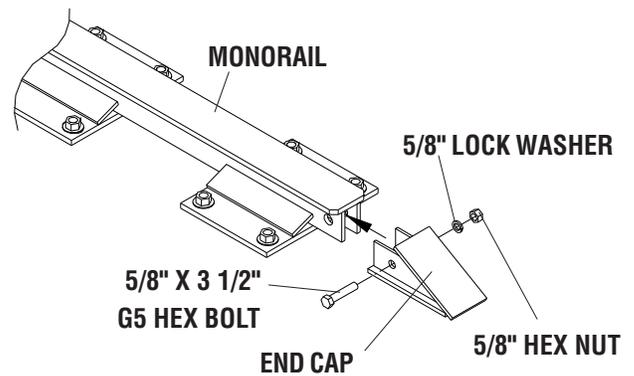


Figure 58
End Cap Assembly

QuadGuard® Elite

This page intentionally left blank.

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

13) Install Fender Panels

Note: Hinge plates may be factory installed to diaphragms. If not, use 5/8" x 4" hex bolts, lock washers and nuts as hinge pins to attach hinge plates to diaphragm.

Starting at the last bay, install left and right fender panels as shown in Figure 60. Attach the hinge plate at the front of the fender panels to the diaphragm in front using three 5/8" x 4" hex bolts, 5/8" hex nuts and 5/8" lock washers.

Attach mushroom washer assembly as shown in Figures Figures 60 & 61 but do not torque at this time.

Be sure mushroom washer lays flat against the fender panel as shown in Figure 62. Standoff on washer must be seated completely through slot.

Note: Do not mix the 5/8" rail nuts (large) with the 5/8" hex nuts (small). The rail nuts are oversize.

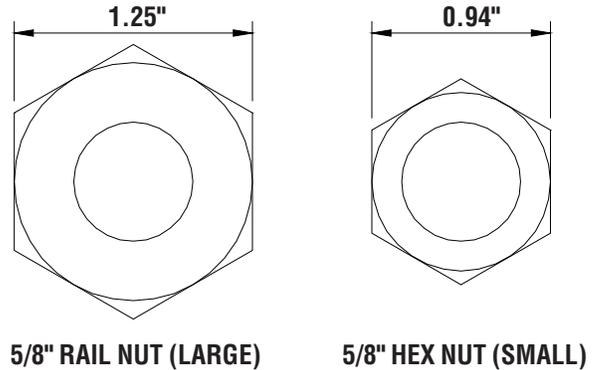


Figure 59
Rail Nuts are Oversize

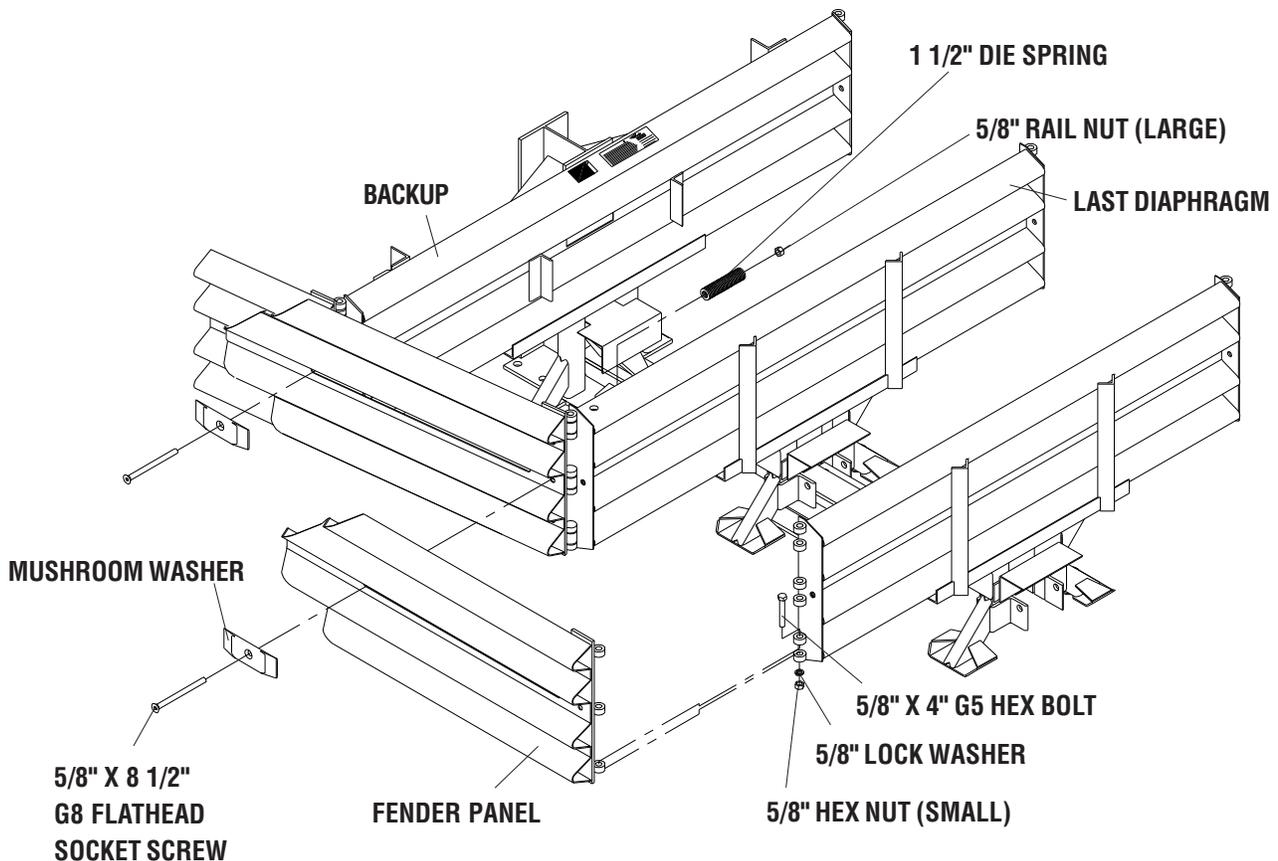


Figure 60
Fender Panel Assembly

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

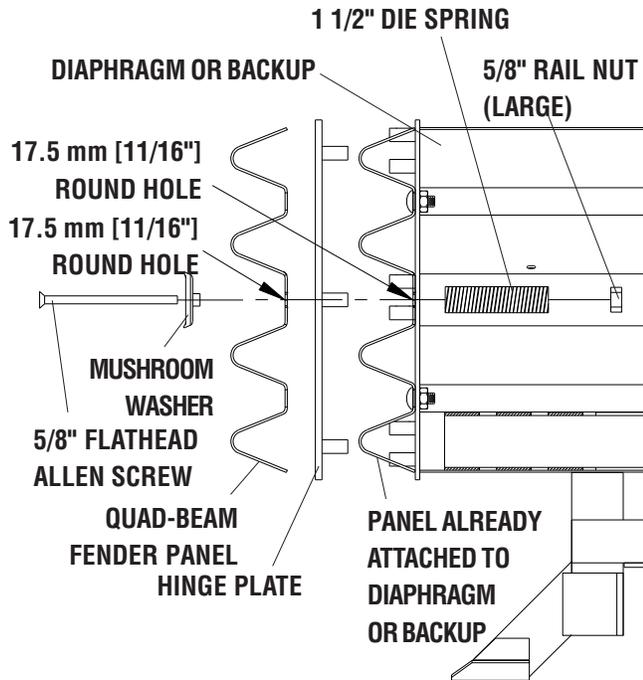


Figure 61
Mushroom Washer Assembly

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Figure 62. Standoff on washer must be seated completely through slot.

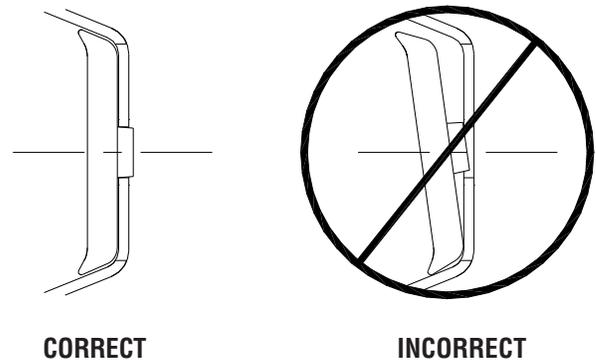


Figure 62
Mushroom Washer Orientation

14) Attach Pullout Brackets

Using 5/8" X 2 1/4" G8 hex bolts, 5/8" x 1 3/4" flat washers and 5/8" hex nuts, attach pullout brackets to 1st diaphragm as shown in Figure 63.

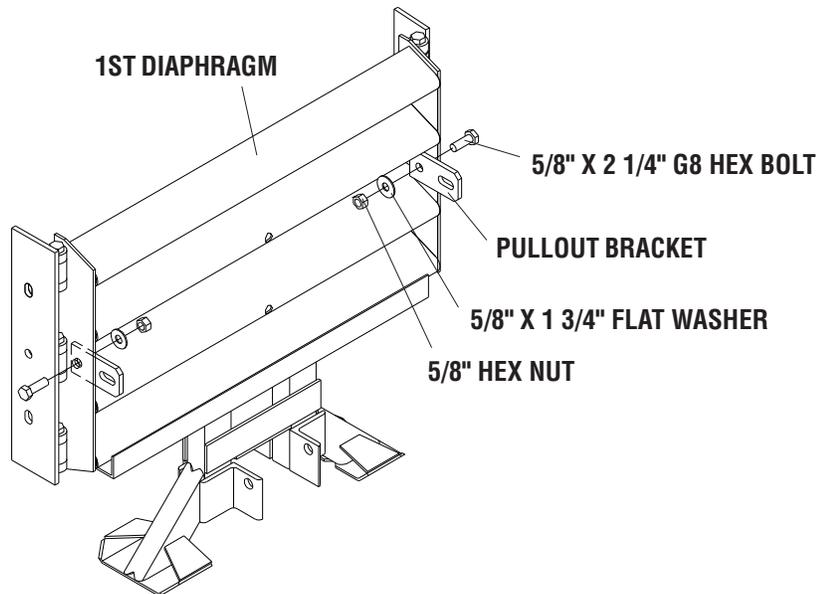


Figure 63
Pullout Bracket Attachment

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

15a) Install Nose Assembly

Attach the nose cylinder using two 1/2" x 5 3/4" long threaded rods through the nose cylinder plate, nose cylinder, and diaphragm (see Figure 64). Secure each 1/2" threaded rod with flat washers, nuts and a nose clamp shim and torque to 27 Nm [20 ft-lbs] minimum, 80 Nm [60 ft-lbs] maximum.

WARNING!

Placing the wrong type cylinder in the nose or any bay may result in unacceptable crash performance as described in NCHRP Report 350.

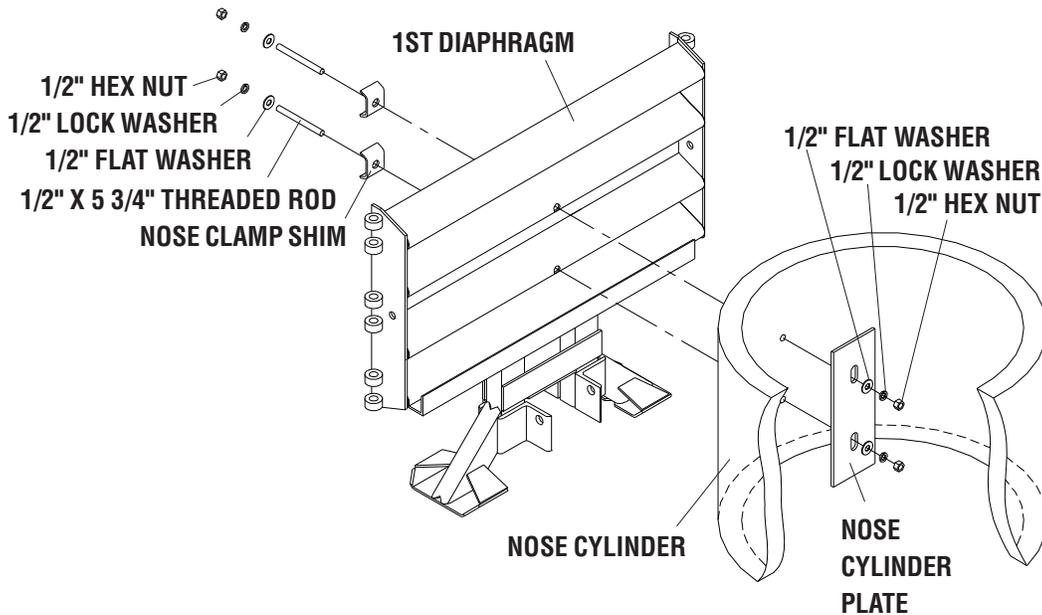


Figure 64

Attach Nose Cylinder To First Diaphragm

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

15b) For Wide Systems with Optional Nose Belt Assembly:

- Using 5/8" x 5" hex bolts, 5/8" x 1 3/4" flat washers and 5/8" hex nuts, attach hinge plate to fender panel as shown in Figure 65 (three places per side).
- Thread second 5/8" nuts onto the installed bolts. Be sure the face of the nuts are flush with humps on fender panels (see Figure 66). Slide second 5/8" x 1 3/4" flat washers onto bolts (three places per side).
- Align holes in each end of the nose belt with the installed bolts (three per side) and slide nose belt onto bolts.
- Align holes in belt clamps with bolts and slide belt clamps onto bolts.
- Using third 5/8" x 1 3/4" flat washers and third 5/8" hex nuts, secure the belt clamps and nose belt (three places per side).
- Be sure fender panel assembly is bolted to diaphragm at the hinge plate with 5/8" x 4" hex bolts, 5/8" nuts and 5/8" lock washers 3 places each side.

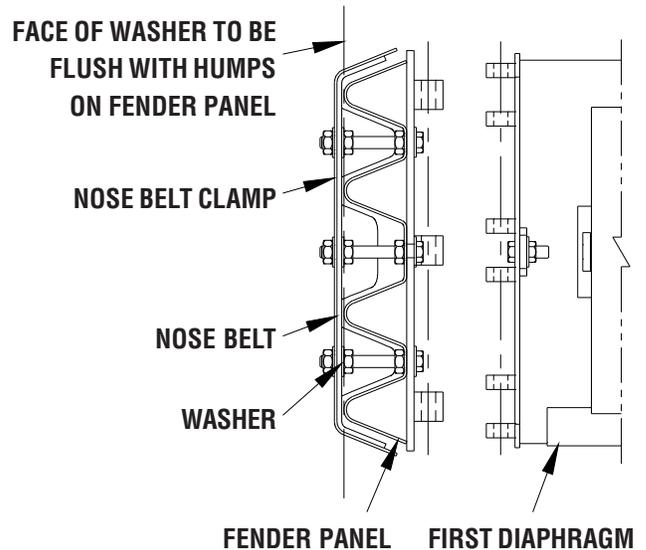


Figure 65

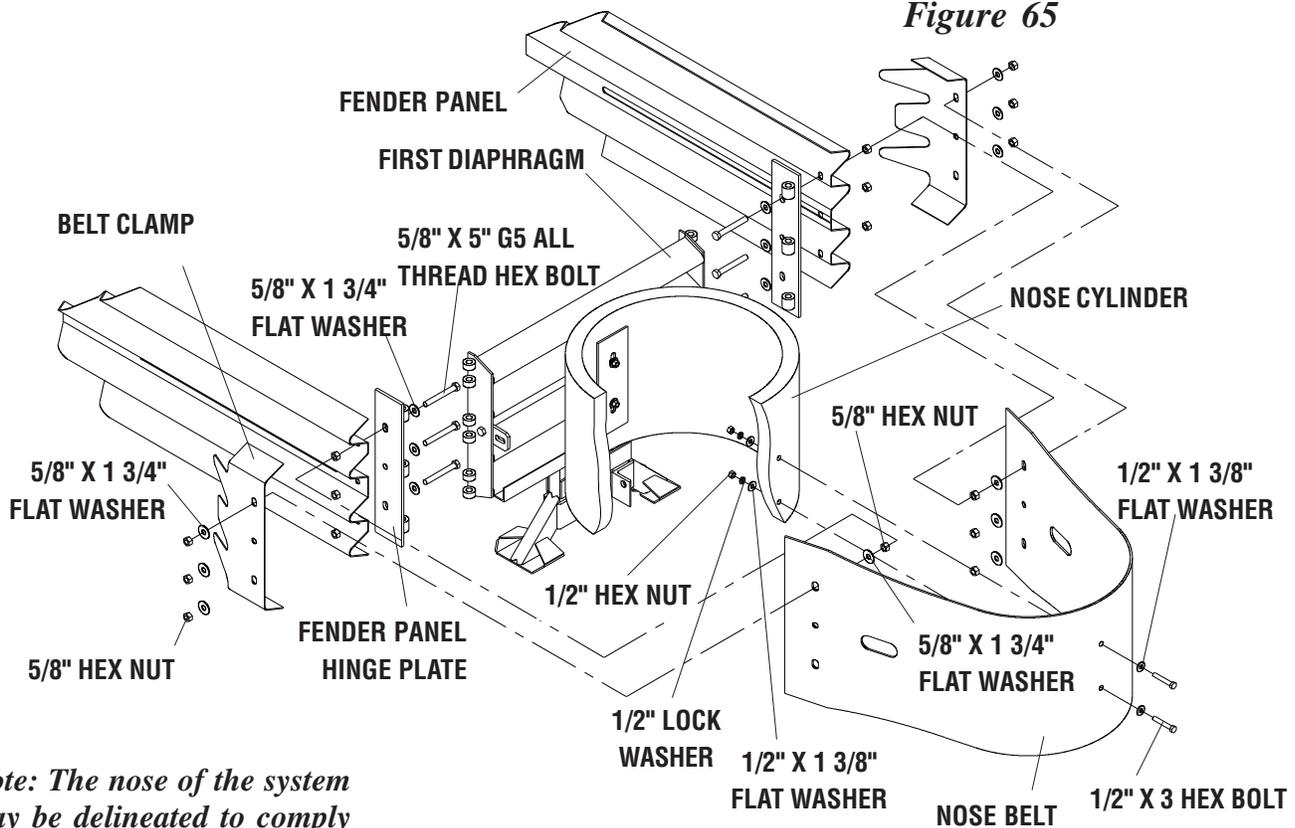


Figure 66

Attach Nose Belt to Fender Panels

Note: The nose of the system may be delineated to comply with local codes (chevron, reflectorized sign, etc.).

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

16) Diaphragm Spacing

Attach 10 mm [3/8"] grade 40 x 6 m [20'] chain to Pullout Brackets on Diaphragm No.1 (see Figure 67). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup).

Pull the QuadGuard Elite forward slowly until the system is fully extended, chains are taut, and mushroom bolts are bottomed out in slots in diaphragms without chains.

Torque all mushroom washer assembly nuts until they bottom out on threads of screws. Remove chains from pullout brackets.

17) Install Hit Indicator To Diaphragm No. 1

The Hit Indicator should be the last component installed on the system. Bolt the Hit Indicator to the first diaphragm with the hardware provided as shown in Figure 68.

Rotate the hit indicator to it's horizontal position and lock it into position by bending the trigger clip around the second diaphragm as shown in Figure 69.

WARNING!

Stand clear in case chain breaks or becomes disconnected.

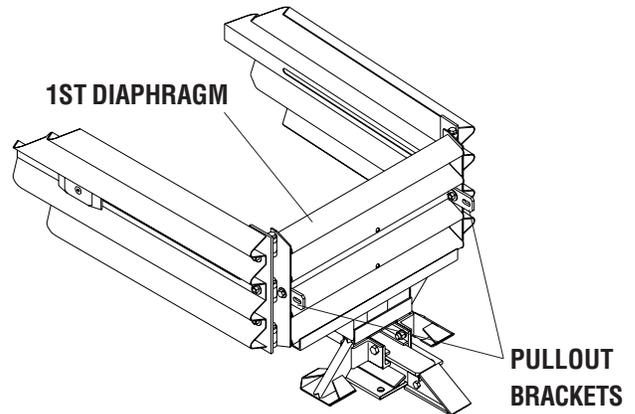


Figure 67

Attach Chain to Pullout Brackets

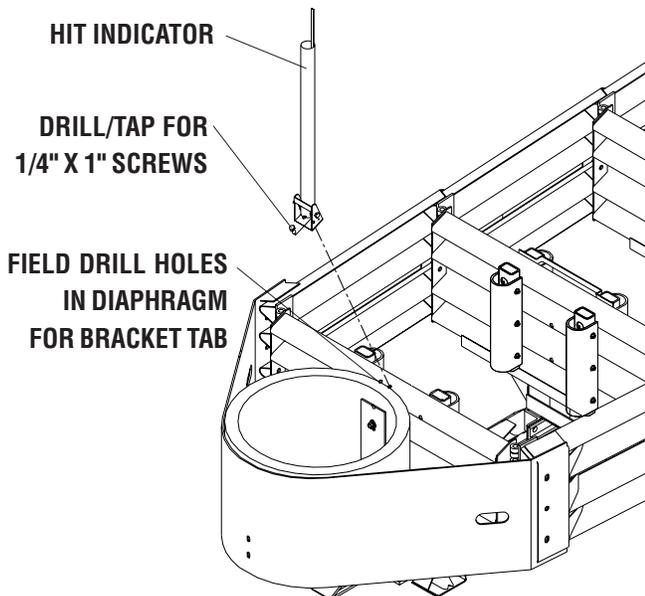


Figure 68

Install Hit Indicator

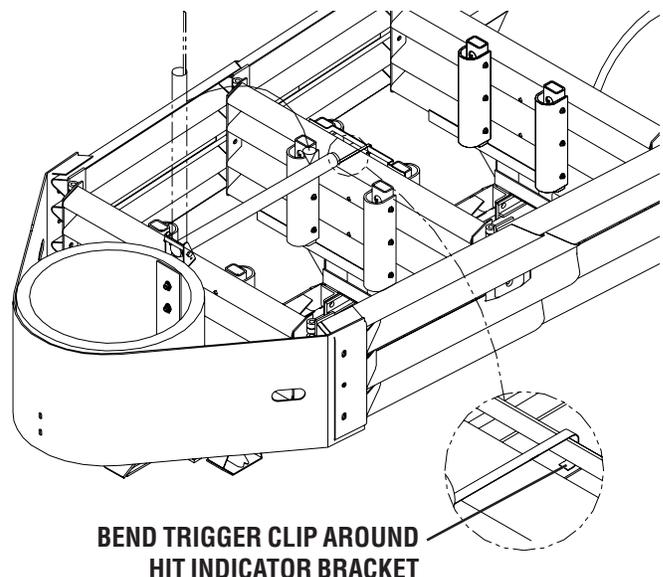


Figure 69

Rotate Hit Indicator/Bend Trigger Clip

QuadGuard® Elite

Installation for Wide Hazards (cont'd.)

18) Checking The System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See Table B. Check all Fender Panels. If they do not fit tightly against the underlying panel, system realignment may be necessary. (See Figure 70).

Table B

Checking The System Assembly

WARNING!

Mushroom Bolt Assemblies	Torqued to 80 Nm [60 ft-lbs]
Anchor Studs.....	Torqued to 165 Nm [120 ft-lbs]
	Should NOT Protrude Above Nuts (see Figure 47 on page 33)
All Other Bolts.....	Tightened
Fender Panel.....	Maximum Gap Allowed:
Wide Systems	25 mm [1.00 "] (see Figure 70)

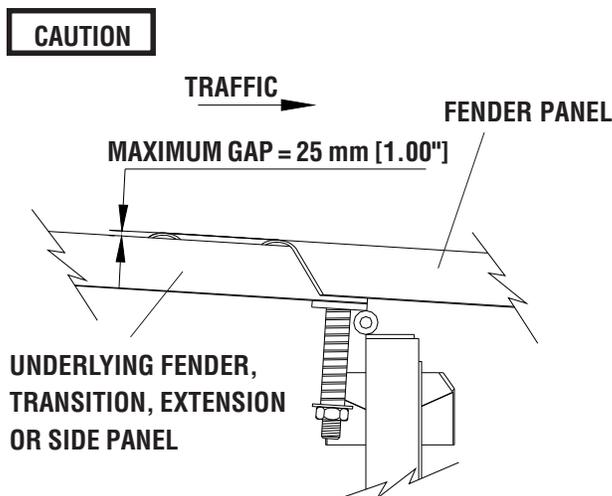


Figure 70
Maximum Fender Panel Gap On Bidirectional Traffic Side Of System

QuadGuard® Elite

MP-3® Polyester Anchoring System

The MP-3 Polyester Anchoring System is a quick and easy way to securely anchor crash cushions and other common highway devices. MP-3 features high pull-out strength, superior vibration resistance, and exceptional durability.

Each MP-3 kit contains a can of MP-3 resin, hardener, cold weather promoter, studs, washers, and a complete safety sheet. The cold weather promoter shortens hardening time by as much as seven hours. Both vertical and horizontal installations are possible using the MP-3 system.

Vertical Installations

Note: Read MP-3 Instructions before starting.

1) Prepare the Concrete Pad

WARNING!

Do not allow the MP-3 resin or hardener to contact skin or eyes. See material safety data sheet supplied with the MP-3 kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

WARNING!

Wear safety goggles and gloves during installation.

The anchor bolts (studs) that anchor the QuadGuard System backup and /or monorail sections to the concrete pad must be those shipped in the kit or of high strength steel (830 MPa [120,000 psi] minimum tensile strength or equal). These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of 7 days before installing MP-3.

2) Drill Holes

Note: Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing the MP-3 anchoring system.

Use the part that is to be anchored as a drilling template. Drill the holes 3 mm [1/8"] larger than the stud diameter to the recommended depth, using a rotary percussive drill. If a diamond drill is used, the surface will be too smooth for the MP-3 to adhere to and full strength will not be achieved. Refer to the MP-3 installation instructions provided with your kit. Check to be sure all the holes are drilled to the proper depth and aligned with the part to be anchored. Refer to Table C.

Table C

MP-3 Anchoring Information

Stud Size	Concrete bit Size	Minimum Depth	Recommended Torque
3/4" x 6 1/2"	22 mm [7/8"]	125 mm [5"]	165 Nm [120 ft-lbs]
3/4" x 7"	22 mm [7/8"]	140 mm [5 1/2"]	165 Nm [120 ft-lbs]
3/4" x 18"	22 mm [7/8"]	420 mm [16 1/2"]	<15 Nm [<10 ft-lbs]

3) Clean the Holes

Blow the concrete dust from the hole, using oil-free compressed air. Thoroughly brush it with a stiff-bristled brush, and then blow it out again. If the hole is wet, completely flush it with water while brushing. Then blow it clean, using oil-free compressed air.

QuadGuard® Elite

MP-3® Polyester Anchoring System (cont'd.)

4) Mix the Resin and Hardener

Wearing gloves and safety goggles, remove the lids from the MP-3® Part A-resin and Part B-hardener containers. Pour Part B into Part A, then mix vigorously for 30 seconds to form MP-3 grout (an anchor stud may serve as a stirring rod).

5) Add Cold Weather Promoter (in Cold Weather)

For faster hardening in cold weather, promoter may be used. Add the entire contents of the partially filled promoter container to the MP-3 grout; then mix for an additional 30 seconds. Use immediately because the MP-3 grout will thicken quickly. Refer to Table D for hardening times.

WARNING!

Do not use promoter when the temperature is above 15 degrees Celsius (60 degrees Fahrenheit). Grout will harden too quickly. Use only in well-ventilated area. Do not use near open flame.

6) Pour Grout into Holes

Crimp the mouth of the can to form a spout, and pour the MP-3 grout mixture down into the hole through the part. Fill the hole 1/3 to 1/2 full.

Caution: Do not overfill or underfill the hole. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is under-filled the grout may not develop the required pull out strength.

7) Add the Washers and Nuts

Place a flat washer onto the stud; then thread a nut on until 1 or 2 threads of the NUT are left exposed.

8) Insert Studs in Holes and Wait for Grout to Harden

Push the stud down through the part to be anchored and into the hole. Give the stud several twists in the MP-3 to wet the threads.

Caution: Do not disturb or load the stud until the MP-3 material has hardened (see Table D).

9) Torque the Nuts

Once the grout has hardened, torque the nut to the recommended values. (See Table C).

Table D

Approximate Hardening Times (hours)

Temperature		Hardening Time (hours)	
(°C)	(°F)	No Promoter	With Promoter
>26	>80	1/2	N/R*
22-26	70-79	1	N/R
16-21	60-69	2	N/R
10-15	50-59	4	3/4
4-9	40-49	8	1
-1-3	30-39	N/R	1 1/2
<-1	<30	N/R	N/R**

*Not recommended

**Contact Customer Service Department for more information

QuadGuard® Elite

MP-3® Polyester Anchoring System (cont'd.)

Horizontal Installations

The horizontal MP-3 kit is the same as the vertical kit except that a cartridge for a standard caulking gun is supplied in the horizontal kits and the resin for the horizontal kits is a thixotropic (TX) resin. The TX-Resin is a gelled resin designed to keep the grout in place in horizontal holes during installation.

When using the horizontal MP-3 kits follow the vertical instructions with the following exceptions:

1) Thread Dispensing Tip onto Dispenser

Prior to mixing the grout carefully thread the dispensing tip onto the dispenser.

2) Pour Mixed Grout into Dispenser

Once the grout is mixed crimp the mouth of the can to form a spout, and pour the MP-3 grout into the open end of the dispenser (use mixing stud to scrape out the portion remaining in the can). You may use the box to hold the dispenser upright. Close the box lid and poke the dispenser tip into the top of it. Seal the dispenser with the plunger provided.

3) Place Dispenser in Caulking Gun and Dispense Grout

Cut the small end of the dispenser tip off. Place the dispenser into a caulking gun and dispense until MP-3 TX grout reaches the tip of the dispenser, then release pressure. Push the dispenser tip through the part to the bottom of the hole and dispense while slowly withdrawing the tip.

Caution: Do not over- or underfill the hole. Fill hole approximately 1/3 to 1/2 full. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is under-filled the grout may not develop the required pull out strength.

4) Add the Washers and Nuts

Put washer and nut on stud leaving nut flush with end of stud.

5) Insert Studs into Holes

Push stud through part to be anchored and into hole.

Note: In horizontal applications the stud should be flush with the top of the nut. Torque to 165 Nm [120 ft-lbs.].

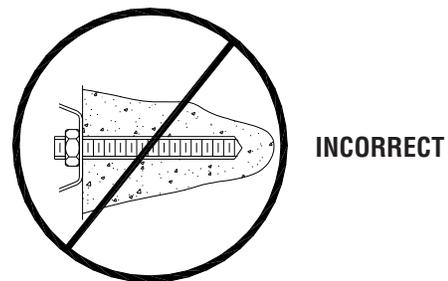
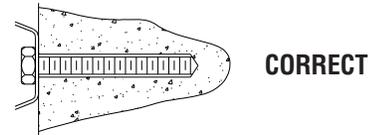


Figure 71
MP-3 Horizontal Installation

QuadGuard® Elite

MP-3® Polyester Anchoring System (cont'd.)

MP-3® Installation Cautions

1) Shelf life

If the shelf life of the MP-3 has expired (see MP-3 kit for expiration information), mix a small amount of MP-3 in the proportions of one part A to two parts B by volume. If the material does not set according to the instructions, contact Energy Absorption Systems, Inc. for guidance.

WARNING!

Do not use the MP-3 if: the material fails to set up, Part A-Resin has gelled (for vertical applications), or TX-Resin is NOT gelled (for horizontal applications).

2) Steel rebar

If steel rebar is encountered while drilling an MP-3 anchor bolt hole, apply one of the following solutions:

- A. Using a diamond core drill or rebar drilling tool, drill through the rebar only, then switch back to the concrete bit and drill into the underlying concrete until the proper hole depth is reached.

Caution: Do not drill through rebar without first obtaining permission to do so from the local project engineer.

- B. Drill a new hole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both holes with MP-3.

QuadGuard® Elite

Maintenance

Frequency

Inspections are recommended as needed based upon volume of traffic and impact history. Visual Drive-By Inspections are recommended at least once a month. Walk-Up Inspections are recommended at least once a year.

Visual Drive-By Inspection

- 1) Encountering a system with the hit indicator in the vertical position mandates inspection of the system. A walk-up inspection will be necessary.
- 2) Inspect the system in accordance with the QuadGuard Elite Maintenance Flow Chart on page 58.

Caution: It is important to inspect a system after it has been impacted even if it appears to be self-restored and fully maintained. In particular, check the fender panels/diaphragm attachment bolts to be sure none have failed.

Note: Refer to cylinder placement Figures 77 & 78 on pages 56 & 57.

- 3) Be sure the nose cover is in place.
- 4) Note the location and condition of the QuadGuard Elite and the date of visual drive-by inspection.

Walk-Up Inspection

Caution: A system that has been impacted can store energy in collapsed cylinders, and may spring back unexpectedly causing possible serious injury (see "Restoring Collapsed Systems" on page 54). Use caution when inspecting, disassembling or restoring systems that are collapsed in any amount.

Maintenance Checklist

- 1) Clear and dispose of any debris on the site.
- 2) Be sure all bolts are tight and rust free.
- 3) Be sure concrete anchor bolts are securely anchored.
- 4) Be sure diaphragm legs are straight, and chains are taut.
- 5) Be sure all mushroom washer assemblies are properly aligned and positioned (see Figure 73).
- 6) Fender panels and transition panels should nest tightly against the system. For wrong way traffic, the maximum gap allowed is 20 mm [.78"].
- 7) Be sure cylinders are in good condition and are properly positioned on their support brackets.
- 8) Inspection of the system is necessary if the hit indicator is in the UP position even if system appears normal.

Note: The energy absorbing plastic cylinders, made from High Density Polyethylene, lose their ability to absorb energy with increasing number of system impacts. After a number of full capacity design impacts, defined as a 2000 kg [4409 lb] vehicle hitting the system head on at 100 km/h [62 m.p.h.], the system will no longer be able to meet the requirements as specified in NCHRP Report 350. To ensure that Cylinder replacement is accomplished before this condition occurs it is essential that this part of the inspection be conducted every time the hit indicator indicates the system has been impacted. (See Figure 72.)

The rear-most cylinder must measure at least 660 mm [26"] for proper impact performance (see Figure 72). If distance is less than 660 mm [26"], replace all QE1, QE2 and QEN cylinders. If distance is greater than 660 mm [26"], inspect all cylinders for major cracks, tears or cuts. Replace any damaged cylinders. Please call Energy Absorption Systems, Inc., Customer Service Department at (888) 323-6374 if you have additional questions.

QuadGuard® Elite

Maintenance (cont'd.)

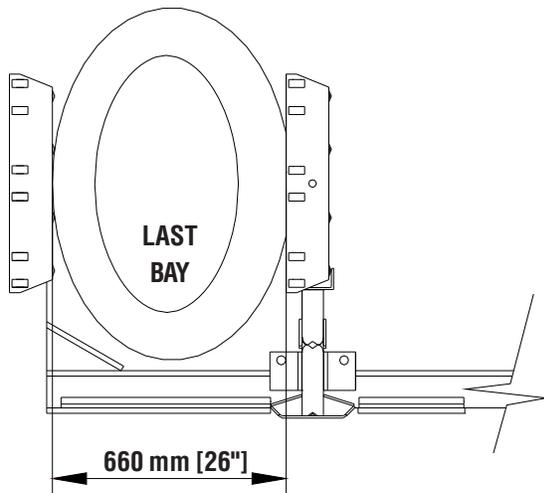


Figure 72

Distance Across Minor Axis Of QE2 Cylinder

Note: Refer to cylinder placement Figures 77 & 78 on pages 56-57.

9) Be sure system is at its full length.

Caution: Systems that are not restored to their full length may not perform to impact performance standards of NCHRP Report 350.

10) Make all necessary repairs as described above. Refer to page 52, Post-Impact Instructions, in this manual for more information.

11) Note the location and condition of the QuadGuard Elite, and any work done, in the Impact Attenuator Inspection Logbook under the date of this inspection. If further repair is necessary, note repair request date in logbook. Walk-up inspections are recommended as needed based upon volume of traffic & impact history. Refer to Post-Impact Instructions beginning on page 52 and installation manual for more information.

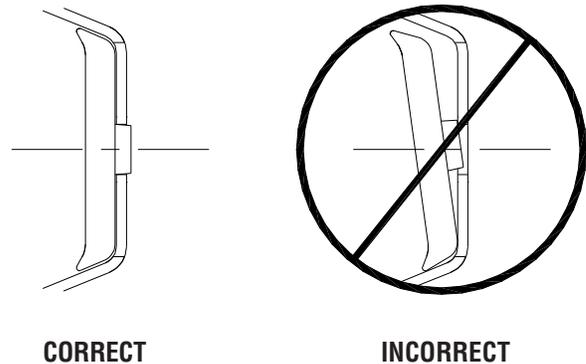


Figure 73

Mushroom Washer Orientation

QuadGuard® Elite

Maintenance (cont'd.)

Tools Required

1. Traffic-control equipment
2. Pickup truck or similar vehicle
3. Ratchet, 1/2" drive with 6" extension rod
4. 1/2" drive hinged handle x 24" long
5. 1/2" drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", and 1 1/4"
6. Box/open-end wrenches: 9/16", 11/16", 3/4", 15/16", 1 1/8", and 1 1/4"
7. Pliers
8. Large screwdriver or drift pin, 300 mm [12"]
9. Allen wrench, 3/8"
10. Hammer, 4 lb.
11. Chain, 3/8", Grade 40, 6m [20'] with hooks 1/2"
12. Crescent wrench 12"
13. Digging or pry bar 1.8 m [6']
14. 1/2" drive torque wrench, 200 ft-lbs.
15. Protective Eyewear
16. Gloves
17. Sledge hammer
18. Tape measure 7.5 m [25']

Note: The above list of tools is a general recommendation. The actual number of tools required will depend on specific site conditions and the complexity of the installation.

Post-Impact Instructions

1. Deploy the appropriate traffic-control devices to protect your crew.

WARNING!

A system that has been impacted can store energy in collapsed cylinders and may spring back unexpectedly, causing possible serious injury (see page 54). Use caution when disassembling and restoring damaged units.

2. Check to see that all anchor bolts have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out. Proper performance of the system depends on the monorail anchors being properly installed.
3. Clear and dispose of any debris on the site.
4. Check the system to be certain that the mushroom washer assemblies holding the fender panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
5. Be sure that the diaphragm support legs are all properly attached to the monorail.
6. Attach 10 mm [3/8"] Grade 40 x 6 m [20'] chain to pullout brackets on first diaphragm (see Figure 79). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup).

WARNING!

Stand clear when pulling System out in case chain breaks or becomes disconnected.

QuadGuard® Elite

Maintenance (cont'd.)

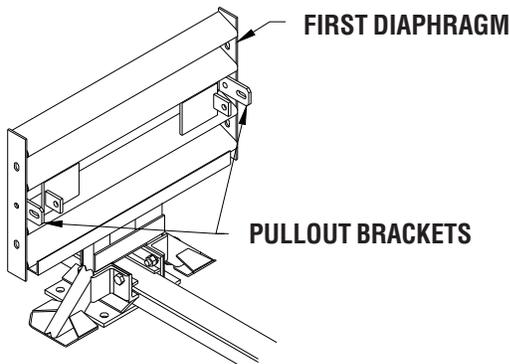


Figure 74

Attach Chain to Pullout Brackets

Note: Do not wrap a chain around the bottom legs of the front diaphragm and pull. This may cause binding of the system. The pull force should be aligned with the long slots in the fender panels to prevent system binding.

Slowly pull the QuadGuard Elite forward, until the system reaches its original length. Have someone watch the system during repositioning to be certain previously undetected damage does not cause the diaphragms to bind or pull out improperly.

7. Remove all damaged cylinders from within the system. Inspect the system in accordance with the QuadGuard Elite Maintenance Flow Chart on page 58. After typical design speed impacts, the cylinders are reusable: refer to Limitations and Warnings on page 61.
8. Check to see that the diaphragms are in usable condition. Diaphragms that are bowed or have bent legs must be replaced.
9. Check that the fender panels are properly attached with the mushroom washer assemblies. Check all bolt connections of fender panels to diaphragms. Damaged bolts, fender panels and transition panels must be replaced.

10. Check the gap of the fender panels. The maximum gap allowed for these overlapping parts on the side of the system with traffic approaching from the rear, (including fender panels overlapping components behind the system) is 20 mm [.78"] for narrow systems and 25 mm [1.00"] for wide systems. Be sure the mushroom washer assemblies are torqued to 80 Nm [60 ft-lbs]. If the gaps between the fender panels are still too large it may be necessary to replace bent parts.
11. Replace all damaged cylinders. Inspect the system in accordance with the QuadGuard Elite Maintenance Flow Chart on page 58. If a cylinder's condition is questionable, a photo of the cylinder may be forwarded to Energy Absorption Systems, Inc. for evaluation.
12. Check the torque of all bolts on the system (see Torque Specifications on page 54).
13. Check to be certain that the site is free from any debris. The QuadGuard Elite is once again ready for use.

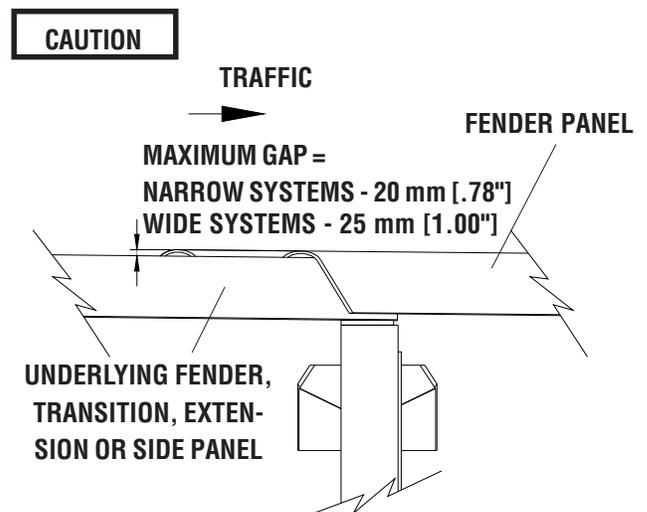


Figure 75
Fender Panel Gap

QuadGuard® Elite

Maintenance (cont'd.)

Torque Specifications

WARNING!

Mushroom Bolt

AssembliesTorqued to 80 Nm [60 ft-lbs]

Anchor Studs.....Torqued to 165 Nm [120 ft-lbs]

Should NOT Protrude Above Nuts
(see Figure 76)

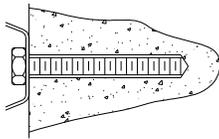
All Other Bolts.....Tightened

Fender Panel.....Maximum Gap Allowed:

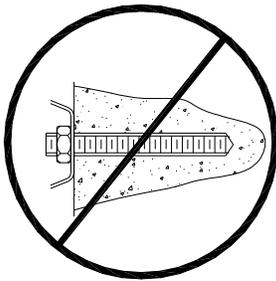
Narrow Systems - 20 mm [.78"]

Wide Systems - 25 mm [1.00"]

(see Figure 75)



CORRECT



INCORRECT

Figure 76

MP-3 Horizontal Installation

The 11 bay QuadGuard Elite has been certified as meeting the requirements of NCHRP 350 Guidelines for Test Level 2 (TL-2), and Test Level 3 (TL-3) terminals and crash cushions. The impact conditions recommended in this guideline are intended to encompass the majority, but not all, of the possible in-service collisions the system may be exposed to. Severe impacts in excess of these guidelines may damage the system causing it to remain in a collapsed state.

WARNING!

Self-restoring systems, such as the QuadGuard Elite, have the ability to "store" spring-back energy that could potentially cause sudden movement of these systems and potential injury to unsuspecting workers. After "extreme" impacts outside the design envelope of these systems (NCHRP 350, TL-3, 100 km/h), these systems may suffer damage and bind up. This condition would be visually evident by bays of the system staying collapsed after an impact (with bay-spacings of 24" or less for the QuadGuard Elite). (It should be noted that this condition did not occur during any of the full scale crash tests of the NCHRP 350 certified QuadGuard Elites.) Extreme compression of QuadGuard Elite cylinders after an impact, especially the thick-walled cylinders (QE2), is an indication that the system is storing large amounts of "spring-back" energy that could potentially cause sudden movement of the system and potential injury to an unsuspecting person. Repair of a QuadGuard Elite in this condition must be done with caution.

WARNING!

A compressed and locked up system may store large amounts of potential energy in the QE2 cylinders. DO NOT stand in front of, on top of, or put any member of your body on or inside any portion of a collapsed system. Instead, use a chain and truck to pull from the front of the system, as explained in the next section.

Restoring Collapsed Systems

1) System Restoration

Before starting this procedure, please read and understand the foregoing "Warning" statement. The following instructions outline a set of steps for positioning a large vehicle up against a compressed system to prevent unexpected system spring-back while maintenance workers are attempting to repair the system.

- A. Position a truck of not less than 6,000 kg [13,000 lbs.] centered on the system just in front of the system's nose assembly. The truck should be presenting its strongest bumper to

QuadGuard® Elite

Maintenance (cont'd.)

the system. The selected bumper's height should be so that the center of the bumper rests on the middle of the systems nose assembly (approximately, 610 mm [24"] in height).

- B. Drive the truck so that the bumper displaces the systems nose cylinder approximately 150 mm [6"]. In the absence of the nose assembly, place a protective material between the bumper and the leading diaphragm leaving approximately 25 mm [1"] gap between the protective material and the vehicle's bumper. The driver should remain in the vehicle depressing the brake pedal after the vehicle has been placed in position.

WARNING!

Once the leading bumper is over the system's monorail, the vehicle may be subject to impact by the system due to an unexpected restoration. The driver should be wearing a seat belt and have the vehicle in the lowest possible gear when approaching the system. In the event that the system unexpectedly deploys before step two is completed the driver should apply the brakes immediately, bringing the vehicle to a controlled stop. The driver should then put the vehicle in neutral while still applying the brakes. Gradually release the brakes allowing the system to push the vehicle back in a safe and controlled manner.

- C. It should now be safe for a maintenance worker to inspect the system to determine where mechanical binding is present. Remove all debris from the system prior to checking for binding. The binding will probably be located at the monorail guides on the forward-most diaphragm(s) or fender panels. Cautiously, using a pry bar or jostling of the system with the vehicle may aid in releasing the mechanism of binding. Once released, the driver should allow the system to self restore in a safe, controllable manner.

WARNING!

Use caution when releasing the mechanism of binding. Keep hands and other body parts as far away as practically possible from the system. Be careful of tools (pry bar, etc.) that may move unexpectedly by the system if binding is released.

- D. Replace all damaged system components and reassemble per the QuadGuard® Elite manual instructions.

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on pages 56, 57, 59, 60 and the installation drawings. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

Table F

QuadGuard Elite Ordering Information Chart

Description	Choices	Fill in this section
What type of transition panel? (Be sure to note right side, left side, both side or no transitions. Refer to page 60.)	Quad to W Quad to Thrie Quad to End Shoe Quad to Safety Shape Barrier	
Width of Backup	100 mm [4"] Offset Panel 610 mm [24"] 760 mm [30"] 915 mm [36"] 1620 mm [64"] 2100 mm [83"] Other	

QuadGuard® Elite

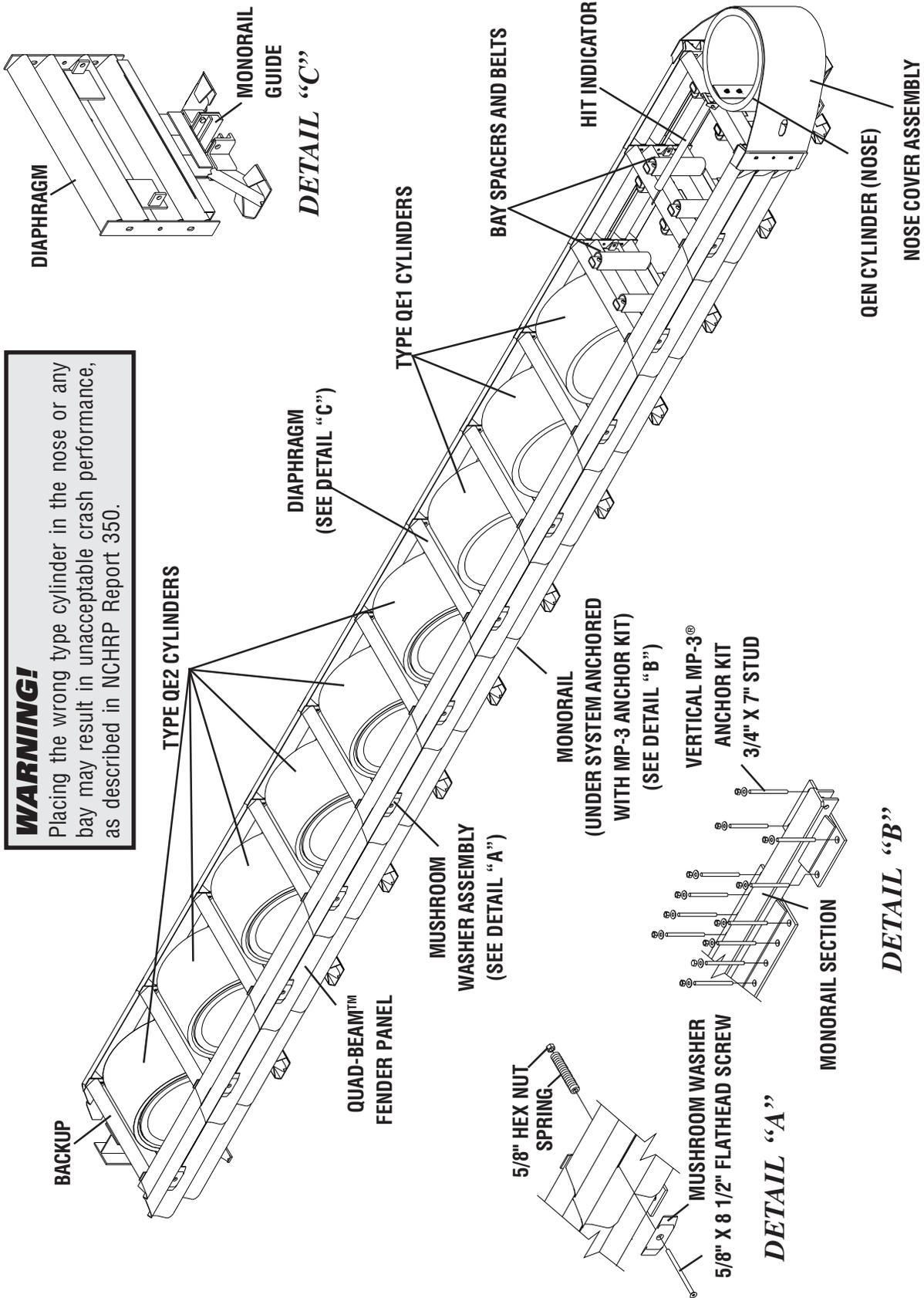
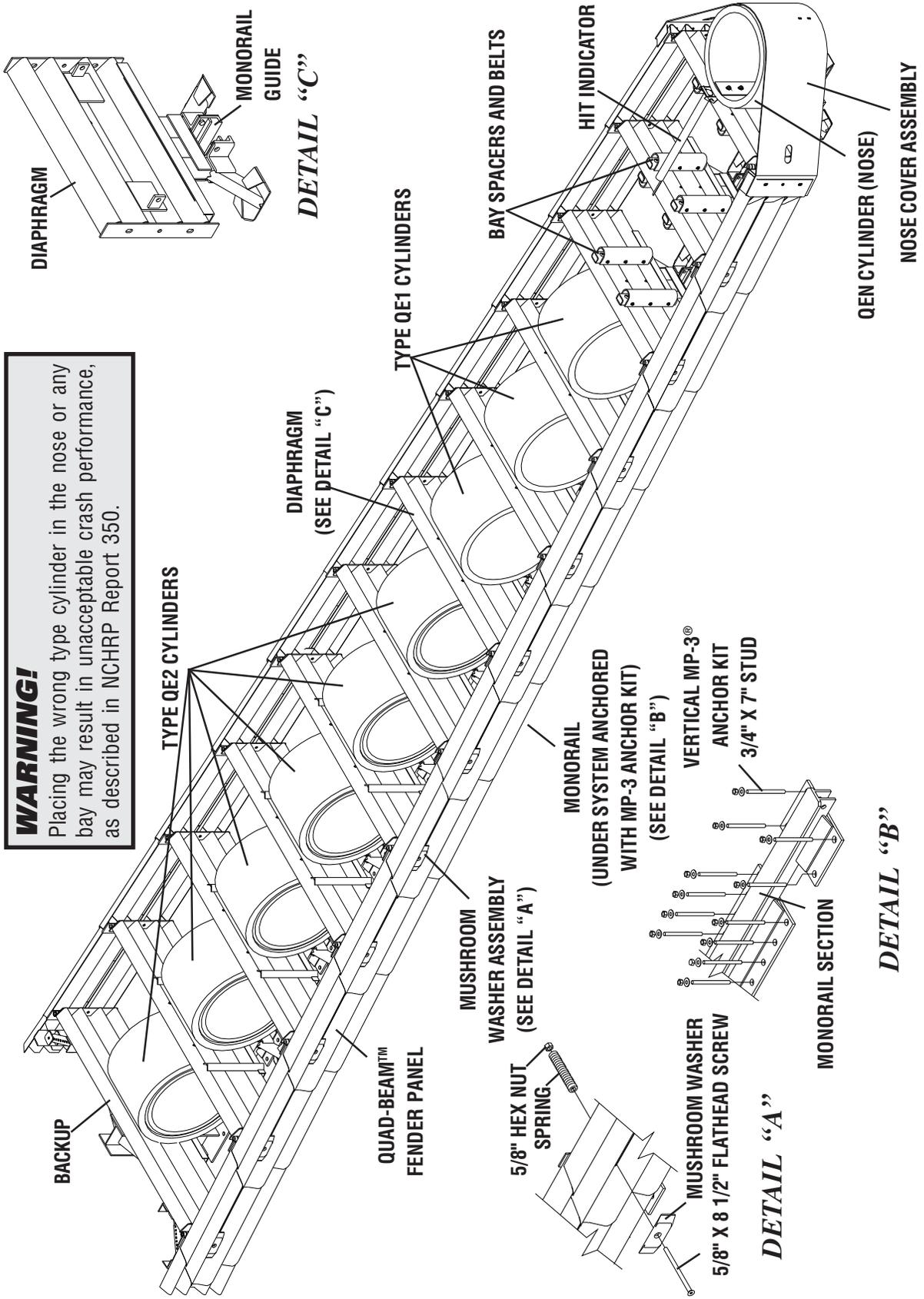


Figure 77

QuadGuard® Elite



WARNING!
Placing the wrong type cylinder in the nose or any bay may result in unacceptable crash performance, as described in NCHRP Report 350.

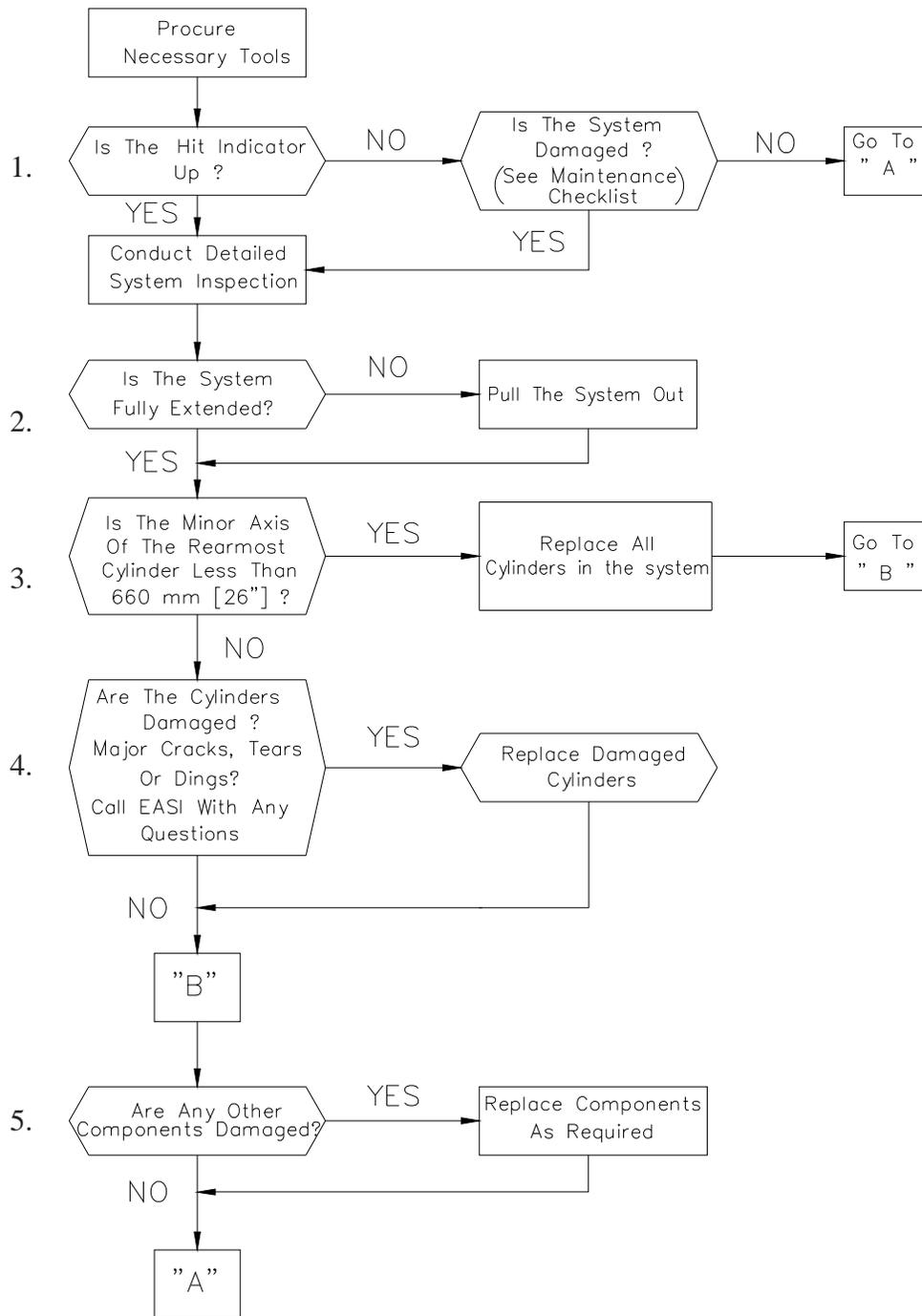
Figure 78

QuadGuard® Elite

Maintenance (cont'd.)

Maintenance Flow Chart

The flow chart is provided only to clarify the sequence of steps. Refer to the appropriate sections of this manual for the procedures that need to be performed.



QuadGuard™ Elite® Maintenance Flow Chart

QuadGuard® Elite

Maintenance (cont'd.)

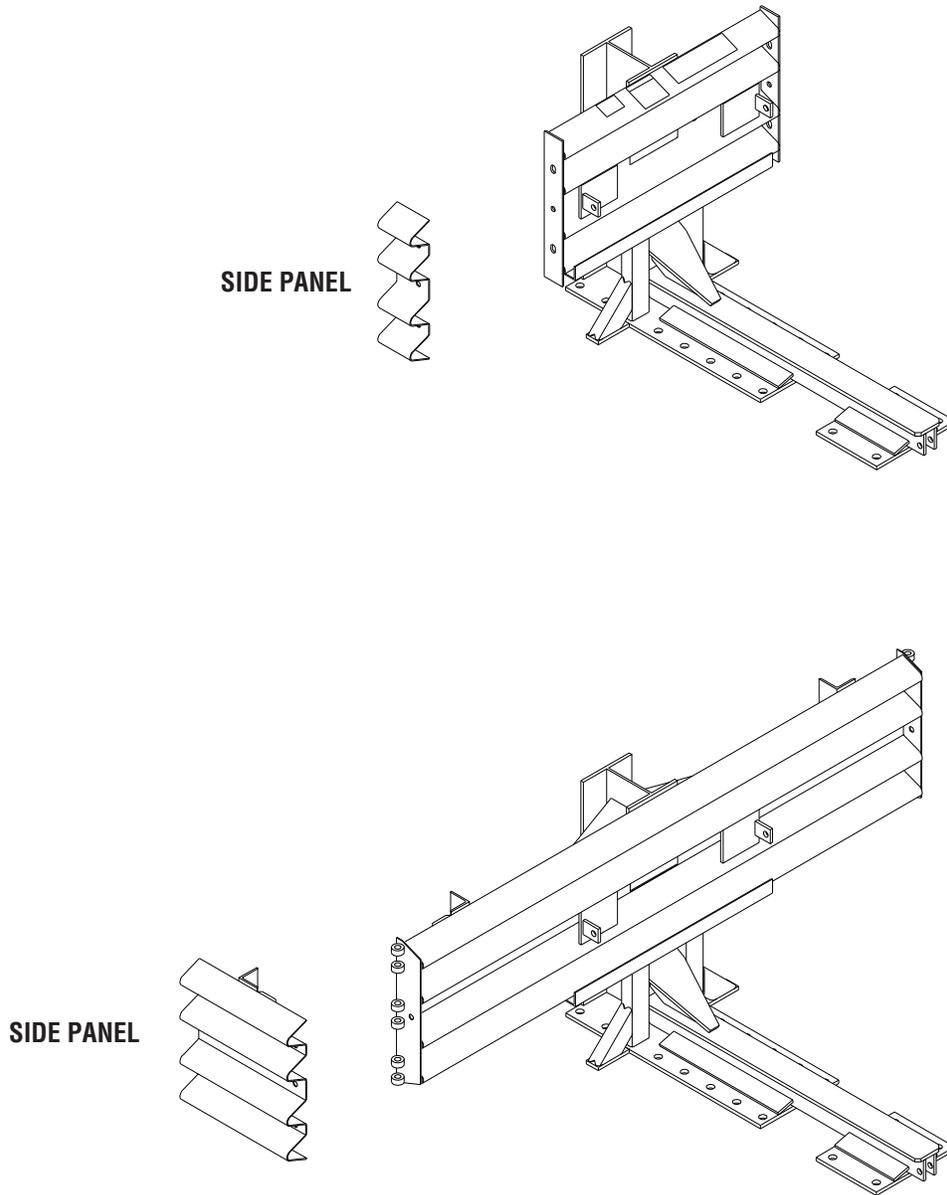


Figure 79
Backups

QuadGuard® Elite

Maintenance (cont'd.)

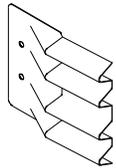


Figure 80
Quad-Beam End Shoe

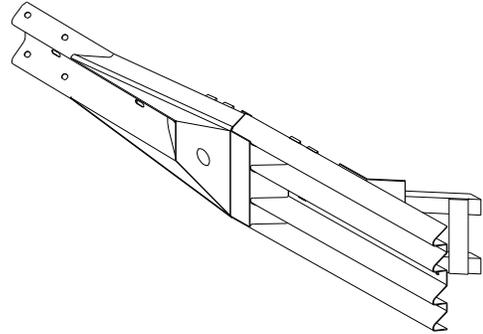


Figure 81
Quad-Beam to W-Beam Transition Panel

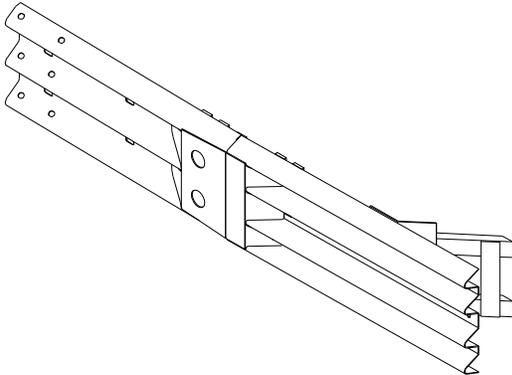


Figure 82
Quad-Beam to Thrie-Beam Transition Panel

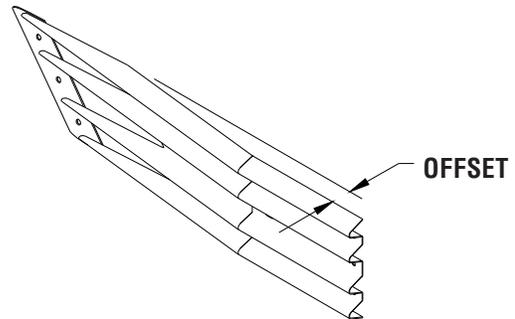


Figure 83
Quad-Beam to Safety Shape Barrier Transition Panel

QuadGuard® Elite

Limitations and Warnings

Energy Absorption Systems, Inc., in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) "Recommended Procedures for the Safety Performance of Highway Safety Features", contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The QuadGuard® Elite System has been approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350* TL-2 (7 bay System) and TL-3 (8 bay System). These tests typically evaluate product performance by closely simulating actual impacts involving a typical range of vehicles on roadways, from lightweight cars (approx. 820 kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]). A product can be certified for various speed levels.

TL-1: 50 km/h [31.10 m.p.h.]

TL-2: 70 km/h [43.49 m.p.h.]

TL-3: 100 km/h [62.13 m.p.h.]

These tests are not designed to represent the performance of products when impacted by every vehicle type or every impact condition.

Energy Absorption Systems, Inc. does not represent nor warrant that the results of these controlled tests show that vehicle impacts with the products in other conditions would necessarily avoid injury to person(s) or property. Impacts that exceed the design capabilities of the product may not result in acceptable crash performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk and vehicle trajectory. Energy Absorption Systems, Inc. expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision, or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were installed by or under the direction of Energy Absorption Systems, Inc. or by third parties.

The QuadGuard Elite System was designed to be installed, delineated, and maintained in accordance with State and Federal guidelines. It is important to select the most appropriate product configuration for a site. The customer should be careful to properly select, install and maintain the product. Careful evaluation of the site geometry, vehicle population type, speed, traffic direction and visibility are some of the elements that require evaluation in the proper selection of a safety appurtenance. For example, curbs could cause unsafe vehicle trajectory.

After an impact occurs, the product should be restored to its original condition as soon as possible. When a reusable safety product is struck, it is still necessary to restore the product to its original length and inspect all the components for damage and repair and/or replace components as necessary.

The restorable nature of the cylinders could provide for potential rebounding of an impacting vehicle into pathways beyond the reserve area under certain impact conditions. Consideration for a System for a particular site should include an assessment of this factor.

Impact conditions which differ from those described in the NCHRP Report 350* test matrix for non-gating, redirective crash cushions may result in different crash results than those encountered in testing. Furthermore, impacts in excess of TL-3 impact severity, or the existence (at the site of the installation) of curbs or cross slopes in excess of 8%, may yield crash performance which does not meet NCHRP 350 evaluation criteria relative to structural adequacy, occupant risk and vehicle trajectory factors.

* Copy of NCHRP Report 350 may be obtained from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

It is also available at: http://safety.fhwa.dot.gov/fourthlevel/pro_res_road_nchrp350.htm

QuadGuard® Elite

Notes

QuadGuard® Elite

Notes

Customer Service Department

USA

Phone 1-888-323-6374

Fax 1-312-467-1356

Asia Pacific

Phone +65 6276 3398

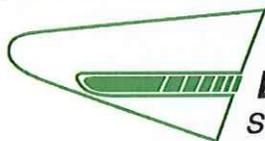
Fax +65 6276 6218

Europe

Phone +44-1473-221-105

Fax +44-1473-221-106

35 East Wacker Dr., 11th Floor
Chicago, IL 60601-2076
Engineering and Manufacturing Facilities:
Rocklin, California and Pell City, Alabama



ENERGY ABSORPTION
SYSTEMS, INC.



A TRINITY INDUSTRIES, INC. COMPANY

Saving Lives By Design

Rev. D 7/26/10 <http://www.energyabsorption.com/>

Part No. 115269B
©2009 Energy Absorption Systems, Inc.

QuadGuard® Elite

Product Manual

Part No. 612790B

Revision E March 2012



TRINITY
HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

QuadGuard[®] Elite

Product Manual



2525 Stemmons Freeway
Dallas, Texas 75207



Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the QuadGuard[®] Elite system. These instructions are for standard assemblies specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted for use by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Energy Absorption Systems representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Energy Absorption Systems at (888) 323-6374 or download from websites below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest QuadGuard[®] Elite system information available to Energy Absorption Systems at the time of printing. We reserve the right to make changes at any time. Please contact Energy Absorption Systems to confirm that you are referring to the most current instructions.

Table of Contents

Customer Service Contacts	3
Important Introductory Notes	3
Recommended Safety Rules for Assembly	4
Safety Symbols	5
Warning and Cautions	5
Limitations and Warnings.....	6
System Overview	7
Design Criteria	9
Special Site Conditions	11
General Assembly Information.....	15
General Maintenance and Repair	18
Reference Drawings	19
QuadGuard® Elite System w/ Tension Strut Backup 70km/h [44 mph]	19
QuadGuard® Elite System w/ Tension Strut Backup 70km/h [44 mph]	20
QuadGuard® Elite System w/ Tension Strut Backup 100 km/h [62mph]	21
QuadGuard® Elite System 69" w/ Tension Strut Backup 70 km/h [44 mph].....	22
QuadGuard® Elite System 90" w/83" Tension Strut Backup 70 km/h [44 mph].....	23
QuadGuard® Elite System 69" w/64" Tension Strut Backup 100 km/h [62 mph].....	24
QuadGuard® Elite System 90" w/83" Tension Strut Backup 100 km/h [62 mph].....	25
QuadGuard® Elite System Backup Assembly, TS, QGE Wide	26
QuadGuard® Elite System Fender Panel Assembly, 24, 30, 36 & 48	27
QuadGuard® Elite System Hit Indicator Assembly	28
QuadGuard® Elite System Diaphragm Assembly, QGE, 24, 30, 36.....	29
QuadGuard® Elite Fender Panel Assembly QG LMC/QGE/CEN, 69/90.....	30
QuadGuard® Elite System Monorail Assembly, QGE for 5, 7, 8, 11 & 14 Bay Systems.....	31
QuadGuard® Elite System Concrete Foundation, QG Elite.....	32
QuadGuard® Elite System Backup Assembly, TS, QGE, 24, 30, 36.....	33
Chain Assembly, QGE, 24, 30 36 Bay 1 & 2.....	34
Chain Assembly, QGE	35
QuadGuard® Elite System Bay Assembly, QGE, 24, 30, 36	36
QuadGuard® Elite System Bay Assembly, QGE, 24, 30, 36	37
QuadGuard® Elite System Bay Assembly, QGE, 69/90	38
QuadGuard® Elite System Bay Assembly, QGE, 69/90	39
QuadGuard® Elite System Nose Assembly, QGE, 24, 30, & 36, G or Y	40
QuadGuard® Elite System Nose Assembly, QGE, G or Y, 69/90	41
QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90.....	42
QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 11 Bay	43
QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 7 & 8 Bay	44
QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 5 Bay	45

Customer Service Contacts

Energy Absorption Systems (a Trinity Highway Products company) is committed to the highest level of customer service. Feedback regarding the QuadGuard® Elite system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Energy Absorption Systems:

Telephone:	(888) 323-6374 (USA Only) (312) 467-6750 (USA or International)
E-mail:	customerservice@energyabsorption.com
Internet: Energy Absorption Systems Trinity Highway Products, LLC Trinity Industries, Inc.	http://www.energyabsorption.com http://www.highwayguardrail.com http://www.trin.net

Important Introductory Notes

Proper assembly of the QuadGuard® Elite system is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the QuadGuard® Elite system. These instructions are to be used only in conjunction with the assembly of the QuadGuard® Elite system and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Energy Absorption Systems is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

A set of product and project shop drawings will be supplied by Energy Absorption Systems. The shop drawings will be for each section of the assembly. These drawings should be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any assembly.



Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® Elite system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep these instructions for later use.



Warning: Ensure that all of the QuadGuard® Elite system Warnings, Cautions, and Important statements within the QuadGuard® Elite Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the QuadGuard® Elite system. Additional copies of this Manual are immediately available from Energy Absorption Systems by calling (888) 323-6374 or by email at customerservice@energyabsorption.com. This Manual may also be downloaded directly from the websites indicated below. Please contact Energy Absorption Systems if you have any questions concerning the information in this Manual or about the QuadGuard® Elite system.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or the QuadGuard® Elite components. Gloves, safety goggles, steel toe boots, and back protection shall be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this QuadGuard® Elite Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

<u>Symbol</u>	<u>Meaning</u>
---------------	----------------



Safety Alert Symbol: Indicates Danger, Warning, or Caution. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.

Warning and Cautions

Read all instructions before assembling, maintaining, or repairing the QuadGuard® Elite system.



Warning: Do not assemble, maintain, or repair the QuadGuard® Elite system until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important statements within the Manual are completely followed. Please call Energy Absorption Systems at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Use only Energy Absorption Systems parts that are specified herein for the QuadGuard® Elite for assembling, maintaining, or repairing the QuadGuard® Elite system. Do not utilize or otherwise commingle parts from other systems even if the systems are other Energy Absorption Systems or Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.



Warning: Do NOT modify the QuadGuard® Elite system in any way. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that the QuadGuard® Elite system and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death in the event of a collision.

Limitations and Warnings

Energy Absorption Systems, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) "Recommended Procedures for the Safety Performance of Highway Safety Features", contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The QuadGuard[®] Elite system has been approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350 TL-2 and TL-3. These tests typically evaluate product performance by closely simulating actual impacts involving a typical range of vehicles on the roadways, from lightweight cars (approx. 820kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]) as selected by the NCHRP and specified by the FHWA. A product can be certified for multiple Test Levels. The QuadGuard[®] Elite is certified to the Test Level(s) as shown below:

Test Level I: 50 km/h [31 mph]

Test Level II: 70 km/h [43 mph]

Test Level III: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP 350 as approved by FHWA.

These tests are not designed to represent the performance of products when impacted by every vehicle type or every impact condition.

Energy Absorption Systems does not represent nor warrant that the results of these controlled tests show that vehicle impacts with the products in other conditions would necessarily avoid injury to person(s) or property. Impacts that exceed the specifications of the product may not result in acceptable impact performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk and vehicle trajectory. Energy Absorption Systems expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision, or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were assembled by or in the presence of Energy Absorption Systems representatives or by third parties.

The QuadGuard[®] Elite system is intended to be assembled, delineated, and maintained in accordance with specific state and federal guidelines. It is important to select the most appropriate product configuration for a site. The customer should be careful to properly select, assemble and maintain the product. Careful evaluation of the site geometry, vehicle population type, speed, traffic direction and visibility are some of the elements that require evaluation in the proper selection of a safety appurtenance. For example, curbs could cause an untested effect on an impacting vehicle.

After an impact occurs, the product should be restored to its original condition as soon as possible. When a potentially reusable product is impacted, it is still necessary to restore the product to its original length and inspect all the components as necessary.

System Overview

The QuadGuard® Elite is a potentially reusable, redirective, non-gating impact cushion for hazards ranging in width from 610 mm to 2285 mm (24" to 90"). It consists of high molecular weight, high density polyethylene (HMW/HDPE), energy-absorbing cylinders surrounded by a framework of Quad-Beam™ panels.

The QuadGuard® Elite utilizes three types of Cylinders in a “staged” configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site.

Measuring the Width

The nominal width of the Tension Strut Backup is the width between Side Panels behind the Backup (See Figure 1). The outside width of the system is approximately 150 mm [6"] to 230 mm [9"] wider than this measurement.

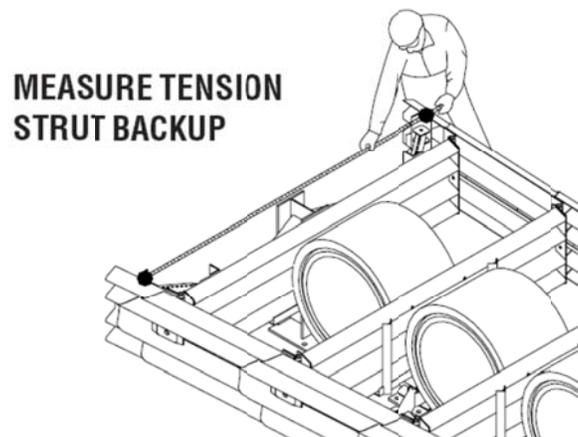


Figure 1
Tension Strut Backup Width

Counting the Number of Bays

One bay consists of one Diaphragm, two Fender Panels, etc. The Nose section is not considered a bay (See Figure 2)

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the system facing the hazard. Your left is the system's left and your right is the system's right (See Figure 3).

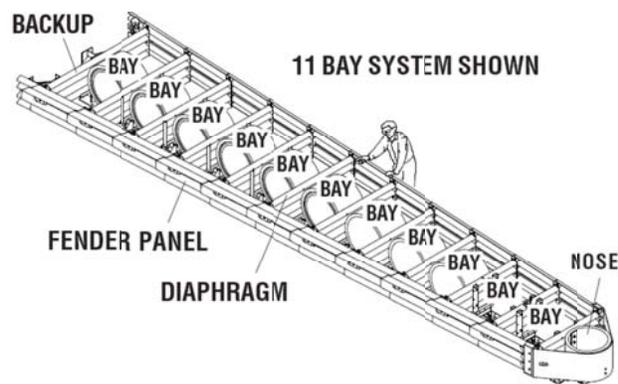


Figure 2
Number of Bays

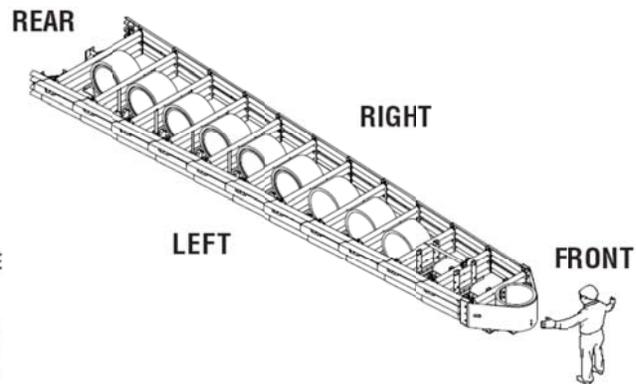


Figure 3
Left/Right

Impact Performance

The 5 bay and 7 bay EC QuadGuard® Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 2 tests with both the light car and pickup at speeds of up to 70 km/h [43 mph] at angles up to 15 degrees.

The 8 bay and 11 bay EC QuadGuard® Elite systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 15 degrees.

The EC designation of the 11 bay system stands for “Extra Capacity”. This system has additional energy absorbing capacity compared to the 8 bay EC system.

The 14 bay 24”, 30” and 36” wide QuadGuard® Elite have successfully been tested with the pickup at speeds up to 115 km/h [70 mph].

During head-on impacts, the QuadGuard® Elite telescopes rearward to absorb the energy of impact. When impacted from the side, the system redirects the vehicle back toward its original travel path and away from the hazard.

Design Criteria

FHWA Criteria

The 5 bay and 7 bay QuadGuard® Elite systems have passed the requirements stipulated in NCHRP Report 350, Test Level 2 tests with both the light car and pickup at speeds of up to 70 km/h [43 mph] at angles up to 20°.

The 8 bay and 11 bay QuadGuard® Elite systems are capable of passing the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20°.

Establish Basic System Specifications

The specification of a QuadGuard® Elite system for a particular site must always include system width and system length.

1) Specification of System Width

The QuadGuard® Elite system is available in five nominal widths (See Figure 8 on Page 13).

610 mm [24"]

760 mm [30"]

915 mm [36"]

1755 mm [69"]

2285 mm [90"]

As a general rule, selection of the narrowest width that adequately shields the hazard is recommended.

2) Specification of System Length

System length is specified by the number of bays the system includes. The number of bays required is a function of the design speed of the roadway. The system nose is not considered to be a bay.

Backup Structure for the System

The Tension Strut backup drawings are available at the back of this Manual on Pages 26 & 33 and are appropriate for use on grade or deck.

Establish Required System Footing

The system must be anchored. MP-3[®] polyester anchor bolts will be supplied for all required anchorages in concrete. Refer to QuadGuard[®] Elite system Installation Manual, or MP-3[®] kits for detailed assembly instructions.

- 1) **Existing concrete** – Concrete must be at least 150 mm [6"] thick, reinforced 28 MPa [4000 psi] Portland cement concrete (P.C.C.), or 200 mm [8"] thick non-reinforced measuring at least 3.66 m [12' – 0"] wide by 15.24 m [50' – 0"] long. The concrete should be in good condition and be free of major cracks.
- 2) **New concrete** – If existing concrete does not meet these criteria, a new concrete foundation must be placed to properly secure the system.
- 3) **Cross slope**– if there is a cross slope of more than 8% (5 deg.), or if the cross slope varies (twists) more than 2% (1 deg.) over the length of the system, a concrete leveling foundation may be required (See Figure 4).
- 4) **No Cross slope** – If the cross slope is within the range described above, the leveling foundation is not required:
 - **Transversal slope $\leq 8\%$**
 - **Longitudinal slope $\leq 2\%$**

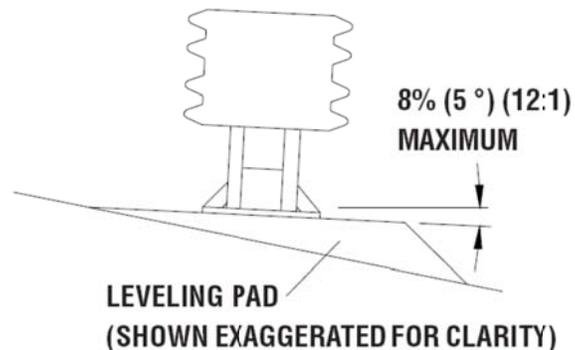


Figure 4
Cross Slope

Special Site Conditions

Contact Energy Absorption Systems Customer Service Department if you are a representative of the highway authority and would like input with your application. You will need to answer the following questions:

1. Are curbs, islands or elevated objects (delineators or signs) present at the site? What height and width are they? All curbs and elevated objects 100 mm [4"] high should be removed. If possible, curbs less than 100 mm [4"] high should be removed approximately 15 m [50'] in front of the QuadGuard® Elite system and as far back as the system's backup. Any curbs that must remain should be 100 mm [4"] maximum and be mountable.
2. If the deployment site is a gore area, (place where two roads diverge), what is the angle of divergence?
3. What is the general geometry of the site? (Include the roadway for 150 m [500'] in front, so traffic patterns can be visualized.)
4. When there is an existing guardrail or median barrier at the site, the backup of the QuadGuard® Elite system should tie into it when possible.
5. Will there be traffic approaching from the rear of the system? Is the system in a two-way traffic situation, with traffic going in opposite directions on either side of the system? Or, is the system on the side of the road in a location where crossover traffic is a concern? If so, a transition from the back of the system to the hazard is necessary to prevent vehicle snagging (See "Transition Panel Types" on next page).
6. Are there any other unique features at the site that may affect positioning or performance of the QuadGuard® Elite system? (See next paragraph.)



Caution: The potentially restorable nature of the cylinders could provide for possible rebounding of an impacting vehicle into pathways beyond the reserve area under certain impact conditions. Consideration of a system for a particular site should include an assessment of this factor.

Other Factors That May Affect Your Design:

1. The existence of drain inlets.
2. Junction boxes or other appurtenances located near the hazard.
3. Insufficient space for the length preferred.
4. The location and movement of expansion joints. Contact Energy Absorption Systems Customer Service Department before proceeding with your design. For Customer Service call (888) 323-6374.

Transition Panel Types

If a system is placed in a location where traffic will be approaching from the rear, a Transition Panel is necessary. Figures 5, 6 & 7 show the standard panel types. There are variations for each panel type. The specific Panel needed will depend on system and site conditions. Therefore, it is important to send site specific data to the customer service department for a recommendation for exact Panel needed for your application.

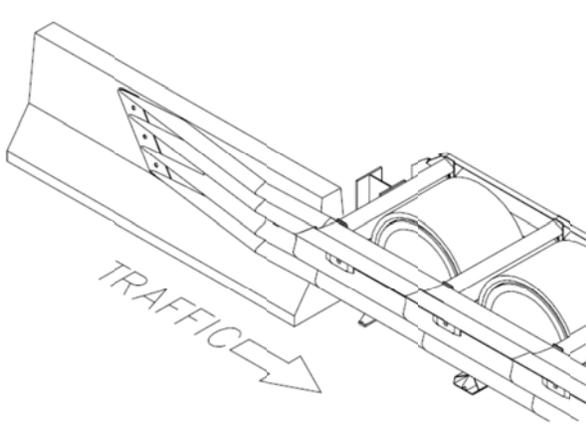


Figure 5
Quad-Beam™ to Safety Shape Barrier
Transition Panel

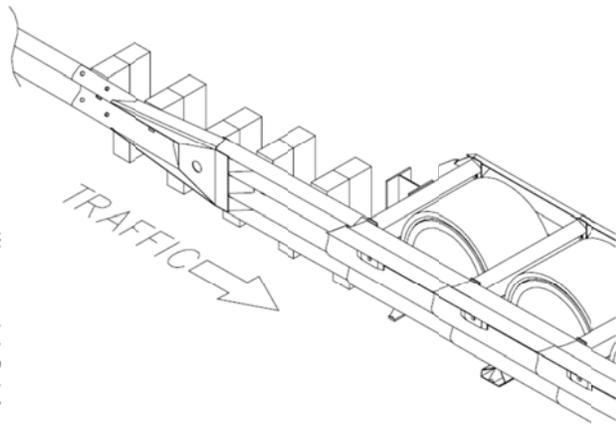


Figure 6
Quad-Beam™ to W-Beam Transition Panel

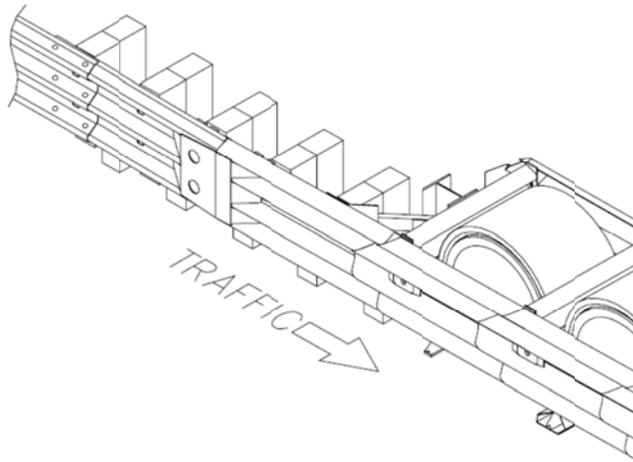


Figure 7
Quad-Beam™ to Thrie-Beam Transition Panel

System Width	5 Bay 70 km/h [43 mph]	7 Bay EC 85 km/h [53 mph]	8 Bay 100 km/h [62 mph]	11 Bay EC 105 km/h [65 mph]	14 Bay 115 km/h [72 mph]
610 mm [24"]	QS2405E	QS2407E	QS2408E	QS2411E	QS2414E
760 mm [30"]	QS3005E	QS3007E	QS3008E	QS3011E	QS3014E
915 mm [36"]	QS3605E	QS3607E	QS3608E	QS3611E	QS3614E
1755 mm [69"]	QS6905E	QS6907E	QS6908E	QS6911E	Not Available
2285 mm [90"]	QS9005E	QS9007E	QS9008E	QS9011E	Not Available

Figure 8
QuadGuard® Elite System Model Numbers

Model Number Description

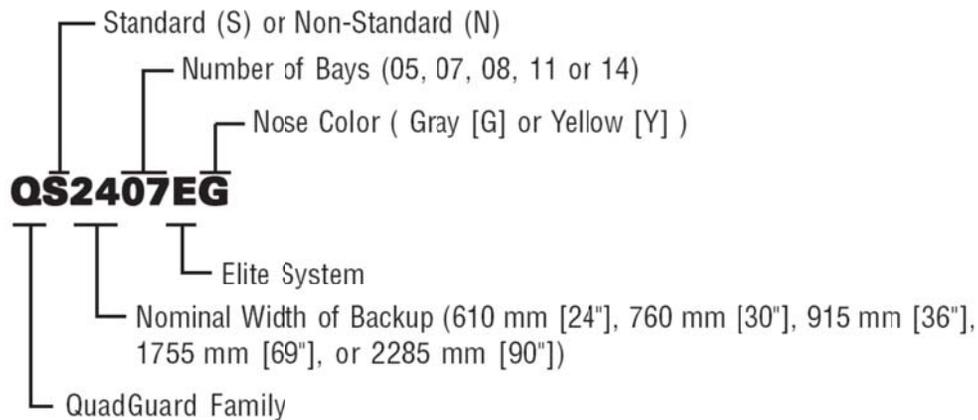
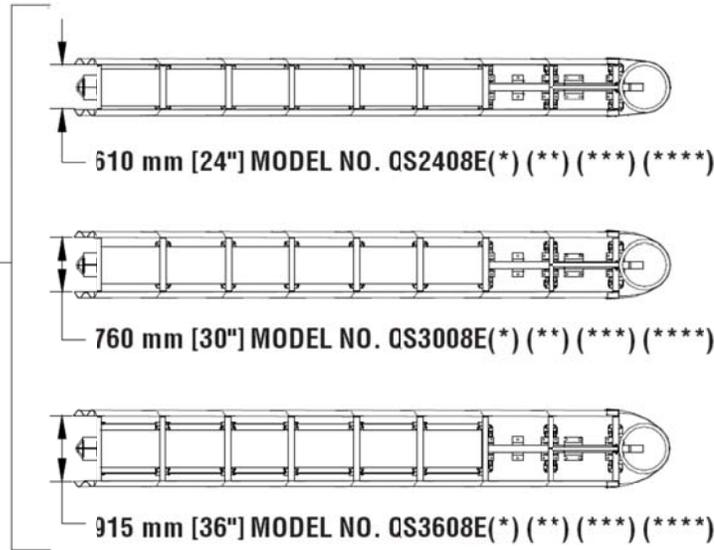
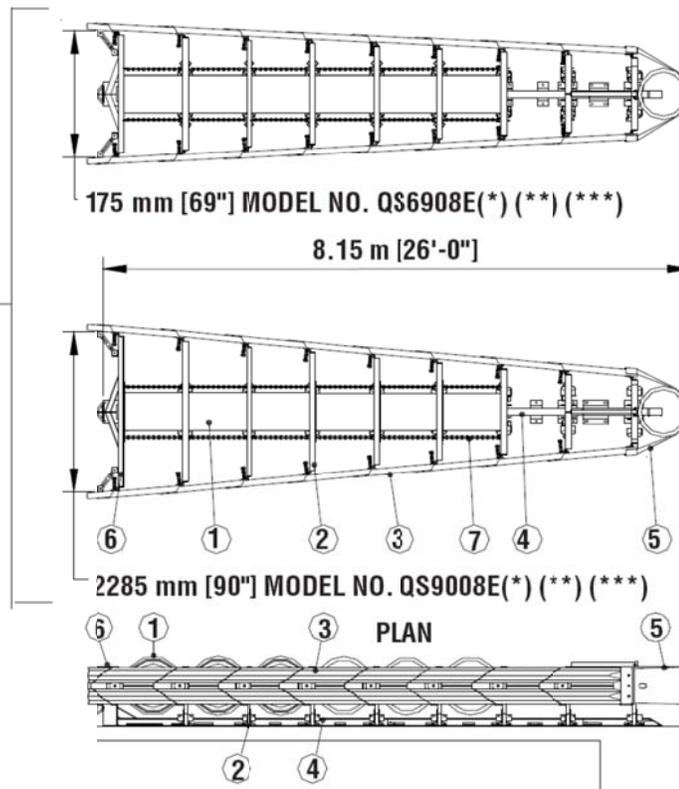


Figure 9
Model Number Key

QUADGUARD ELITE
FOR NARROW HAZARDS



QUADGUARD ELITE
FOR WIDE HAZARDS



Key

- 1) Energy-Absorbing Cylinder
- 2) Diaphragm
- 3) Quad-Beam™ Fender Panel
- 4) Monorail
- 5) Nose Cover
- 6) Backup
- 7) Chain Assembly

- * Also Available in 5 Bay Lengths
- ** Also Available in 7 Bay Lengths (EC Model)
- *** Also Available in 11 Bay Lengths (EC Model)
- **** Also Available in 14 Bay Lengths

Figure 10
Plan & Elevation

General Assembly Information

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's drawing package

Cutting equipment

- Rebar cutting bit
- Concrete drill bits – 22 mm [7/8"] (*Two Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill motor
- Drill bits 1/16" through 7/8"

Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing the MP-3[®] anchoring system.

Hammers

- Rotohammer
- Sledgehammer
- Standard hammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/2" drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2" drive Deep sockets: 15/16", 1 1/4"
- 1/2" drive Ratchet and attachments
- 1/2" drive Breaker bar - 24" long
- 1/2" drive Torque wrench: 200 ft-lbf
- Crescent wrench: 300 mm [12"]
- Allen wrench: 3/8
- Impact Wrench: 1/2"

Personal Protective equipment

- Safety Glasses
- Gloves
- Apron for MP-3[®] application

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Compressor (100 psi) and Generator 95 KW)
- Long pry bar
- Drift pin 300 mm [12"]
- Center punch
- Tape measure 7.5 m [25']
- Chalk line
- Concrete marking pencil
- Nylon bottle brush for cleaning 7/8" drilled holes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified site.



Caution: The assembly/maintenance information provided here is for planning and system selection purposes only. Do not attempt to deploy or maintain the QuadGuard® Elite system without the proper plans and Assembly/Maintenance Manual from the manufacturer. If you need additional information, or have questions, please contact the highway authority who has planned and specified this installation and, if needed, call Energy Absorption Systems Customer Service Department at (888) 323-6374.

Site Preparation/Foundation

The QuadGuard® Elite system should be deployed only on an existing or freshly placed and cured concrete foundation (28 MPa [4000 psi] minimum). Location and orientation of the concrete foundation and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundation are provided in Energy Absorption Systems concrete foundation drawings, supplied with the system. System may be deployed on concrete roadway (See Page 10). Deployment cross slope shall not exceed 8% and should not vary more than 2% over the length of the system. The foundation surface shall have a light broom finish.



Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete Anchor Bolts.



Warning: Location of the backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the fender panels telescope toward and extend beyond the rigid backup as much as 635 mm [25"] from their pre-impact location. Position the backup so that the rear ends of the last fender panels are a minimum of 635 mm [25"] forward of objects that would otherwise interfere with movement of the panels. Failure to comply with this requirement will result in impaired system performance offering motorists less protection and cause component damage.

Estimated Time for Assembly

With the use of proper tools and trained crew of three workers, the estimated time for deployment on a fully cured foundation is six to eight hours depending on site conditions, traffic, size and experience of work crew, and quality of tools.

General Maintenance and Repair

The QuadGuard® Elite System is considered to be a potentially reusable system. The system must be inspected after each impact and must be manually pulled out to its original length if necessary. Depending on the impact, components may get damaged and need replacement.

Estimated time for Maintenance

An experienced two person crew with the proper tools and spare parts should be able to complete the work in one to three hours depending on the damage done to the system.

Life Expectancy

Environment

Except due to damage, it is anticipated that the cylinders may survive in a highway environment for a period ranging from five to fifteen years from the date of deployment.

Impact

Life expectancy is also affected by:

1. The number of impacts
2. The severity of the impacts
3. The temperature at the time of the impacts

Systems must be inspected after each impact. Any cylinder that is cracked or otherwise damaged should be replaced and the system should be pulled out to its original length.



Caution: After an impact, always follow “Post-Impact Instructions” in the maintenance and repair section of the Assembly Manual.

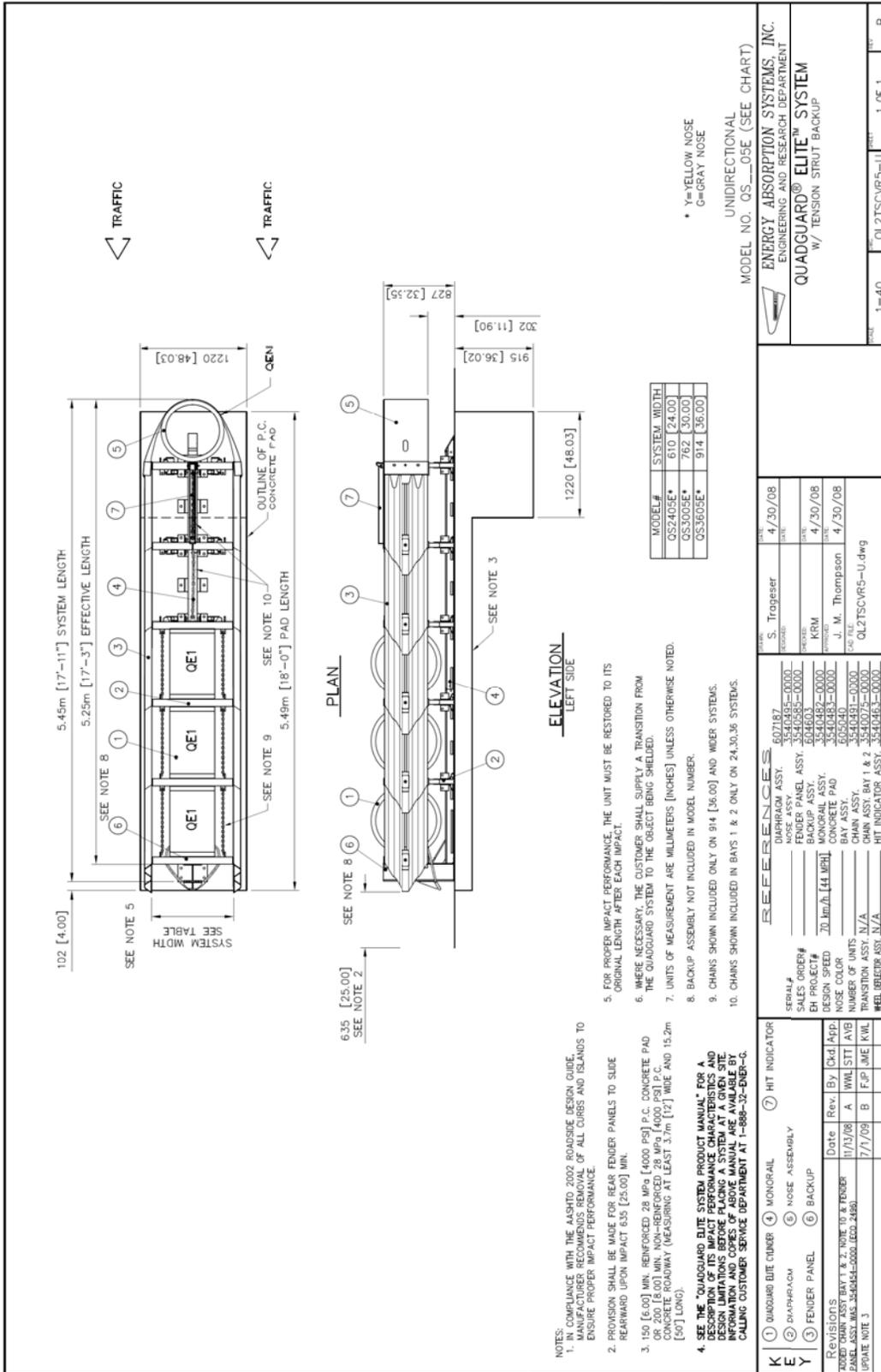
Recycle Information

When parts need to be replaced, it is recommended that the old parts be recycled as follows:

Steel should be sold as scrap to a local metal recycler.

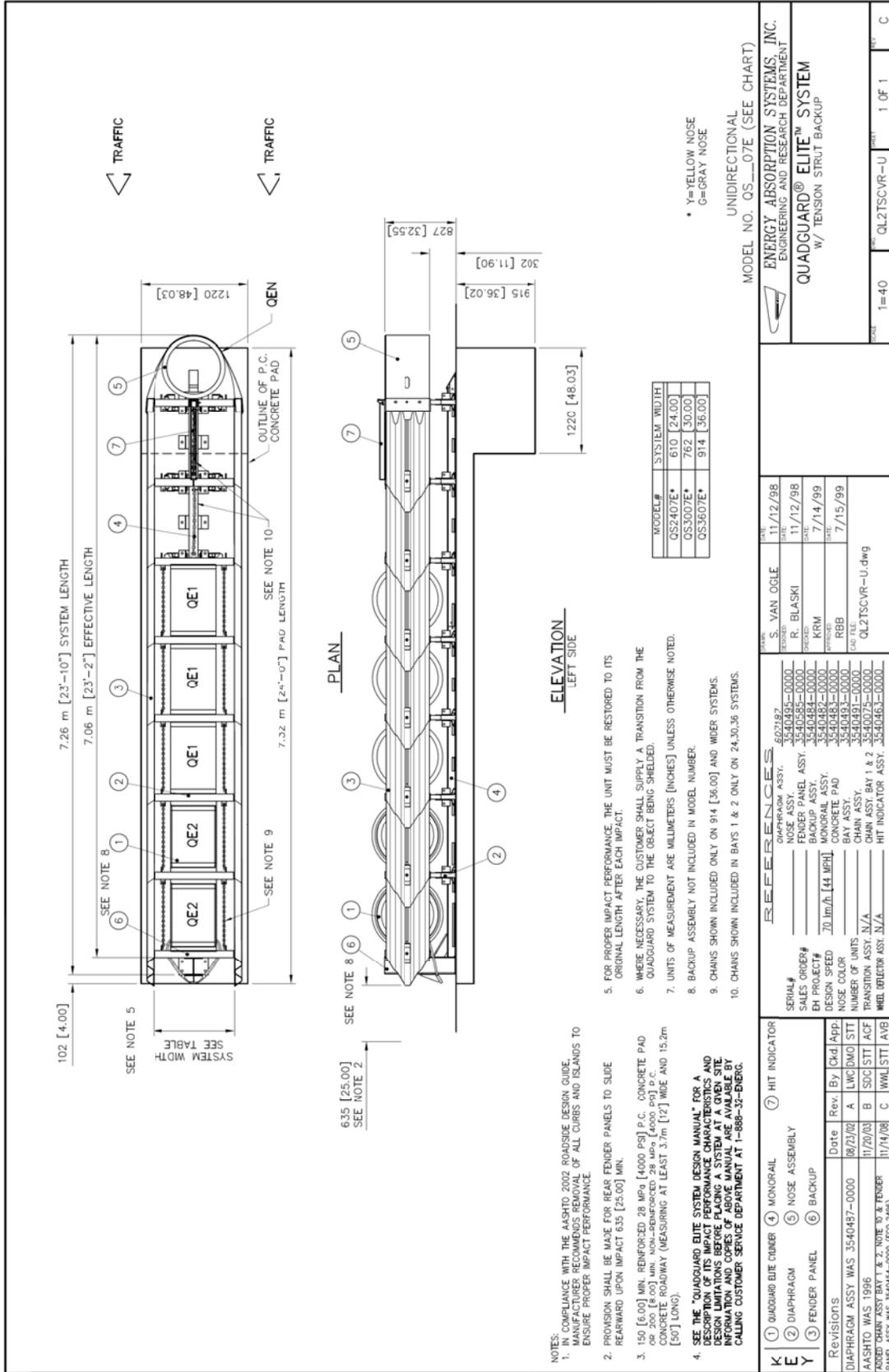
Cylinders should be sold to a plastic recycler if available. If a recycler is unavailable, dispose of the material as plastic refuse.

Reference Drawings



QuadGuard® Elite System w/ Tension Strut Backup 70km/h [44 mph]

DWG QL2SCVR5-U



QuadGuard® Elite System w/ Tension Strut Backup 70km/h [44 mph]

- NOTES:**
- IN COMPLIANCE WITH THE AASHTO 2002 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
 - PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 635 [25.00] MIN.
 - 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY (MEASURING AT LEAST 3.7m [12'] WIDE AND 15.2m [50'] LONG).
 - SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENRG.
 - FOR PROPER IMPACT PERFORMANCE THE UNIT MUST BE RESTORED TO ITS ORIGINAL LENGTH AFTER EACH IMPACT.
 - WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
 - UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 - BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.
 - CHAINS SHOWN INCLUDED ONLY ON 914 [36.00] AND WIDER SYSTEMS.
 - CHAINS SHOWN INCLUDED IN BAYS 1 & 2 ONLY ON 24,30,36 SYSTEMS.

REFERENCES

SERIAL#	DESCRIPTION	DATE
687182 <td>DIAPHRAGM ASSY. <td>11/12/98 </td></td>	DIAPHRAGM ASSY. <td>11/12/98 </td>	11/12/98
3540487-0000 <td>FENDER PANEL ASSY. <td>11/12/98 </td></td>	FENDER PANEL ASSY. <td>11/12/98 </td>	11/12/98
3540488-0000 <td>BACKUP ASSY. <td>7/14/99 </td></td>	BACKUP ASSY. <td>7/14/99 </td>	7/14/99
3540484-0000 <td>MONORAIL ASSY. <td>7/15/99 </td></td>	MONORAIL ASSY. <td>7/15/99 </td>	7/15/99
3540483-0000 <td>CONCRETE PAD <td> </td></td>	CONCRETE PAD <td> </td>	
3540483-0000 <td>BAY ASSY. <td> </td></td>	BAY ASSY. <td> </td>	
3540493-0000 <td>CHAIN ASSY. <td> </td></td>	CHAIN ASSY. <td> </td>	
3540474-0000 <td>HIT INDICATOR ASSY. N/A <td> </td></td>	HIT INDICATOR ASSY. N/A <td> </td>	
3540463-0000 <td>HIT INDICATOR ASSY. N/A <td> </td></td>	HIT INDICATOR ASSY. N/A <td> </td>	

REVISIONS

Rev.	Date	By	App.
A	08/23/02	LWC	DWO/SJT
B	11/20/03	SOC	SJT/ACF
C	11/14/08	C	IKW/SJT/AVB

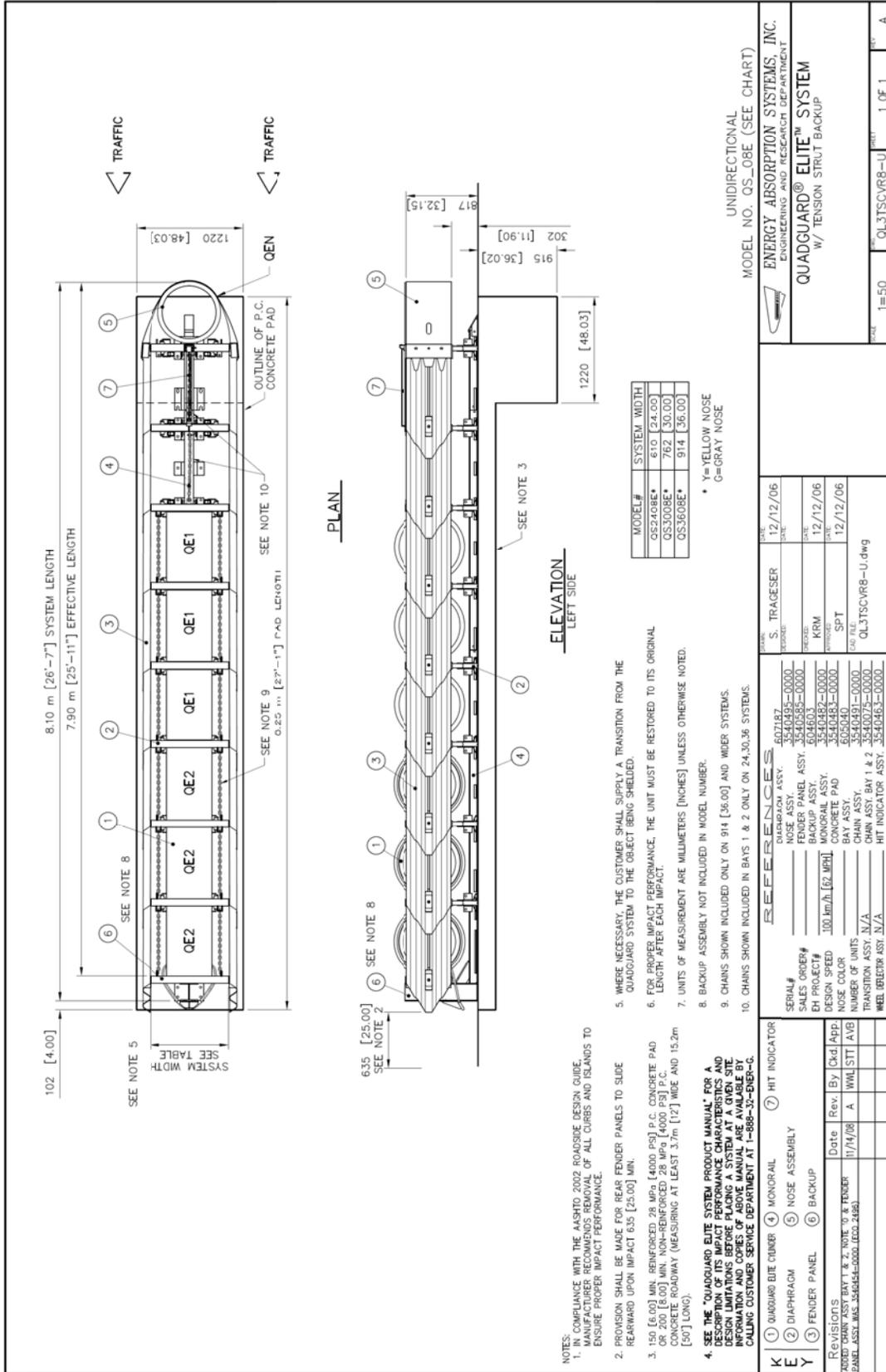
DIAPHRAGM ASSY WAS 3540487-0000

AASHTO WAS 1996

ROBERT CHAIN ASSY BAY 1 & 2, NOTE 10 & FENDER

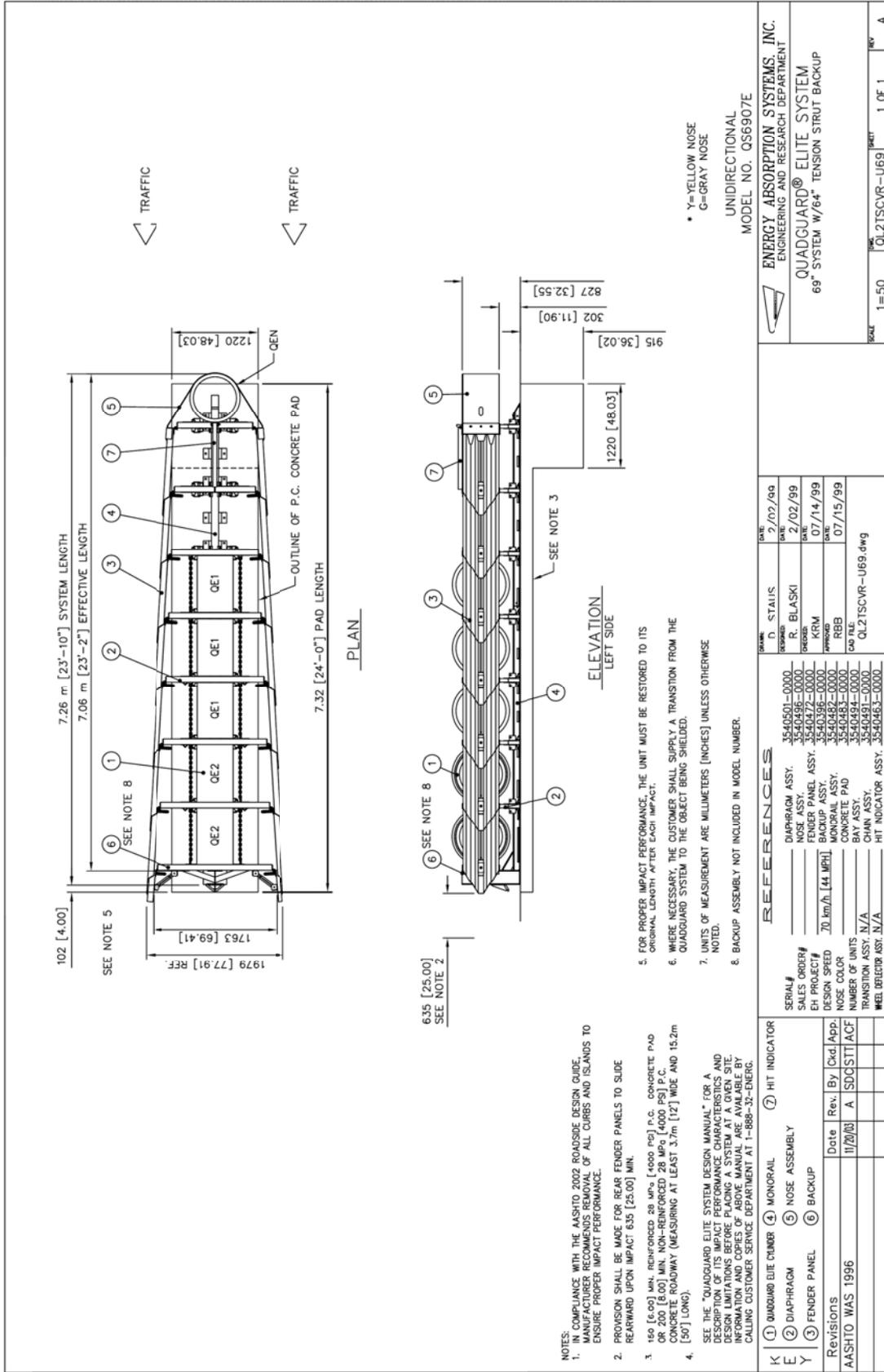
PANEL ASSY. WAS 3540484-0000 (REV. 2/8/04)

DWG QL2TSCVR-U



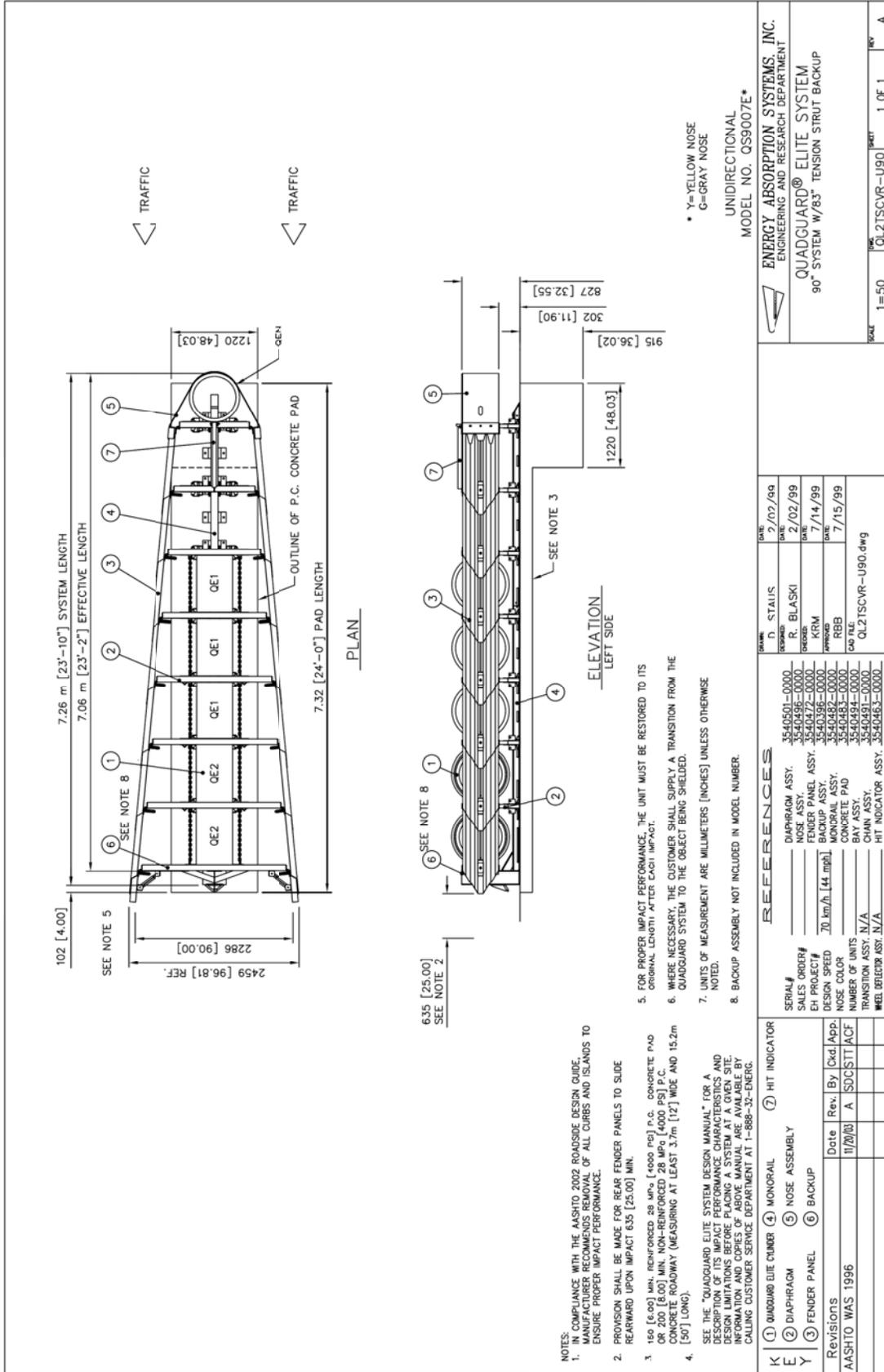
QuadGuard® Elite System w/ Tension Strut Backup 100 km/h [62mph]

DWG QL3TSCVR8-U



DWG QL2TSCVR-U69

QuadGuard® Elite System 69' w/ Tension Strut Backup 70 km/h [44 mph]



DWG QL2TSCVR-U90

- NOTES:
- IN COMPLIANCE WITH THE AASHTO 2002 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
 - PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 6.35 [25.00] MIN.
 - 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY (MEASURING AT LEAST 3.7m [12'] WIDE AND 15.2m [50'] LONG).
 - SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENERG.
 - FOR PROPER IMPACT PERFORMANCE, THE UNIT MUST BE RESTORED TO ITS ORIGINAL LENGTH AFTER EACH IMPACT.
 - WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
 - UNITS OF MEASUREMENT ARE MILLIMETERS (INCHES) UNLESS OTHERWISE NOTED.
 - BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.

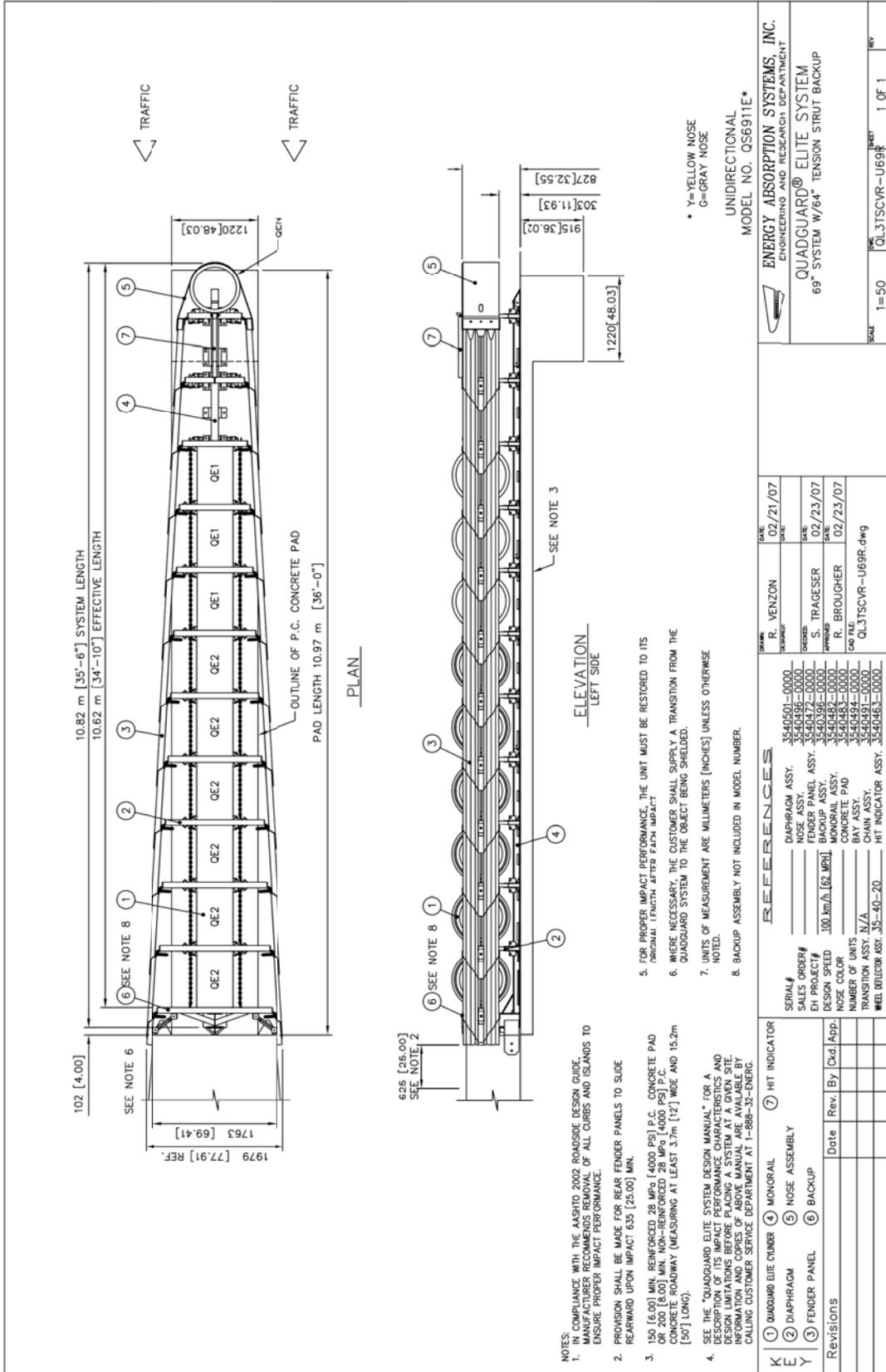
K	(1) QUADGUARD ELITE CURBER	(4) MONORAIL	(7) HIT INDICATOR
E	(2) DIAPHRAGM	(5) NOSE ASSEMBLY	
Y	(3) FENDER PANEL	(6) BACKUP	
Revisions	Date	Rev. By	Ckd. App.
AASHTO WAS 1996	11/20/03	A	SOCSTI/ACF

REFERENCES	
SERIAL#	3540501-0000
SALES ORDER#	3540496-0000
EH PROJECT#	3540472-0000
DESIGN SPEED	70 km/h [44 mph]
NOSE COLOR	MONORAIL ASSY.
NUMBER OF UNITS	CONCRETE PAD
TRANSITION ASST.	BAY ASSY.
WEL. INDICATOR ASST.	CHAIN ASSY.
	HIT INDICATOR ASSY.

DESIGNED BY	STALIS	DATE	7/02/99
DRAWN BY	R. BLASKI	DATE	2/02/99
CHECKED BY	KRM	DATE	7/14/99
APPROVED BY	RBB	DATE	7/15/99
DWG NO.	QL2TSCVR-U90.dwg		

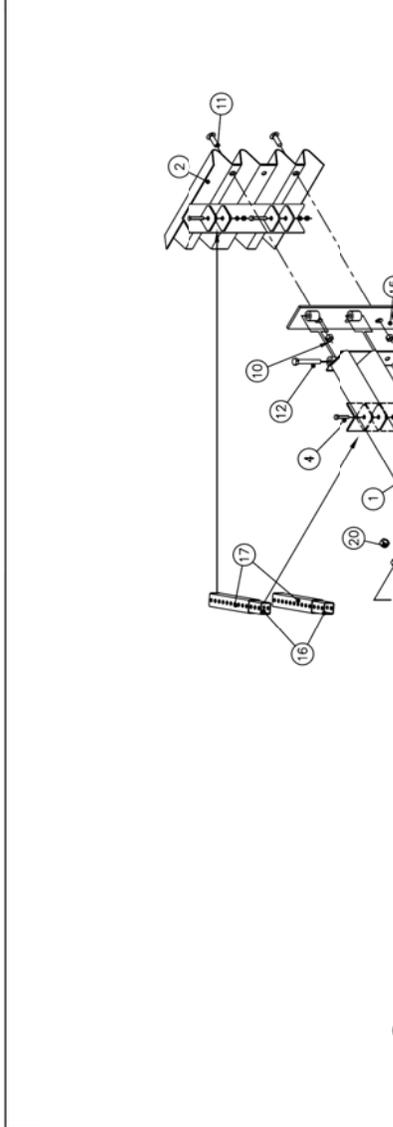
ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT	
QUADGUARD® ELITE SYSTEM 90" SYSTEM W/83" TENSION STRUT BACKUP	
SCALE	1=50
DWG NO.	QL2TSCVR-U90
SHEET	1 OF 1

QuadGuard® Elite System 90" w/83" Tension Strut Backup 70 km/h [44 mph]



QuadGuard® Elite System 69" w/64" Tension Strut Backup 100 km/h [62 mph]

ITEM	STOCK NO.	DESCRIPTION	REQ'D
1	SEE TABLE	BACKUP, TS, 64.00 LMC/QGE W/DECALS	1.00
2	611900G	PANEL, SIDE, OG WIDE, G	2.00
4	113612G	BOLT, HX, 3/8X3 1/2, 6Z, G, ALL THREAD	16.0
5	115960G	NUT, HX, 3/8, G	16.0
7	118092G	WASHER, LOCK, 3/8, G	16.0
9	603673B	ANCHOR, MP-3, PT-KIT, 3/4X7, VT	3.00
10	003340G	NUT, HX, 5/8, G, RAIL	4.00
11	003400G	BOLT, HX, 5/8X2, G	4.00
12	113666G	BOLT, HX, 5/8X4, 6S, G	6.00
13	118100G	WASHER, LOCK, 5/8, G	6.00
14	115970G	NUT, HX, 5/8, G	6.00
15	610172G	HINGE PLATE, FENDER PANEL, OG LMC 69/90	2.00
16	615756B	TEL ST 1 3/4X1 3/4X12GA, HAS, G, 10" LG	4.00
17	615765B	TEL ST 2X2X12GA, HZS, G, 10" LONG	4.00
18	605418G	BRACKET, CARREL SUPPORT, 1, BACKUP	1.00
19	113552G	BOLT, HX, 3/4X2, 6Z, G	4.00
20	115953G	NUT, HX, 3/4, G	4.00



DWG 604607B

ASSY. NO.	STOCK NO.	DESCRIPTION	WIDTH
604607B	604783B	BACKUP, TS, 64.00 LMC/QGE W/DECALS	1620 [64"]
604608B	604791B	BACKUP, TS, 83.00 LMC/QGE W/DECALS	2100 [83"]

- NOTES:
1. WHEN TRANSITIONING QUADGUARD SYSTEM TO EXISTING BARRIER REFER TO THE TRANSITION ASSEMBLY DRAWINGS FOR PROPER USE OF SIDE DIMENSIONS ARE IN MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 2. PANEL PART NO. 611898G.

ASSEMBLY NO. SEE TABLE

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE™ SYSTEM
BACKUP ASSY, TS, QGE WIDE



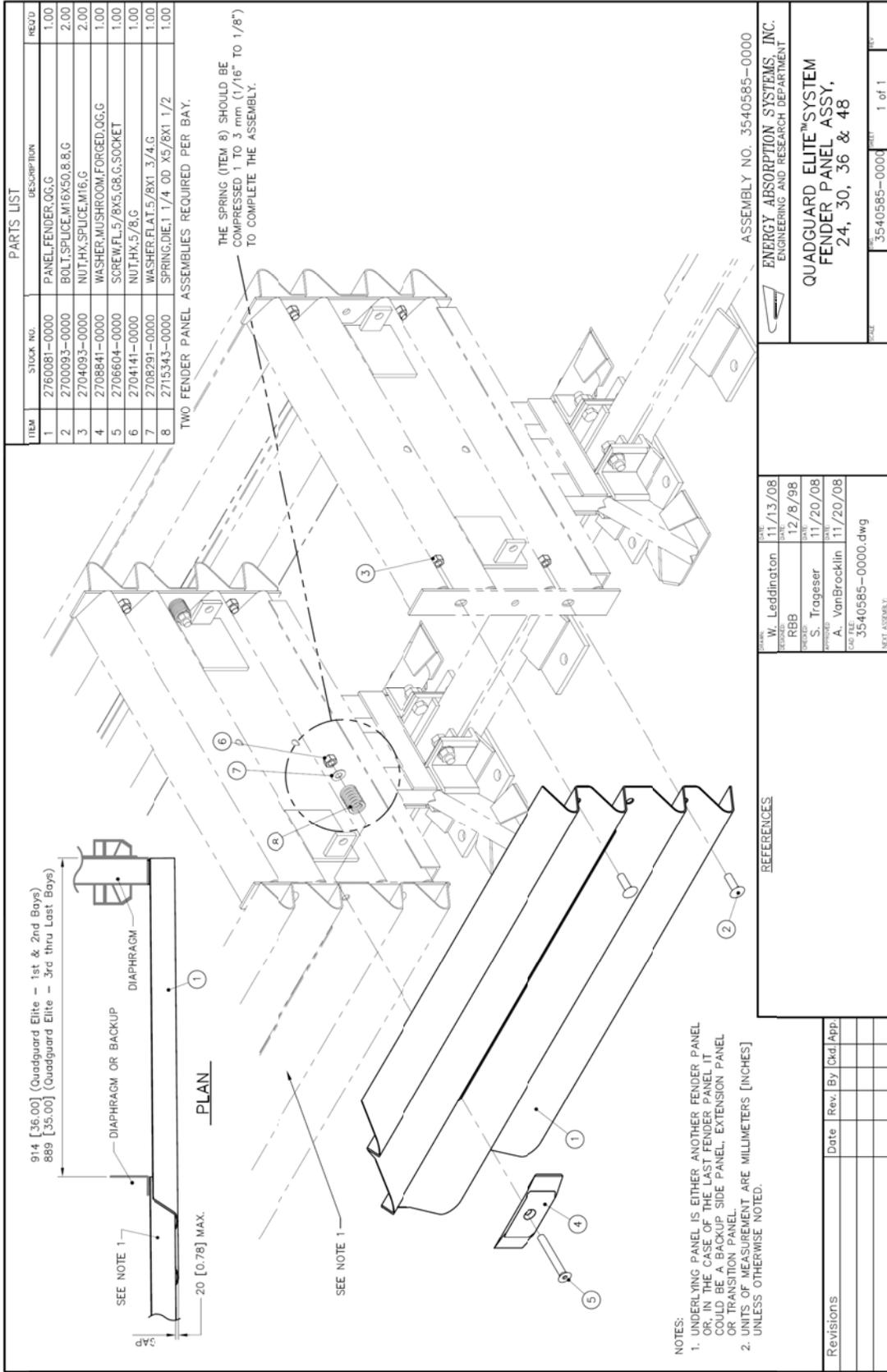
SCALE: 1:20
PART: 604607
1 of 1
REV: A

REFERENCES

DATE	BY	DATE
12/01/98	S. Chalda	
12/1/98	R. Blaski	
3/19/99	KRM	
3/23/99	RBB	
DWG FILE: 604607.dwg		
NEXT ASSEMBLY:		

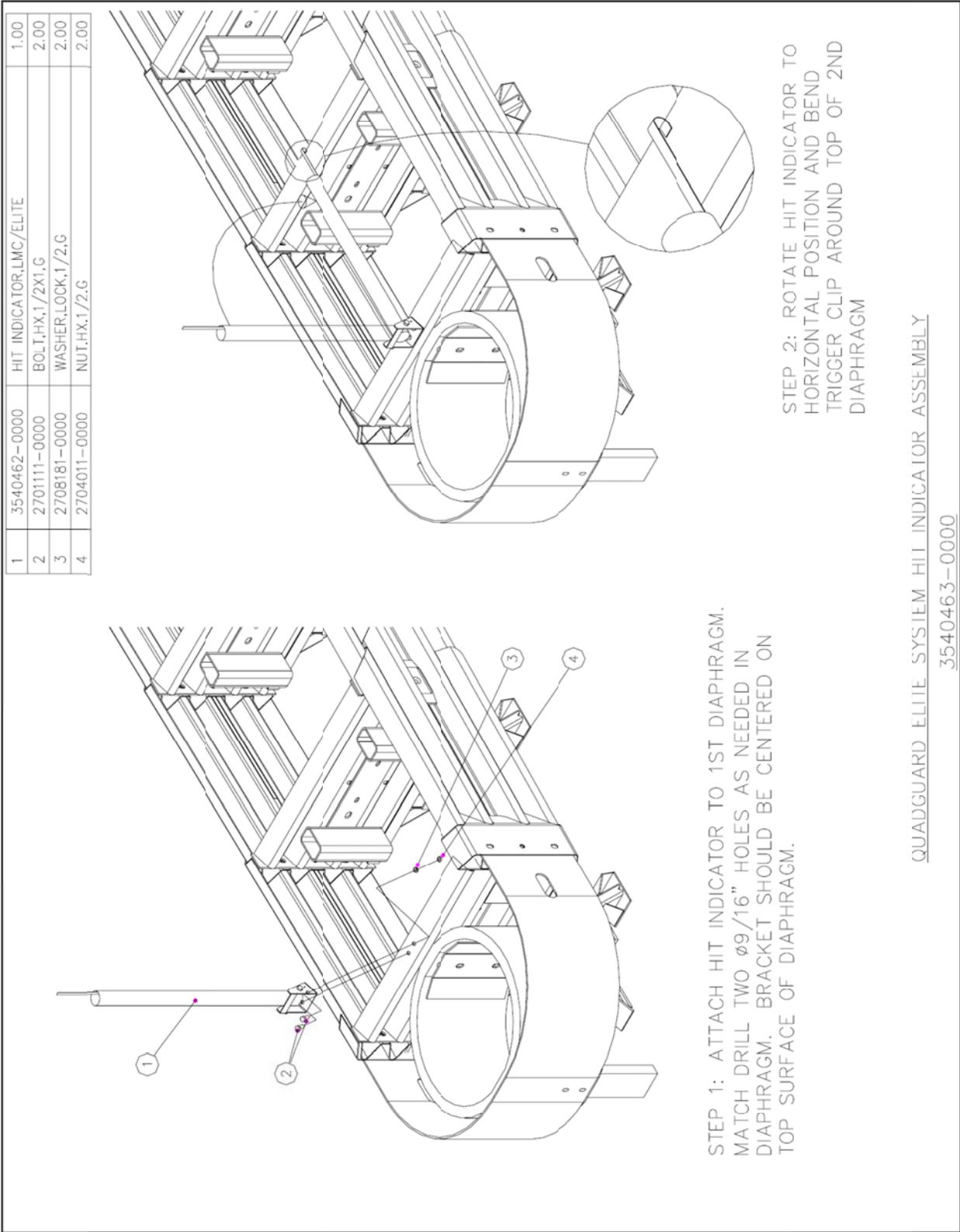
Revisions	Date	Rev.	By	Chk.	App.
1	1/2/11	A	WML	JAE	ST

QuadGuard® Elite System Backup Assembly, TS, QGE Wide

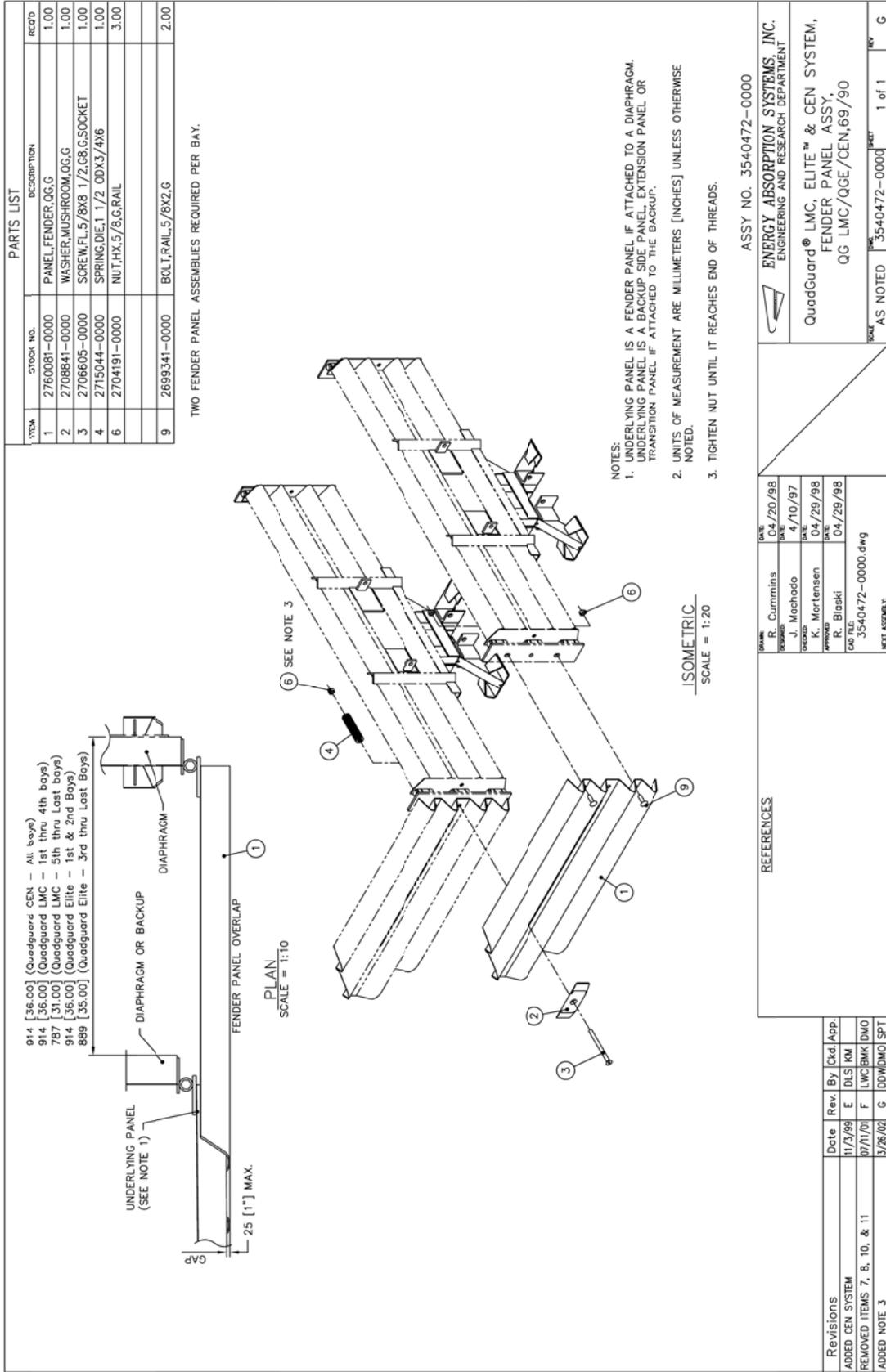


DWG 608235B

QuadGuard® Elite System Fender Panel Assembly, 24, 30, 36 & 48



DWG 3540463-0000



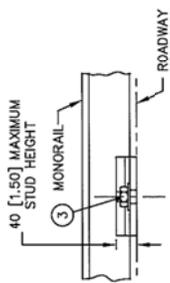
QuadGuard® Elite Fender Panel Assembly QG LMC/QGE/CEN, 69/90

DWG 608240B

PARTS LIST		5 BAY	7 BAY	8 BAY	11 BAY	14 BAY
ITEM	STOCK NO.	DESCRIPTION	QTY	QTY	QTY	QTY
1	2760071-0000	MONORAIL, THREE BAYS, QG,G	1.00	2.00	3.00	4.00
2	2760041-0000	END CAP MONORAIL, QG,G	1.00	1.00	1.00	1.00
3	3525300-0000	ANCHOR, MP-3, PT-KIT, 3/4X7, VT	4.00	7.0	8.00	12.0
4	2699571-0000	BOLT, HX, 5/8X3 1/2, G5, C	1.00	1.00	1.00	1.00
5	2704141-0000	NUT, HX, 5/8, G	1.00	1.00	1.00	1.00
6	2708231-0000	WASHER, LOCK, 5/8, G	1.00	1.00	1.00	1.00
7	2760051-0000	MONORAIL, ONE BAY, QG,G	1.00	N/A	1.00	1.00

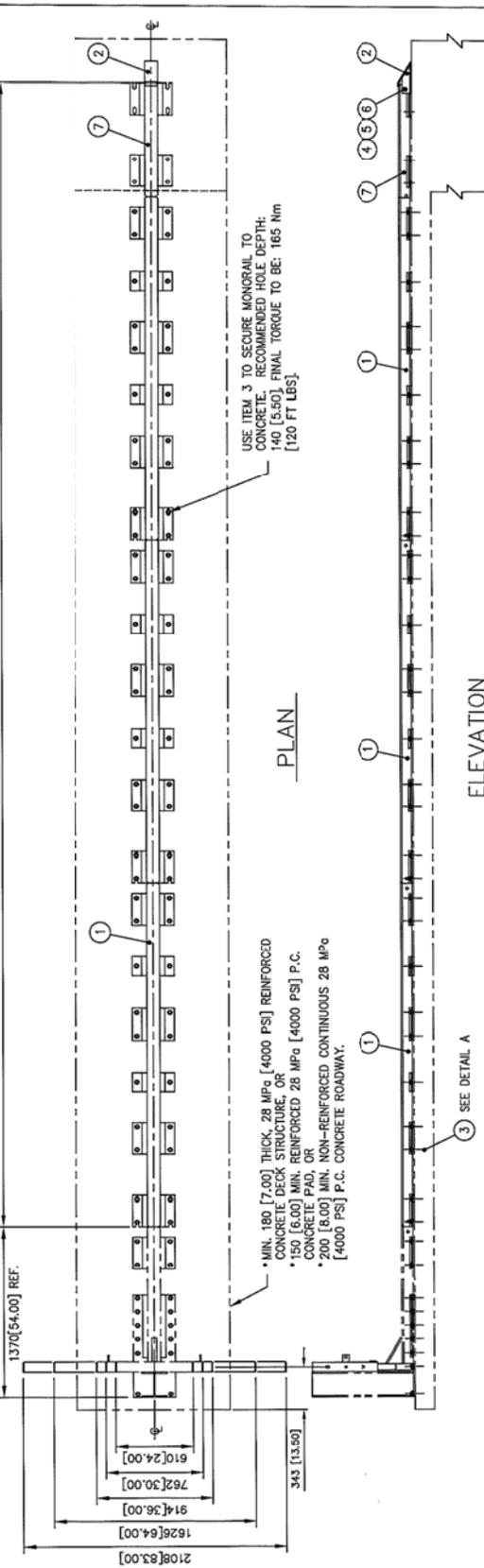
NOTE: MONORAIL & BACKUP ASSEMBLY MUST BE STRAIGHT TO WITHIN 15mm [0.5"]

TOTAL RAIL LENGTH: 5 BAY: 3660 [144.10]; 7 BAY: 5490 [216.10]; 8 BAY: 6405 [252.10]; 11 BAY: 9150 [360.20]; 14 BAY: 11895 [468.00]



DETAIL A

TENSION STRUT BACKUP ASSEMBLY



PLAN

ELEVATION
(W/TENSION STRUT BACKUP)

- * MIN. 180 [7.00] THICK, 28 MPa [4000 PSI] REINFORCED CONCRETE DECK STRUCTURE, OR
- * 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD, OR
- * 200 [8.00] MIN. NON-REINFORCED CONTINUOUS 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY.

- NOTES:
1. USE MONORAILS (ITEMS 1 & 7) AS TEMPLATES TO LOCATE MP-3 ANCHOR BOLTS (ITEM 3).
 2. CROSS SLOPE OF PAD SHALL NOT EXCEED 8% NOR VARY MORE THAN 2% FROM FRONT TO BACK.
 3. UNITS OF MEASUREMENT ARE MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.
 4. EVERY STUD MUST BE EMBEDDED TO A DEPTH OF 140 [5.5]. IF REBAR IS ENCOUNTERED IN A P.C. CONCRETE PAD, DRILL THROUGH IT. IF REBAR IS ENCOUNTERED ON A DECK STRUCTURE, DO NOT DRILL THROUGH REBAR WITHOUT FIRST GETTING PERMISSION FROM A PROJECT ENGINEER.

REFERENCES

DATE	11/6/98
BY	D. Stalus
APPROVED	KRM
APPROVED	RBB
DATE	3/22/99
FILE	3540482-0000.dwg

Revisions	Date	Rev.	By	Chk.	App.
REMOVED HOLES IN TOP VIEW, WAS 30 MPa	8/24/03	A	WKL	ACF	STT
ADDED 8 BAY SYSTEM	12/12/08	B	STI	KM	SPT
ADDED 5 BAY SYSTEM	04/30/08	C	STI	KA	SPY

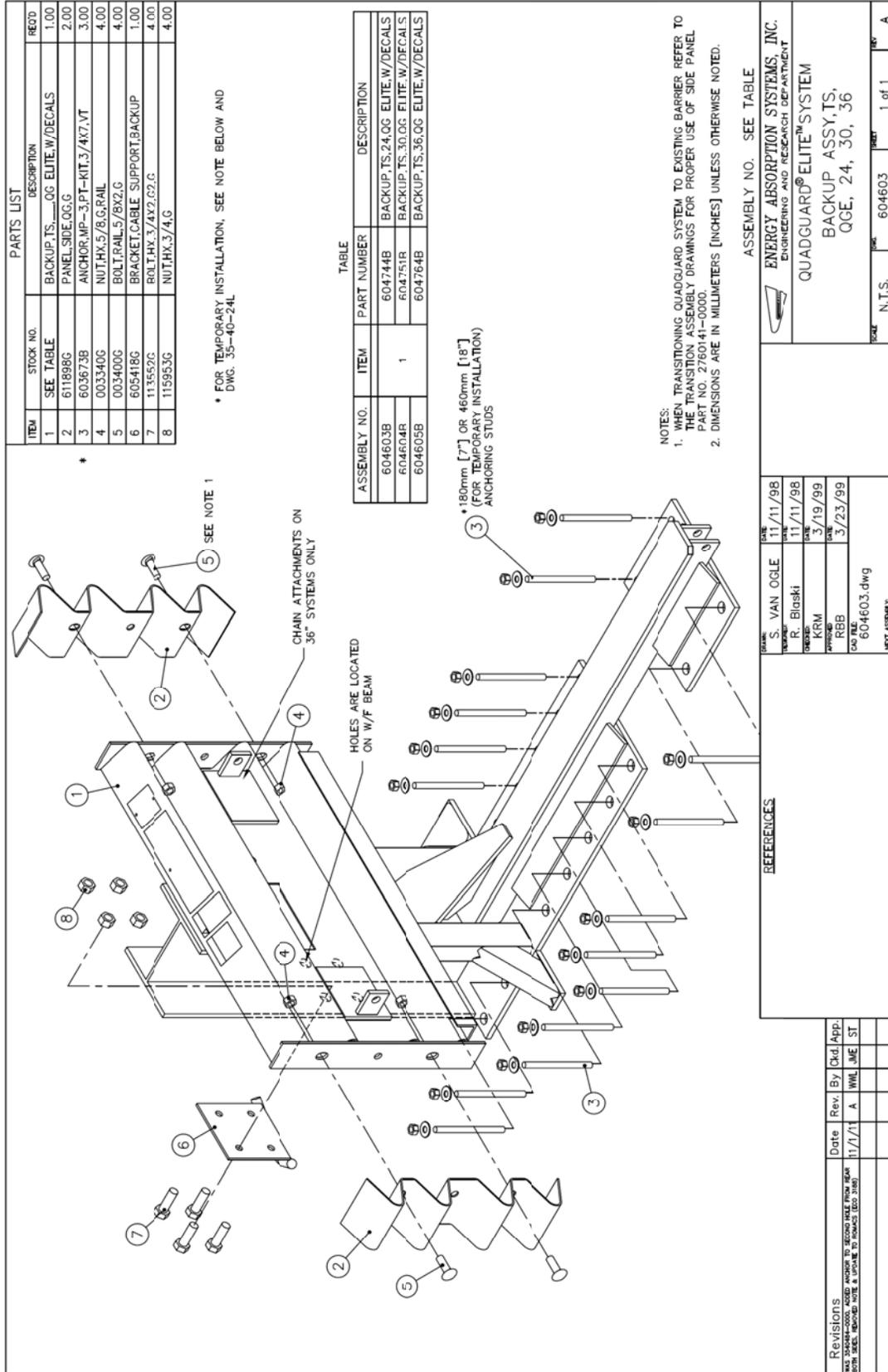
ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE™ SYSTEM
MONORAIL ASSY, QGE
FOR 5, 7, 8, 11 & 14 BAY SYSTEMS

SCALE: 1:32
3540482-0000 SHEET 1 of 1

QuadGuard® Elite System Monorail Assembly, QGE for 5, 7, 8, 11 & 14 Bay Systems

DWG 3540482-0000



PARTS LIST			
ITEM	STOCK NO.	DESCRIPTION	REQ'D
1	SEE TABLE	BACKUP, TS, 24, 30, 36 ELITE, W/DECALS	1.00
2	611898G	PANEL, SIDE, 0G, G	2.00
3	603673B	ANCHOR, MP-3, PT-KIT, 3/4K7, VT	3.00
4	003340G	NUT, HX, 5/8, G, RAIL	4.00
5	003400G	BOLT, RAIL, 5/8X2, G	4.00
6	605418G	BRACKET, CABLE, SUPPORT, BACKUP	1.00
7	113552C	BOLT, HX, 3/4X2, 6Z, G	4.00
8	115953G	NUT, HX, 3/4, G	4.00

* FOR TEMPORARY INSTALLATION, SEE NOTE BELOW AND DWG. 35-40-24L

TABLE

ASSEMBLY NO.	ITEM	PART NUMBER	DESCRIPTION
604603B	1	604744B	BACKUP, TS, 24, 30, 36 ELITE, W/DECALS
604604B		604751R	BACKUP, TS, 30, 36 ELITE, W/DECALS
604605B		604764B	BACKUP, TS, 36, 36 ELITE, W/DECALS

*180mm [7"] OR 460mm [18"] ANCHORING STUDS (FOR TEMPORARY INSTALLATION)

NOTES:
 1. WHEN TRANSITIONING QUADGUARD SYSTEM TO EXISTING BARRIER REFER TO THE TRANSITION ASSEMBLY DRAWINGS FOR PROPER USE OF SIDE PANEL PART NO. 272641-0000.
 2. DIMENSIONS ARE IN MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

ASSEMBLY NO. SEE TABLE

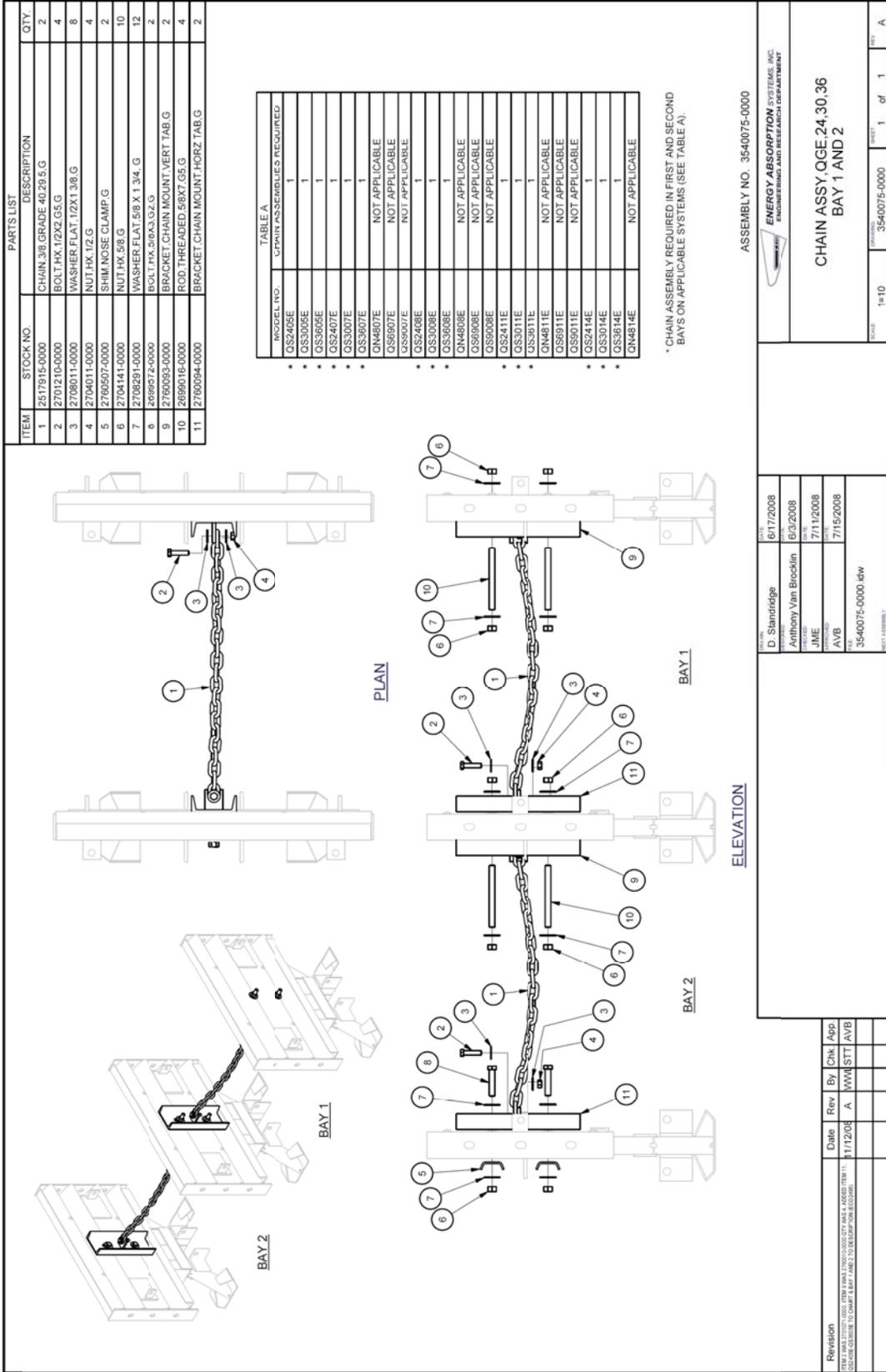
ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT	
QUADGUARD® ELITE™ SYSTEM	
BACKUP ASSY, TS, QGE, 24, 30, 36	
SCALE	N.T.S.
DWG. NO.	604603
REV.	1 of 1

DATE	BY	CHKD.	APP.
11/11/98	S. VAN OGLE		
11/11/98	R. BLOSKI		
3/19/99	KRM		
3/23/99	RBB		
CAD FILE: 604603.dwg			
REV. ASSEMBLY:			

Revisions	Date	Rev.	By	Chd.	App.
1	11/11/98	A	WVL	JME	ST
NOTES: NUMBER TO SECOND VALUE FROM REAR FOR 36\"/>					

DWG 604603

QuadGuard® Elite System Backup Assembly, TS, QGE, 24, 30, 36



DWG 3540075-0000

Chain Assembly, QGE, 24, 30 36 Bay 1 & 2

		ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT	
ASSEMBLY NO. 3540075-0000		CHAIN ASSY, QGE, 24, 30, 36 BAY 1 AND 2	
DATE: 6/17/2008 DRAWN BY: Anthony Van Brocklin CHECKED BY: JME APPROVED BY: AVB TITLE: 3540075-0000.dwg PLOT NUMBER:	DATE: 6/17/2008 DATE: 6/2/2008 DATE: 7/11/2008 DATE: 7/15/2008	SCALE: 1=10	SHEET 1 of 1

PARTS LIST			
ITEM	STOCK NO.	DESCRIPTION	QTY
1	2517212-0000	CHAIN, 3/8" GRADE 40, 31,G	1.00
2	2701210-0000	BOL, HX, 1/2X2, G5, G	2.00
3	2708011-0000	WASHER, FLAT, 1/2X1 3/8, G	4.00
4	2704011-0000	NUT, HX, 1/2, G	2.00

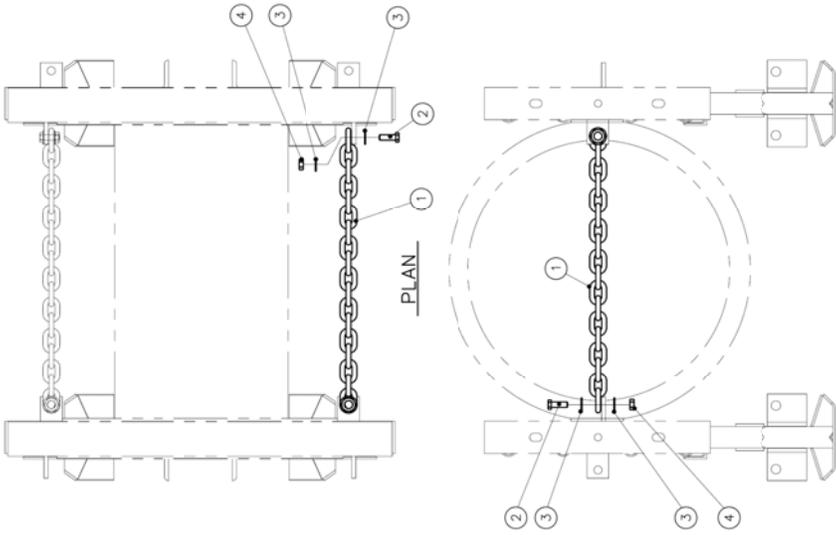


TABLE A	
MODEL NO.	CHAIN ASSEMBLIES REQUIRED
OS2405E	NOT APPLICABLE
OS3005E	NOT APPLICABLE
OS3605E	6
ON4805E	6
OS6905E	6
OS9005E	NOT APPLICABLE
OS3007E	NOT APPLICABLE
OS3607E	10
ON4807E	10
OS6907E	10
OS9007E	10
OS2408E	NOT APPLICABLE
OS3008E	NOT APPLICABLE
OS3608E	2
ON4808E	2
OS6908E	12
OS9008E	12
OS2411E	NOT APPLICABLE
OS3011E	NOT APPLICABLE
OS3611E	18
ON4811E	18
OS6911E	18
OS9011E	18
OS2414E	NOT APPLICABLE
OS3014E	NOT APPLICABLE
OS3614E	24
ON4814E	24

* TWO CHAIN ASSEMBLIES REQUIRED IN ALL BAYS EXCEPT FIRST & SECOND BAYS ON APPLICABLE SYSTEMS (SEE TABLE A).

NOTE:
1. SEE TABLE A FOR QUANTITY OF CHAIN ASSEMBLIES NEEDED.

ASSY NO. 3540491-0000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

CHAIN ASSY, QGE

DESIGNED BY	S. VAN OGLE	DATE	11/12/98
DESIGNED BY	RBB	DATE	11/12/98
DESIGNED BY	KRM	DATE	3/2/99
DESIGNED BY	RBB	DATE	3/16/99
PART FILE: 3540491-0000.DWG			
NOTE: ASSEMBLY			

REFERENCES

Revisions	Date	Rev.	By	Chd./App.
ADDED 0N#s TO TABLE A	06/27/07	C	RCC/STI	RCB
ADDED 5 BAY TO TABLE A	02/02/08	D	RCC/STI	RCB
ITEM 2 WKS: 2701071-0000 (ECO: 2694)	1/23/09	E	IWL/STI	FJP

SCALE	1:10	ASSY NO.	3540491-0000	SHEET	1 of 1	REV	E
-------	------	----------	--------------	-------	--------	-----	---

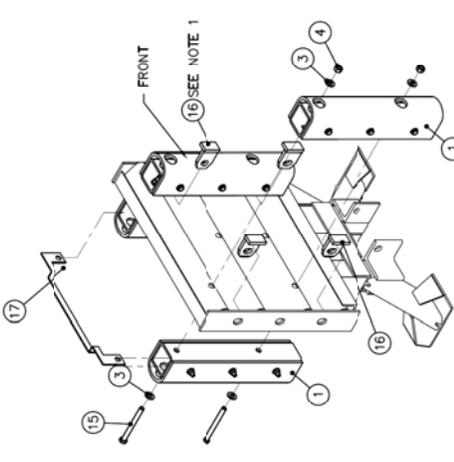
Chain Assembly, QGE

DWG 3540491-0000

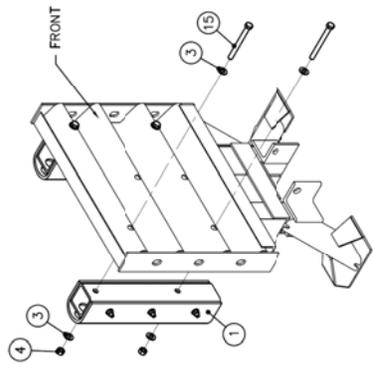
ITEM	STOCK NO.	DESCRIPTION	RECD
1	605707B	BUMPER ASSEMBLY, ELITE, 24, 30, 36	8.00
2	113472C	BOLT, HX, 1/2X2, G2, G	4.00
3	118009G	WASHER, FLAT, 1/2X1 3/8, G	24.0
4	115939G	NUT, HX, 1/2, G	12.0
8	606646B	CYLINDER ASSY, ELITE, QE1	*
9	606647B	CYLINDER ASSY, ELITE, QE2	*
12	618547G	TUBE, CABLE, JACKET	*
13	113851G	CABLE ASSEMBLY, CYLINDER RETAINER	*
14	114108G	CLAMP, WIRE, ROPE, 1/2	*
15	113487G	BOLT, HX, 1/2X5, G	8.00
16	615617G	TAB, STOP	8.00
17	605463B	BRACKET, HIT INDICATOR	1.00

SYSTEM	ASSY NO.	ITEM NUMBER			
		8	9	12	13
5 BAY SYSTEM	605040B	3	0	6	4
7 BAY SYSTEM	605042B	3	2	10	6
8 BAY SYSTEM	605044B	3	3	12	7
11 BAY SYSTEM	605037B	3	6	18	10
14 BAY SYSTEM	605039B	3	9	24	13

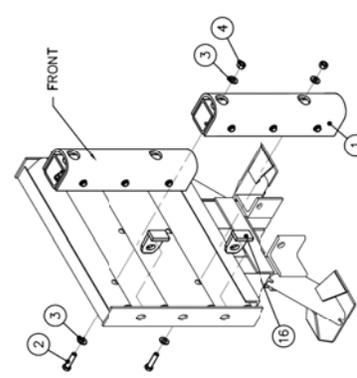
ITEM	QUANTITY	REVISION
1	1	1
2	1	1
3	1	1
4	1	1
15	1	1
16	1	1
17	1	1



DIAPHRAGM 2



DIAPHRAGM 1



DIAPHRAGM 3

ASSEMBLY NO. (SEE TABLE)
ENERGY ABSORPTION SYSTEMS, INC.
 ENGINEERING AND RESEARCH DEPARTMENT
QUADGUARD® ELITE™ SYSTEM
 BAY ASSY, QGE, 24, 30, 36

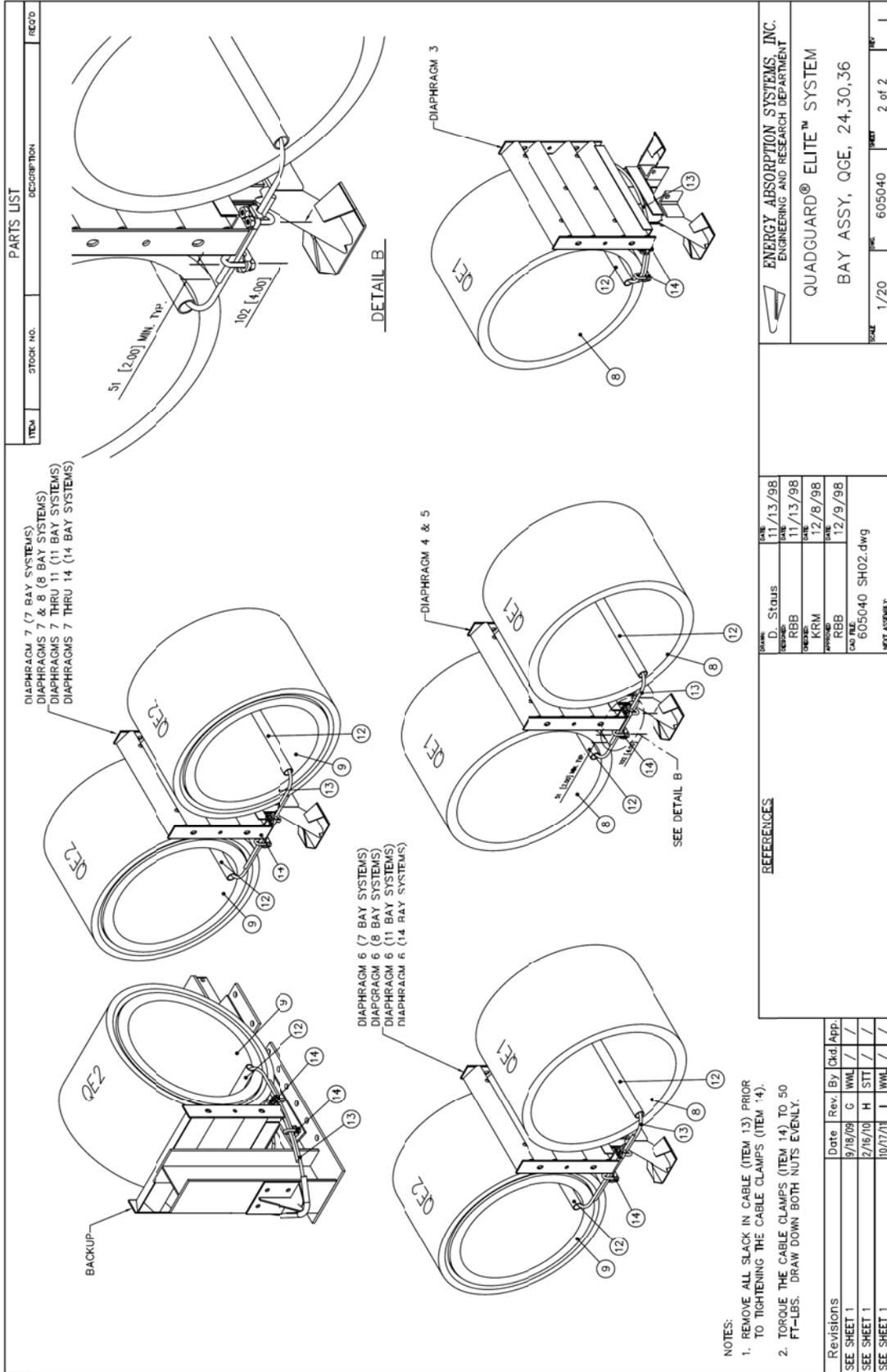
DATE	BY	REVISION
11/13/98	RBB	1
11/13/98	KRM	2
3/19/99	RBB	3
3/23/99	RBB	4

605040.dwg
 NEXT ASSEMBLY

Revisions	Date	Rev.	By	Ckd.	App.
ADDED ITEM 17 (ECO 2765)	9/18/08	G	WML	JME	FJP
REPOSITIONED ITEM 17 TO REAR OF DIAPHRAGM	2/15/10	H	STT	KRM	FJP
UPDATED DIMS & DIM TO NEWARKS (ECO 3180)	10/17/11	T	WML	JME	AJC

NOTE:
 1. PLACE ONLY ON DIAPHRAGMS 2 AND 3.

QuadGuard® Elite System Bay Assembly, QGE, 24, 30, 36



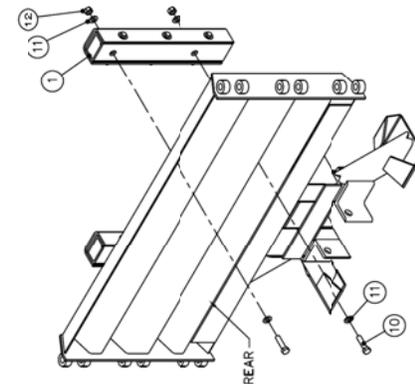
QuadGuard® Elite System Bay Assembly, QGE, 24, 30, 36

DWG 605040 Sheet 2 of 2

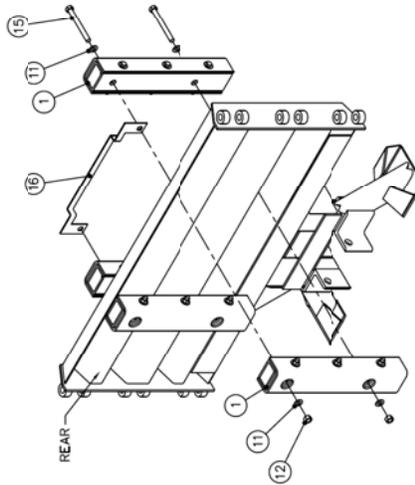
TABLE		ITEM NO.	
SYSTEM	ASSY NO.	5	6
5 BAY SYSTEM	605041B	3	0
7 BAY SYSTEM	605043B	3	2
8 BAY SYSTEM	605045B	3	3
11 BAY SYSTEM	605038B	3	6
		7	8
		8	9

PARTS LIST		DESCRIPTION	8.00
ITEM	STOCK NO.		
1	605705B	BUMPER ASSY,QG	8.00
5	606646B	CYLINDER ASSY,ELITE,QE1	*
6	606647B	CYLINDER ASSY,ELITE,QE2	*
7	618547G	TUBE,CABLE JACKET	*
8	113851G	CABLE ASSEMBLY,CYLINDER RETAINER	*
9	114108G	CLAMP,WIRE ROPE,1/2	*
10	114108G	BOLT,HX,1/2X2,G2,G	4.00
11	118009G	WASHER,FLAT,1/2X1 3/8,G	24.0
12	115939G	NUT,HX,1/2,G	12.0
15	113487G	BOLT,HX,1/2X5,G2,G	8.00
16	605463B	BRACKET,HIT INDICATOR	1.00

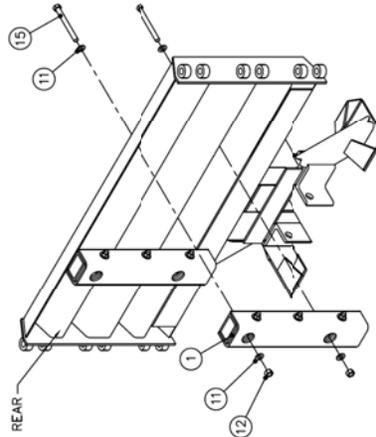
* SEE TABLE



DIAPHRAGM_3



DIAPHRAGM_2



DIAPHRAGM_1

Revisions	Date	Rev.	By	Chd.	App.
ADDED 5 BAY SYSTEM	06/16/08	E	RJV	STT	BMK
ADDED ITEM 16 (ECO 2765)	9/18/08	F	HWL	JME	FJP
THIS YEAR-END CLOSURE FOR 7 BAY SYSTEM 2008-2009	10/18/11	G	HWL	JME	AJC
UPDATED DIMS & DIMS TO ROMACS (ECO 3160)					

DATE	BY	CHKD.	APP.
11/13/98	D. STOUT		
11/13/98	RBB		
3/19/99	KRM		
3/23/99	RBB		

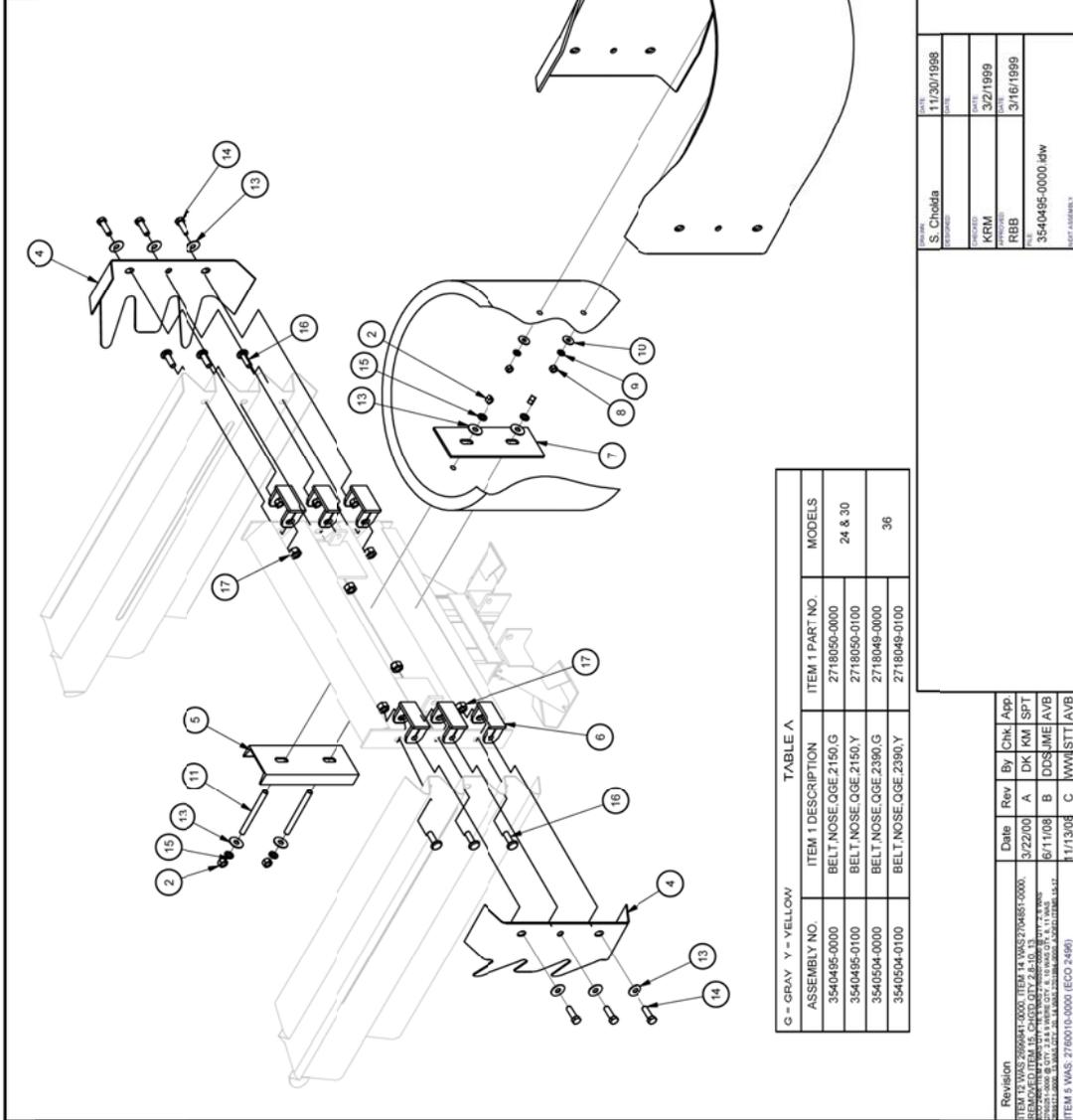
DATE	FILE
11/13/98	605041.dwg

DATE	SCALE	SHEET	TOTAL
1/15	1/15	605041	1 of 2

ASSEMBLY NO. (SEE TABLE)	SCALE	DATE	REV.
ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT	1/15	605041	1 of 2
QUADGUARD® ELITE™ SYSTEM			
BAY ASSY,QGE,69/90			

QuadGuard® Elite System Bay Assembly, QGE, 69/90

ITEM	STOCK NO.	DESCRIPTION	QTY.
1	2718050-0000	BELT NOSE,84.56,QGE,24&30,G	1
2	1159703	NUT,HX,3/8,G	4
3	2021657-0000	CYLINDER NOSE,HDPE,28X20	1
4	27160504-0000	CLAMP NOSE BELT,QG,G	2
5	27160093-0000	BRACKET,CHAIN MOUNT,VERT,TAB,G	1
6	2760009-0000	STOP,TAB,WRAP,WELDMENT	6
7	2753071-0000	PLATE NOSE,CYLINDER,G	1
8	1156968	NUT,HX,1/2,G	2
9	1180082	WASHER,LOCK,1/2,G	2
10	1180093	WASHER,FLAT,1/2X1.3/8,G	4
11	2699016-0000	ROD,THREADED,5/8X7.05,G	2
12	2701381-0000	BOLT,HX,1/2X3,GZ,G	2
13	1180523	WASHER,FLAT,5/8 X 1.3/4, G	10
14	1136593	WASHER,LOCK,5/8,G	6
15	1181003	WASHER,LOCK,5/8,G	4
16	1137034	ROLL T SPLICE,M16X50,R,R,G	6
17	1160273	NUT,HX,SPLICE,M16,G	6



ASSEMBLY NO.	ITEM 1 DESCRIPTION	ITEM 1 PART NO.	MODELS
3540495-0000	BELT NOSE,QGE,2150,G	2718050-0000	24 & 30
3540495-0100	BELT NOSE,QGE,2150,Y	2718050-0100	
3540504-0000	BELT NOSE,QGE,2390,G	2718049-0000	36
3540504-0100	BELT NOSE,QGE,2390,Y	2718049-0100	

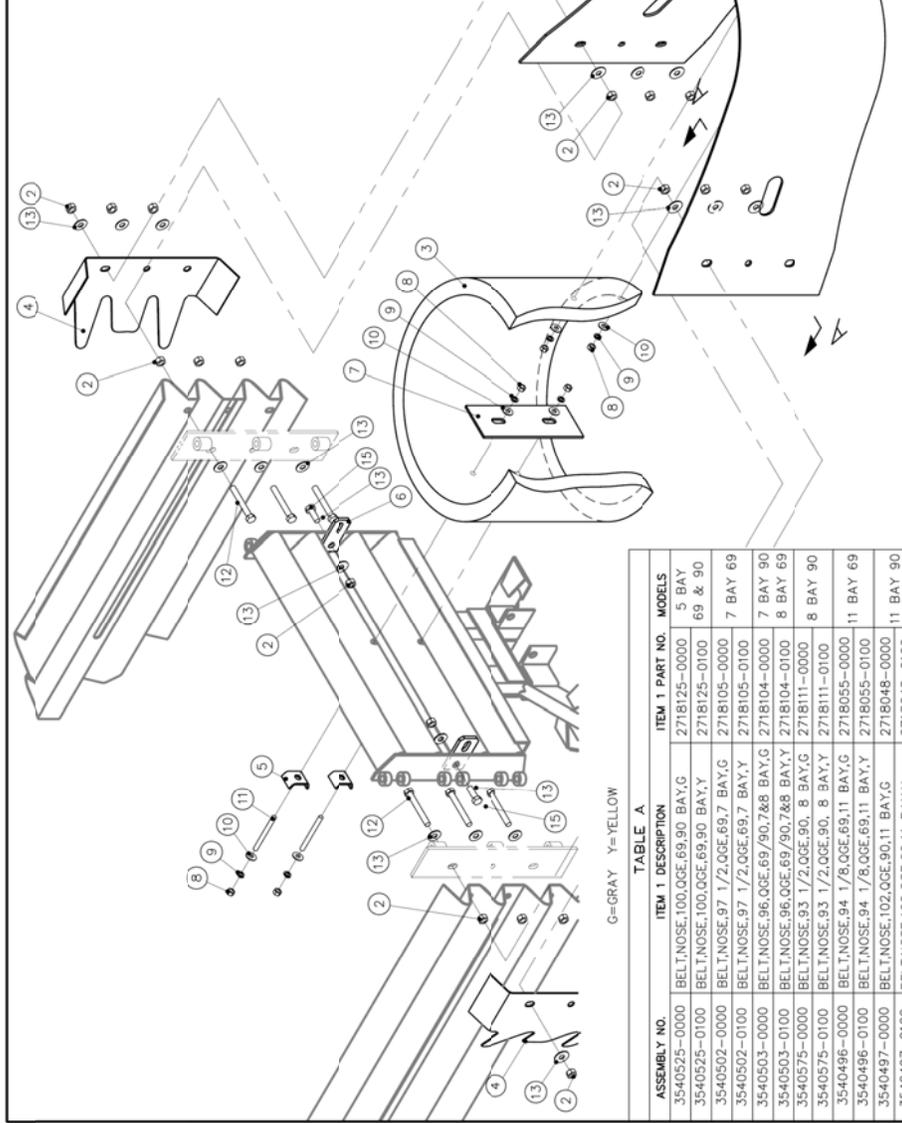
DESIGNED BY	S. Chodda	DATE	11/30/1998
CHECKED BY	KRM	DATE	3/27/1999
APPROVED BY	RBB	DATE	3/16/1999
PROJECT NO.	3540495-0000.dwg		
SCALE	1:13	SHEET	1 of 1

ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT
QUADGUARD® ELITE™ SYSTEM
NOSE ASSY,QGE,24,30 & 36,G OR Y

DWG 3540495-0000

QuadGuard® Elite System Nose Assembly, QGE, 24, 30, & 36, G or Y

ITEM	STOCK NO.	DESCRIPTION	QTY
1	SEE TABLE	BELT,NOSE,QGE	1.00
2	2704141-0000	NUT,HX,5/8,G	20.0
3	2021657-0000	CYLINDER,NOSE,HDPE,28X20X2	1.00
4	2760504-0000	CLAMP,BELT,LMC	2.00
5	2760507-0000	SHIM,NOSE CLAMP, G	2.00
6	2760251-0000	BRACKET,PULL OUT,QG	2.00
7	2753071-0000	PLAT,NOSE CYLINDER	1.00
8	2704011-0000	NUT,HX,1/2,G	6.00
9	2708181-0000	WASHER,LOCK,1/2,G	6.00
10	2708011-0000	WASHER,FLAT,1/2X1 3/8,G	8.00
11	2699171-0000	ROD,THREADED,1/2X5 3/4,G5,G	2.00
12	2701994-0000	BOLT,HX,5/8X5,65,G,ALL THREAD	6.00
13	2708291-0000	WASHER,FLAT,5/8X1 3/4,G	20.0
15	2698241-0000	BOLT,HX,5/8X2 1/4,G8,G	2.00
16	2701361-0000	BOLT,HX,1/2X3,G2,G	2.00



G=GRAY Y=YELLOW

ASSEMBLY NO.	ITEM 1 DESCRIPTION	ITEM 1 PART NO.	MODELS
3540525-0000	BELT,NOSE,100,QGE,69,90 BAY,G	2718125-0000	5 BAY
3540525-0100	BELT,NOSE,100,QGE,69,90 BAY,Y	2718125-0100	69 & 90
3540502-0000	BELT,NOSE,97 1/2,QGE,69,7 BAY,G	2718105-0000	7 BAY 69
3540503-0000	BELT,NOSE,97 1/2,QGE,69,7 BAY,Y	2718105-0100	7 BAY 90
3540503-0100	BELT,NOSE,96,QGE,69,90,7&8 BAY,G	2718104-0000	8 BAY 69
3540503-0200	BELT,NOSE,96,QGE,69,90,7&8 BAY,Y	2718104-0100	8 BAY 90
3540575-0000	BELT,NOSE,93 1/2,QGE,90, 8 BAY,G	2718111-0000	8 BAY 90
3540575-0100	BELT,NOSE,93 1/2,QGE,90, 8 BAY,Y	2718111-0100	8 BAY 90
3540496-0000	BELT,NOSE,94 1/8,QGE,69,11 BAY,G	2718055-0000	11 BAY 69
3540496-0100	BELT,NOSE,94 1/8,QGE,69,11 BAY,Y	2718055-0100	11 BAY 90
3540497-0000	BELT,NOSE,102,QGE,90,11 BAY,G	2718048-0000	11 BAY 90
3540497-0100	BELT,NOSE,102,QGE,90,11 BAY,Y	2718048-0100	11 BAY 90

REFERENCES

DESIGNED BY	S. Chaldo	DATE	12/03/98
CHECKED BY	K. Mortensen	DATE	3/19/99
APPROVED BY	R. Blaski	DATE	3/23/99
DWG FILE	3540496-0000.dwg		
NOT ASSIGNED			

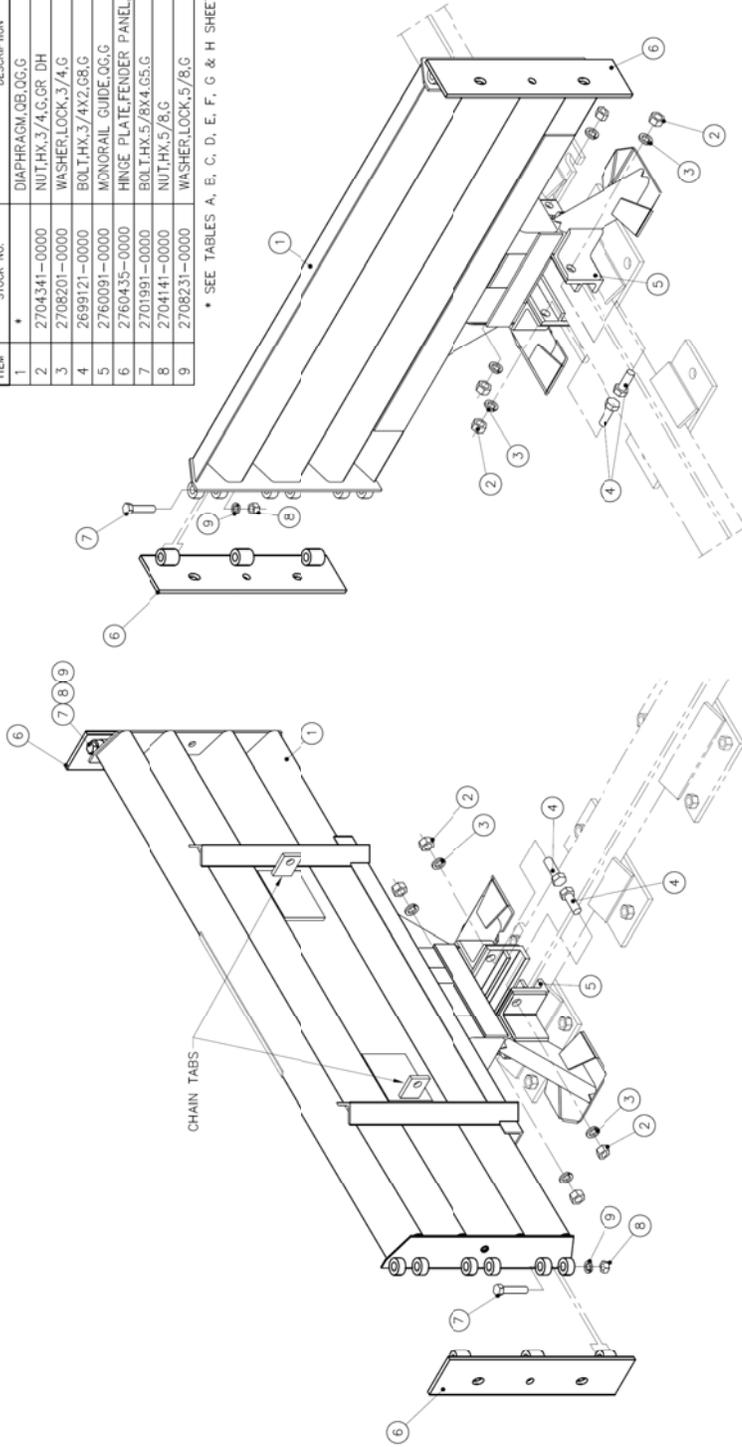
ASSEMBLY NO. SEE TABLE
ENERGY ABSORPTION SYSTEMS, INC. ENGINEERING AND RESEARCH DEPARTMENT
QUADGUARD® ELITE™ SYSTEM NOSE ASSY,QGE,G OR Y,69/90
SCALE: 1:15
3540496-0000
1 of 1
D

QuadGuard® Elite System Nose Assembly, QGE, G or Y, 69/90

DWG 3540496-0000

ITEM	STOCK NO.	DESCRIPTION	QTY
1	*	DIAPHRAGM,QB,QG,G	1.00
2	2704341-0000	NUT,HX.3/4,G,GR DH	4.00
3	2708201-0000	WASHER,LOCK.3/4,G	4.00
4	2699121-0000	BOLT,HX.3/4X2,Q8,G	4.00
5	2760091-0000	MONORAIL GUIDE,QG,G	2.00
6	2760435-0000	HINGE PLATE,FENDER PANEL,QG,G	2.00
7	2701991-0000	BOLT,HX.5/8X4,Q5,G	6.00
8	2704141-0000	NUT,HX.5/8,G	6.00
9	2708231-0000	WASHER,LOCK.5/8,G	6.00

* SEE TABLES A, E, C, D, E, F, G & H SHEETS 2, 3 & 4



VIEW FRONT SIDE

DIAPHRAGM #1-1
DIAPHRAGM #3 ONLY HAS CHAIN TABS ON THE BACK SIDE

VIEW BACK SIDE

DIAPHRAGM #1 AND #2

(SEE TABLES A, B, C, ETC.)

ASSEMBLY NO. 3540

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE™ SYSTEMS
DIAPHRAGM ASSY,
QGE.69/90

DATE	BY	CHKD.	APP.
1/6/99	D. Staus		
1/6/99	R. Blaski		
1/15/99	KRM		
1/15/99	RBB		

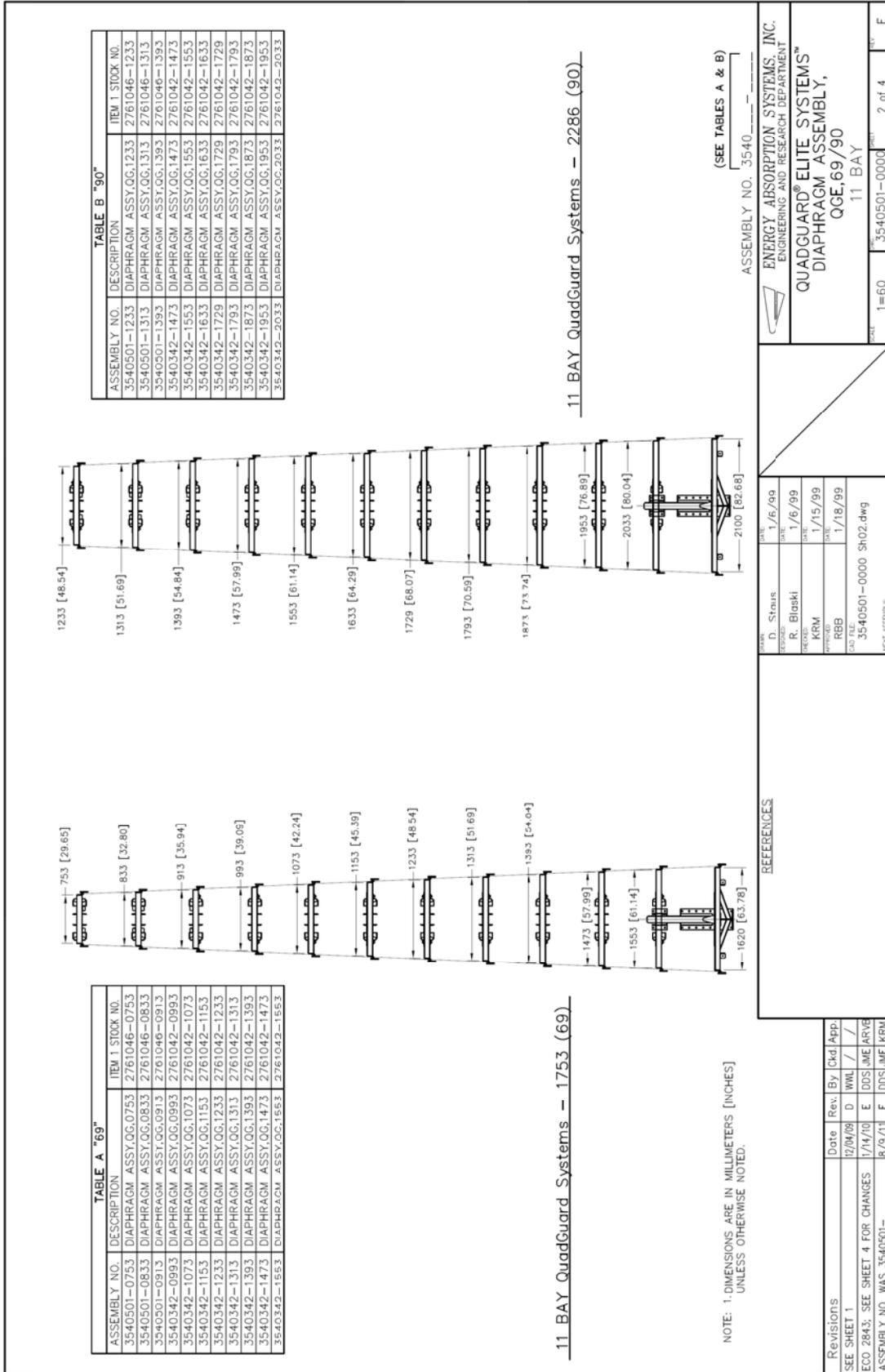
REFERENCES

Date	Rev.	By	Chk.	App.
12/04/09	D	WJ	JME	PAS
1/14/10	E	DDS	JME	JARB
8/9/11	F	DDS	JME	KRM

Revisions
REMOVED BUMPERS FROM ITEM 1 (ECO 2813)
ECO 2843; SEE SHEET 4 FOR CHANGES
ASSEMBLY NO. WAS 354050-
8/9/11 F DDS JME KRM

DATE	SCALE	NO.	OF
1-12	1:12	3540501-0000	1 of 4

QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90



DWG 3540501 Sheet 2 of 4

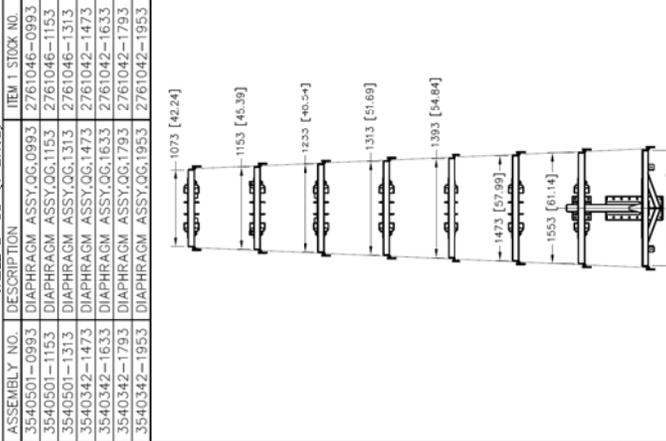
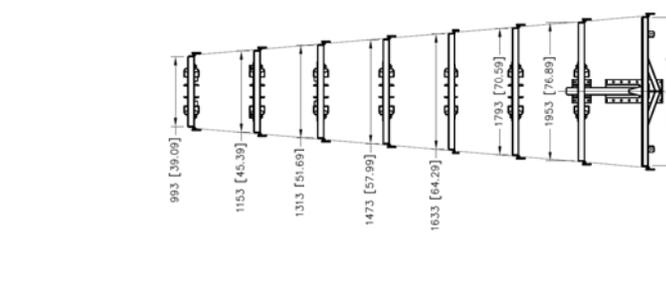
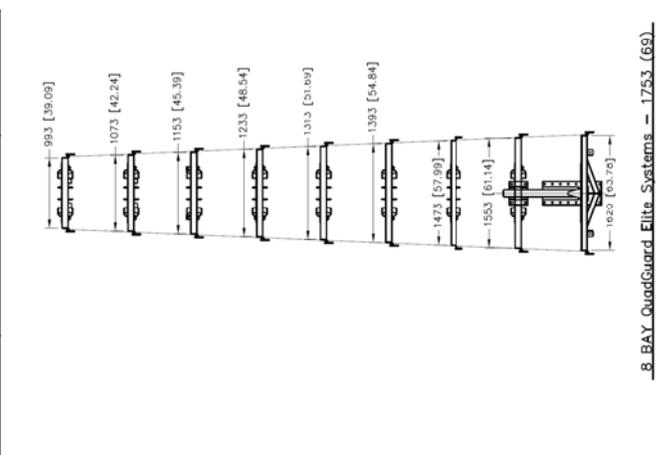
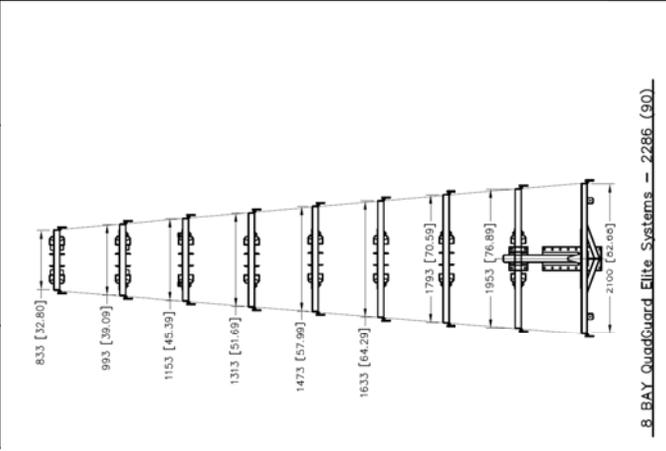
QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 11 Bay

TABLE C "69" (7 BAYS)			TABLE D "90" (7 BAYS)		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.	ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-1073	DIAPHRAGM ASSY.OG.1073	2761046-1073	3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993
3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153	3540501-1073	DIAPHRAGM ASSY.OG.1073	2761046-1073
3540501-1233	DIAPHRAGM ASSY.OG.1233	2761046-1233	3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153
3540342-1313	DIAPHRAGM ASSY.OG.1313	2761042-1313	3540342-1233	DIAPHRAGM ASSY.OG.1233	2761042-1233
3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473	3540342-1313	DIAPHRAGM ASSY.OG.1313	2761042-1313
3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633	3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473
3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793	3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633
3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953	3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793
3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953	3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953

TABLE E "69" (8 BAYS)			TABLE F "90" (8 BAYS)		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.	ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993	3540501-0833	DIAPHRAGM ASSY.OG.0833	2761046-0833
3540501-1073	DIAPHRAGM ASSY.OG.1073	2761046-1073	3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993
3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153	3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153
3540342-1233	DIAPHRAGM ASSY.OG.1233	2761042-1233	3540342-1313	DIAPHRAGM ASSY.OG.1313	2761042-1313
3540342-1393	DIAPHRAGM ASSY.OG.1393	2761042-1393	3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473
3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473	3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633
3540342-1553	DIAPHRAGM ASSY.OG.1553	2761042-1553	3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793
3540342-1553	DIAPHRAGM ASSY.OG.1553	2761042-1553	3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953

TABLE G "69" (7 BAYS)			TABLE H "90" (7 BAYS)		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.	ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993	3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993
3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153	3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153
3540501-1313	DIAPHRAGM ASSY.OG.1313	2761046-1313	3540501-1313	DIAPHRAGM ASSY.OG.1313	2761046-1313
3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473	3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473
3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633	3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633
3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793	3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793
3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953	3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953

TABLE I "69" (7 BAYS)			TABLE J "90" (7 BAYS)		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.	ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993	3540501-0993	DIAPHRAGM ASSY.OG.0993	2761046-0993
3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153	3540501-1153	DIAPHRAGM ASSY.OG.1153	2761046-1153
3540501-1313	DIAPHRAGM ASSY.OG.1313	2761046-1313	3540501-1313	DIAPHRAGM ASSY.OG.1313	2761046-1313
3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473	3540342-1473	DIAPHRAGM ASSY.OG.1473	2761042-1473
3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633	3540342-1633	DIAPHRAGM ASSY.OG.1633	2761042-1633
3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793	3540342-1793	DIAPHRAGM ASSY.OG.1793	2761042-1793
3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953	3540342-1953	DIAPHRAGM ASSY.OG.1953	2761042-1953



8 BAY QuadGuard Elite Systems - 2286 (90)
 (SEE TABLES C THRU F)
 ASSEMBLY NO. 3540

8 BAY QuadGuard Elite Systems - 1753 (69)
 ASSEMBLY NO. 3540

7 BAY QuadGuard Elite Systems - 2286 (90)
 ASSEMBLY NO. 3540

7 BAY QuadGuard Elite Systems - 1753 (69)
 ASSEMBLY NO. 3540

NOTE: 1 DIMENSIONS ARE IN MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

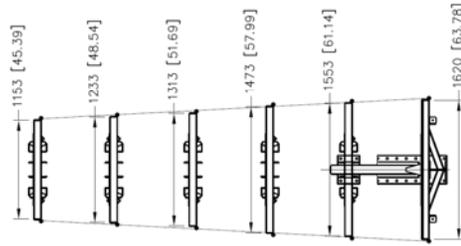
Revisions	Date	Rev.	By	Chd.	App.
UPDATED 2/10/09	12/04/09	D	WJL	JME	PAS
ECCO 2843 - SEE SHEET 4 FOR CHANGES	1/14/10	E	DDJ	JME	JARVE
ISSY NO. IN TABLE F FOR 103 AND OVERALL	8/9/11	F	DDJ	JME	KRM

ENERGY ABSORPTION SYSTEMS, INC.
 ENGINEERING AND RESEARCH DEPARTMENT
 QUADGUARD® ELITE™ SYSTEM
 DIAPHRAGM ASSEMBLY,
 QGE.69/90
 7 & 8 BAY SYSTEMS

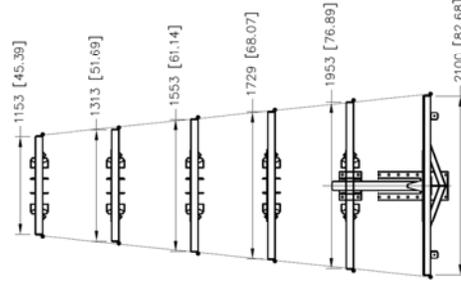
DATE: 1=60
 PART: 3540501-0000
 SHEET: 3 of 4
 OF: F

QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 7 & 8 Bay

TABLE G "69"			TABLE H "90"		
ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.	ASSEMBLY NO.	DESCRIPTION	ITEM 1 STOCK NO.
3540501-1153	DIAPHRAGM ASSY,CG,1153	2761046-1153	3540501-1153	DIAPHRAGM ASSY,CG,1153	2761046-1153
3540501-1233	DIAPHRAGM ASSY,CG,1233	2761046-1233	3540501-1313	DIAPHRAGM ASSY,CG,1313	2761046-1313
3540501-1473	DIAPHRAGM ASSY,CG,1473	2761042-1473	3540501-1553	DIAPHRAGM ASSY,CG,1553	2761042-1553
3540342-1153	DIAPHRAGM ASSY,CG,1153	2761042-1153	3540342-1729	DIAPHRAGM ASSY,CG,1729	2761042-1729
			3540342-1953	DIAPHRAGM ASSY,CG,1953	2761042-1953



5 BAY QuadGuard Systems - 1753 (69)



5 BAY QuadGuard Systems - 2286 (90)

NOTE: 1. DIMENSIONS ARE IN MILLIMETERS [INCHES] UNLESS OTHERWISE NOTED.

Revisions	Date	Rev.	By	Ckd.	App.
SEE SHEET 1	12/04/08	D	WML	/	/
ECCO 2843; UPDATED BOTH TABLES	1/14/10	E	DDSL	JME	ARVB
ASSEMBLY NO. WAS 3540501-	8/29/11	F	DDSL	JME	KRM

REFERENCES

DESIGNED BY	DATE	DATE
R. VENTZON	06/11/09	
S. TRAGESER	06/11/09	
P. SEPULVEDA	06/11/09	
3540501-0000 SH04.DWG		

ASSEMBLY NO. 3540

(SEE TABLES G & H)

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

QUADGUARD® ELITE SYSTEMS™
DIAPHRAGM ASSEMBLY,
QGE,69/90
5 BAY

SCALE 1"=60' 3540501-0000 4 OF 4

QuadGuard® Elite System Diaphragm Assembly, QGE, 69/90 5 Bay

Notes



2525 Stemmons Freeway

Dallas, Texas 75207

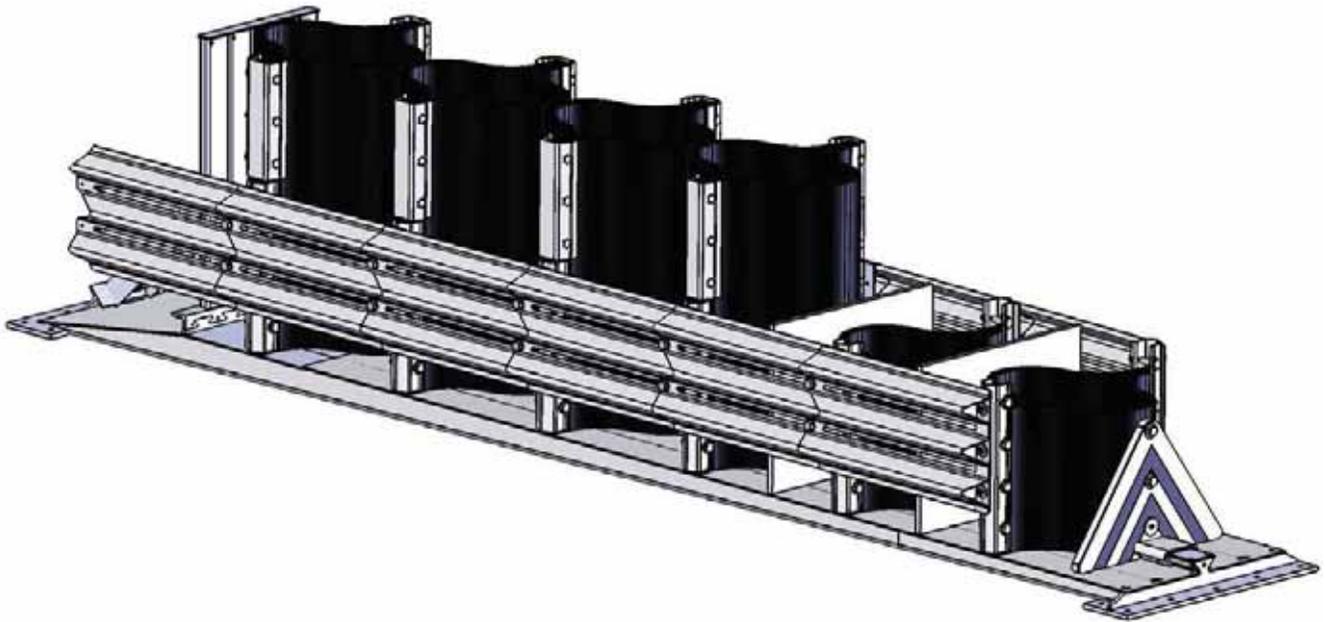
888-323-6374 (USA only)

312-467-6750 (Outside USA)

www.energyabsorption.com

www.highwayguardrail.com

Compressor[®] System Reusable/Low Maintenance Crash Cushion Installation Instruction Manual



160 Ave. La Pata
San Clemente, California 92673
(949) 361-5663
FAX (949) 361-9205
www.traffixdevices.com

PN 55010 Revision A (Dated 01/07/10)

Table of Contents

	Page
Compressor Attenuator Features	1
General System Overview	1
Compressor Identification And Orientation	2
Directional Application Definition	3
Tools Required For Concrete Installation.....	4
Concrete Pad Minimum Requirements	5
Compressor Module Identification	6
Lifting and Moving Of The Compressor	8
Installation Section	11
Transition Kit Installation	14
Design Of The Compressor For Longevity	25
Compressor Product Specification.....	26
Typical Field Installation	28
Appendix A- Drawings	36
Contact Information	46

160 Ave. La Pata
San Clemente, California 92673
(949) 361-5663
FAX (949) 361-9205
www.traffixdevices.com

General System Overview

The Compressor® System is a re-directive, bi-directional crash cushion designed to shield immovable objects up to 36 inches or less in width. The Compressor System incorporates a self contained Uni-Base™ Platform which does not need to be placed against a rigid object to support itself. The Compressor System consists of six engineered shaped self-restoring plastic modules of varying material thickness and heights to produce the desired energy attenuation characteristics to decelerate an impacting vehicle to meet the TL-3 crash worthy requirements of Report NCHRP 350. Attached along the entire length are re-directive fender panels, which slide upon each other when impacted.

Additional Features:

- Passed all required NCHRP 350 TL-3 Tests – Accepted for use on the National Highway System – FHWA Product Acceptance Letters CC-95 and CC-95A
- Compressor System is a low maintenance/self restoring crash cushion designed to take repeated impacts
- Overall length is 21' – Attenuator Modules/Effective length 16'6"
- Delivered assembled and ready to install – Minimal on-site assembly
- Galvanized structural steel Uni-Base™ Platform requires 14 bolts to secure Compressor to concrete
- Compressor's assembled design combined with the Uni-Base Platform construction makes job site installation fast, easy, and safe – one crew can safely install several units in one day
- Compressor's specially formulated attenuator modules are injection molded from HDPE plastic and are designed to be more efficient by attenuating the impact energy in a shorter distance
- Attenuator modules are pre-flattened to provide more consistent results after repeated impacts
- Compressor's telescoping steel side-panels re-direct side impacts with minimal damage to attenuator modules or panels

Compressor Identification and Orientation

Figure 1 and 2 (or on Pg 37 and 38) identifies the Compressor Systems front and rear orientation for installation. The plastic impact nose bolts to Module #1 orients to the front. Module #6 attached to the rear backstop orientated to the rear.

Figure 1 (or on pg 37) identifies a Uni-directional configuration which is used in single traffic flow conditions. Figure 2 (or on pg 38) identifies a bi-directional traffic configuration which is used in counter flow conditions which utilizes the concrete median barrier transition kit.

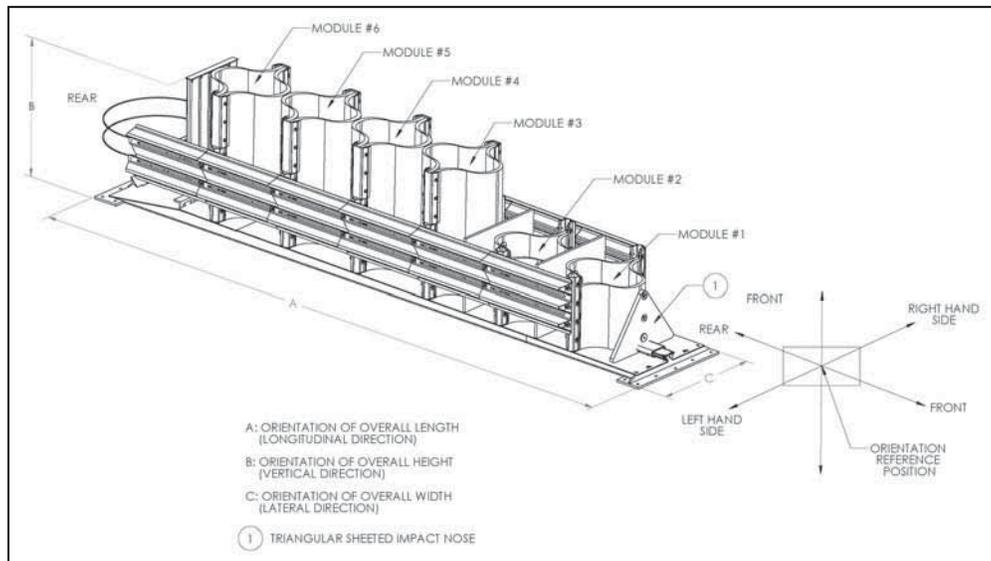


Figure 1: Uni-Directional Configuration.

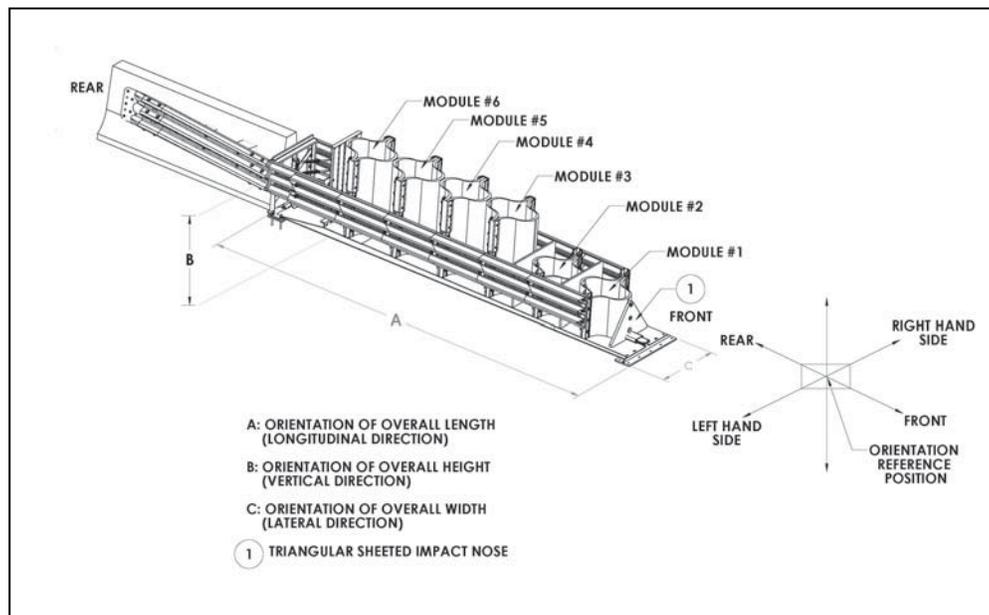


Figure 2: Bi-Directional Configuration Shown With Transition Kit Attached to CMB

Directional Application Definition

The Compressor System is designed for use in either a uni- or bi-directional traffic flow condition as shown in Figures 3 and 4 (or on Pg 39 and 40). A general definition of these applications are seen below with diagrams.

Uni-Directional Application: Uni-directional refers to the flow of traffic in a single direction as seen in Figure 3 (or on Pg 39). In this type of application opposite direction impacts would not be probable.

Bi-directional Application: Bi-directional refers to the flow of traffic in both directions typically referred to as counter flow seen in Figure 4 (or on Page 40). In this type of application the counter flow of traffic will result in a both frontal and reverse impacts into the Compressor System. Because reverse impacts may occur, a transition kit, is used to shield the CMB end.

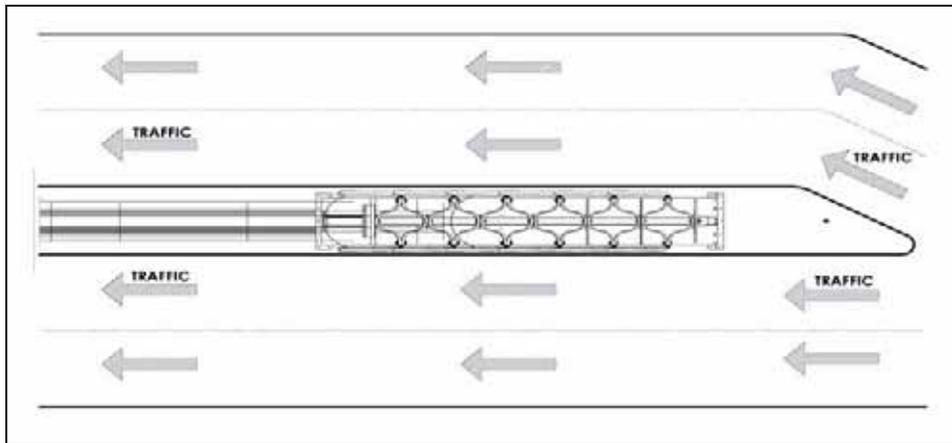


Figure 3: Traffic Flow Application in Single Direction.

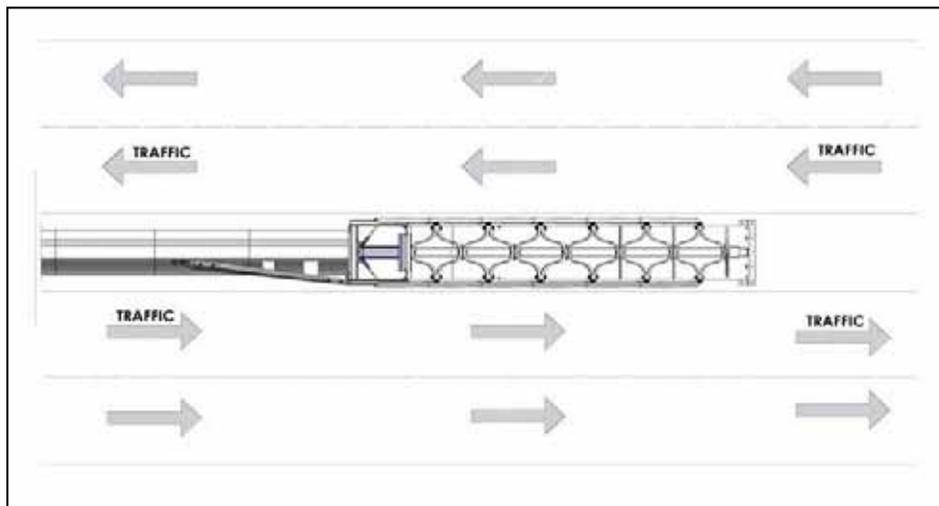


Figure 4: Traffic Flow Application in Counter Flow Direction.

Tools & Equipment for Concrete Installation

List of tools is a recommendation only and the actual tools required will depend on site conditions for the installation. Personal protective equipment should always be used during Compressor installation. Safety glasses, steel toe boots, hard hat and gloves are recommended as protection devices for the installer's safety.

Documents

Before installation it is recommended that the complete manufactures manual and drawing package be reviewed for clarity of the installation.

- Factory Installation Manual and drawing package

Tools

Concrete Hole Drilling Tools

- Two Fluted Concrete Drill Bit 1" [25.4 mm]
- Rebar Cutting Drill Bit 1" [25.4 mm]
- Roto Hammer Drill
- Nylon brush and container of cleaning solvent for cleaning 1" [25.4 mm] drilled holes

Drill bits should be capable of drilling to depths of 6" below grade and be of good quality to drill through 4000 psi concrete and steel rebar.

Additional Tools

In addition to the lifting tools, the following is required:

- Electrical Generator (5 KW) and Air Compressor (100 psi)
- Torque wrench 200 ft-lbs
- Impact Wrench 1/2" Drive
- Sockets 1/2" Drive 3/4"-2" Nut and Bolt Size Shallow and Deep Sockets
- Ratchet and extensions 1/2" Drive
- Wrench Set Open/Box End 3/4"-2" Nut and Bolt Size
- Adjustable Wrench 12"
- Pry/Breaker Bars
- Sledge and Ball Peen Hammers
- Chalk Line
- Concrete Marking Pencil
- Tape Measure
- Optional Tools that may be needed Grinders, Hacksaw, or Torch

The Compressor is delivered assembled and does not require any assembly beyond anchoring to the pad. Cutting of any components on the Compressor is not acceptable and cutting tools should not be used on the Compressor itself.

Concrete Pad Requirements

Existing concrete must meet Portland (PCC) grade of minimum 4000 psi and be a minimum of 6" thick and be steel reinforced or 8" thick un-reinforced. The concrete should not have any cracks which could have the potential for further propagation during anchor bolt drilling. During concrete drilling a minimum of 14 anchor bolt holes will be needed to secure the Compressor System to the concrete foundation.

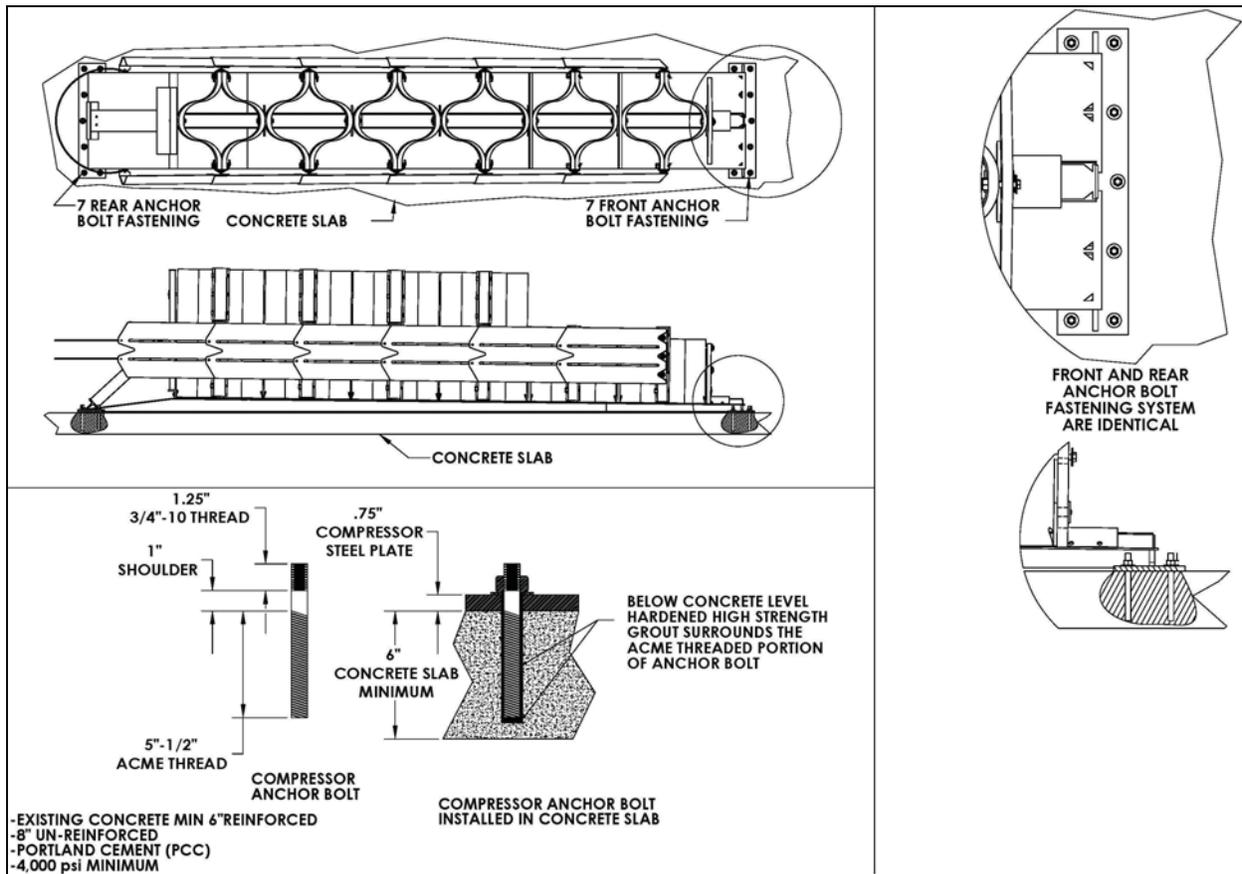


Figure 5: Compressor System Concrete Anchor Bolt Attachment

The concrete foundation requirements must be met to accept the drilling of fourteen anchor bolt holes 5-1/2" below grade as seen in Figure 5 (or on pg 41). The Compressor is anchored to the concrete foundation using high strength grout which bonds to the concrete. When the anchor bolts are set in the in the grout it creates a high strength anchoring system. For a complete installation in concrete seven anchor bolts are used on both the front and back mounting plates.

Compressor Module Identification

The Compressor Module identification sequence is based on a numeric sequence of 1-6. The front Module #1 begins the array and the subsequent Modules are 2, 3, 4, 5, and 6. Hardware diagram Figure 6 (or on pg 42) identifies the complete Module assembly sequence.

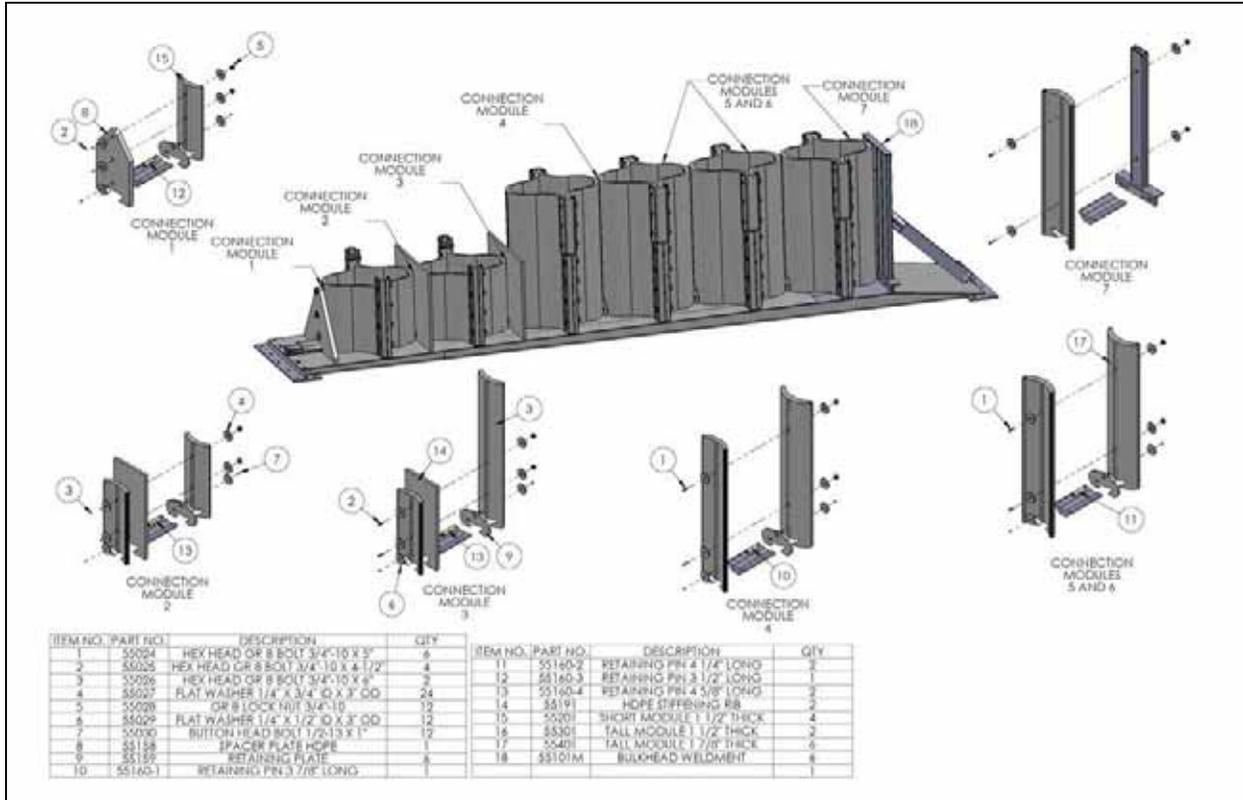


Figure 6: Module Identification Sequence with Hardware.

Module Element Types

The Compressor system consist of three configurations.

Modules 1 and 2
Height: 28-1/2"
Thickness: 1-1/2"

Module 3
Height: 48"
Thickness: 1-1/2"

Module 4, 5, and 6
Height: 48"
Thickness: 1-7/8"

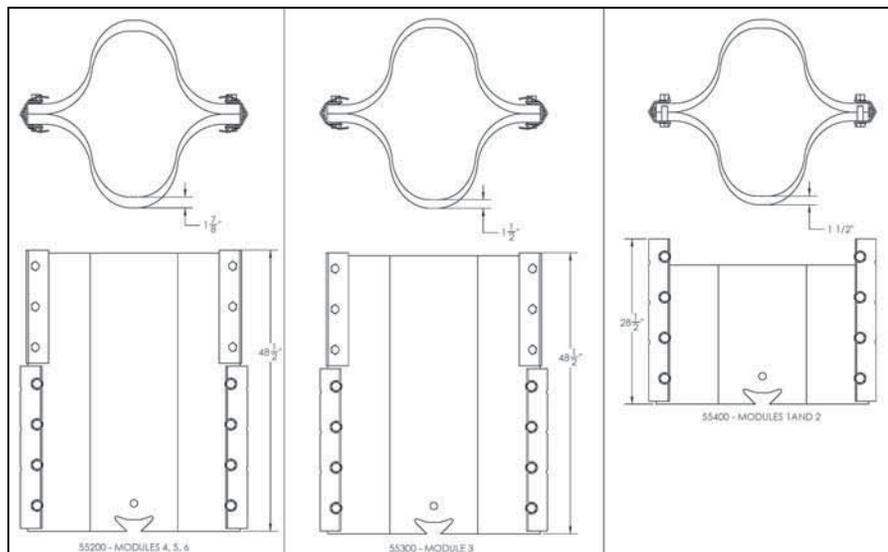


Figure 7: Module Element Overall Size and Dimensions.

Module Attachment Hardware:

Figure 8 (or on pg 44) identifies the hardware used to attach the Compressor Modules to each other in the final assembly. When the complete unit arrives at the job site, all hardware is attached and properly torqued to manufacturer’s specifications. In the event a Module Element needs replacement, these components may also need to be ordered with the individual Module Element. Reference Figures 6 (or on pg 42) for Module Element position and hardware requirements.

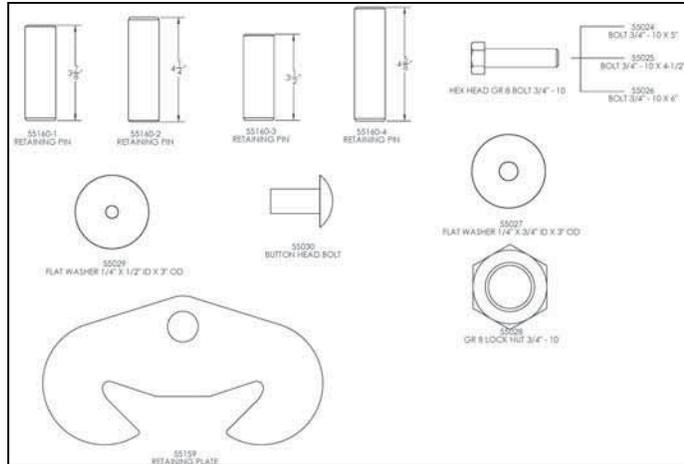


Figure 8: Module Hardware.

Side Fender Panels:

Attached to the Compressors sides are twelve telescoping steel fender panels. The Compressor’s side panels are designed to re-direct a vehicle upon impact on the Compressor side. Figure 9 (or on pg 45) lists the components and the hardware necessary to install fender panels within the array.

Fender Panels must be placed as shown in Figure 9 in order to operate correctly.

- Item 1- Front Fender Panel: Bolted to Module 1
 - Item 2- Center Fender Panels: Bolt to Module 2, 3, 4 and 5
 - Item 3- Rear Fender Panel: Bolt to Module 6
- Hardware is identical for all fender panel attachment.

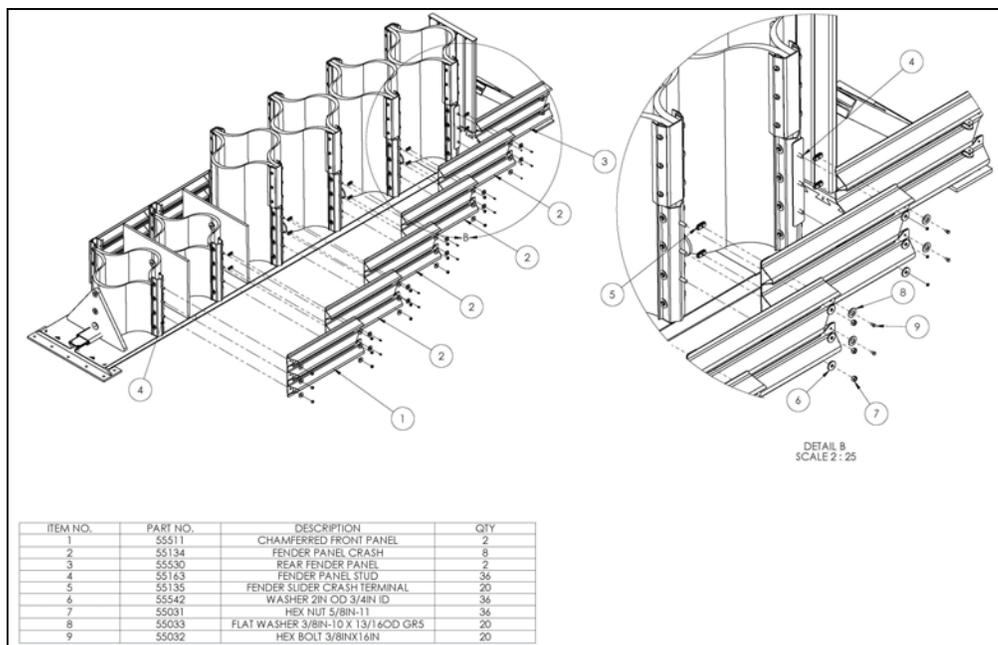


Figure 9: Fender Panels Mounting and Hardware List.

Lifting and Moving Compressor System

Lift points are located on the front anchor plate and the rear vertical upright as shown in Figure 11 (or on pg 46). In addition, a fork lift can be used under the Uni-Base Platform to move the Compressor.

Assembled Weight: 5500 lbs

Overall Dimensions: 3' [.9 m] X 4' 5" [1.4 m] X 21' [6.4 m]

Lifting and moving devices must be capable of meeting the above requirements for the Compressor System.

When using a lifting device such as a crane it is recommend that a spreader bar be used to lift the Compressor in the vertical direction from the eyes located at the front and rear as seem in Figure 11 (or on Page 46).

Before Lifting:

- Inspect harness for damage
- Inspect and insure correct operation
- Check that the anchor points are correctly located and have not been damaged
- Ensure that the harness is correctly fitted, adjusted and connected to anchor point
- Inspect for damage on chain such as:
 - Stretching or bending of links
 - Small dents on the surface of links
 - Wear on parts of the links that seat each other
 - Deformation
 - Rust, nicks or gouges, pitting or corrosion and
 - Links that are locked or without free movement

When using a fork lift position lift about the Center of Gravity as seen in Figure 11 (or on pg 46). The forklift should be widely spaced, straddling the center of gravity. Position about the CG will assure proper balancing when lifting and maneuvering.

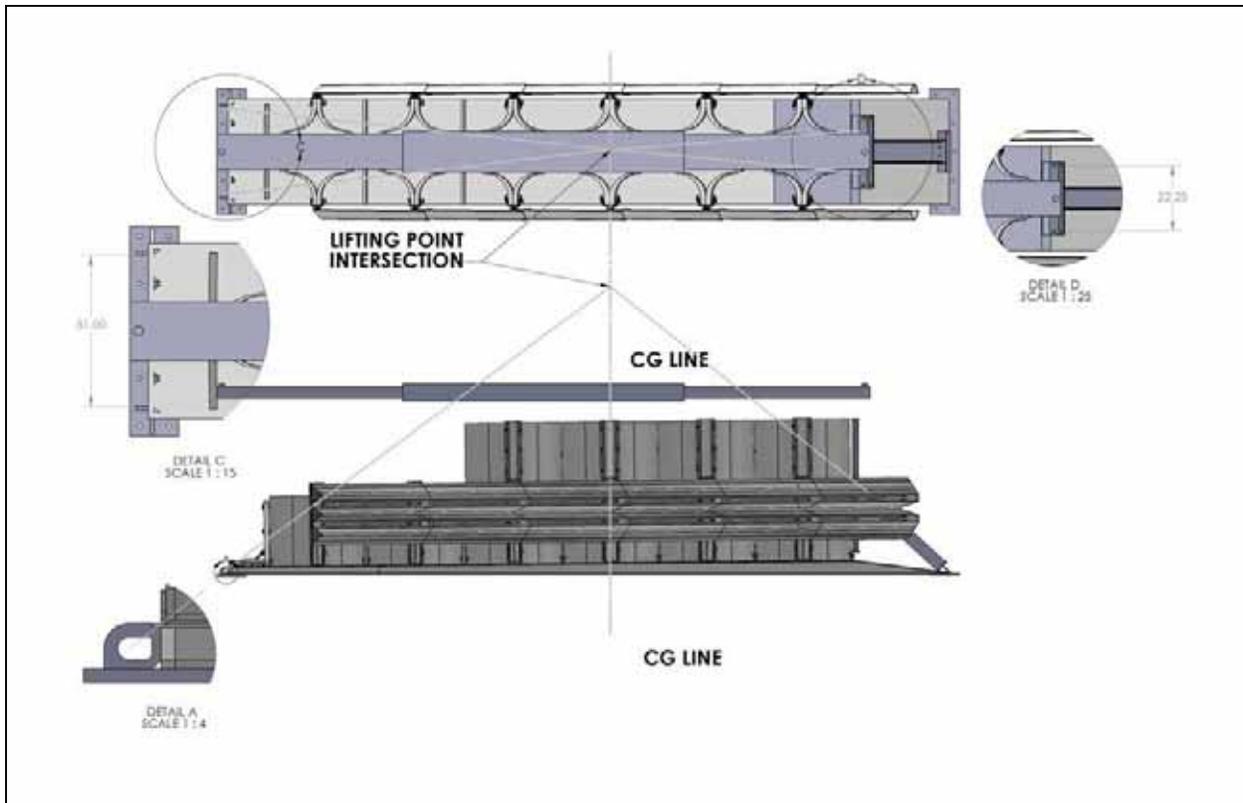


Figure 11: Compressor System Lifted at Angle from Lifting Points.

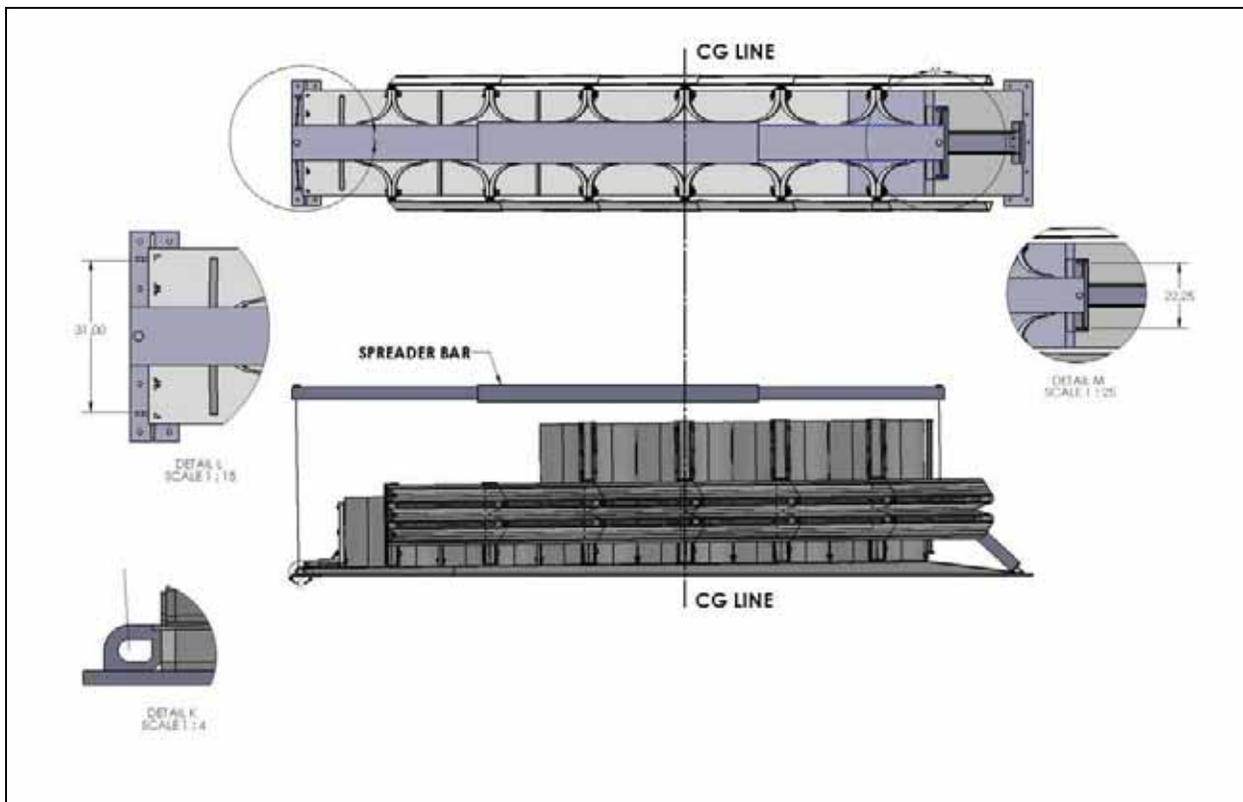


Figure 12: Compressor System Lifted Using Spreader Bar at Angle from Lifting Points

Anchor Grout Specification

Anchor Bolt Hardening Grout

The anchor bolts used to attach the Compressor System to the concrete foundation are set in place with a high strength polyester resin anchoring material which prevents pullout from the concrete.

The two part grout is easily mixed by hand and does not require any special equipment for mixing or pouring, The harden powder which is provided with each can of grout causes an exothermic reaction between the grout and the harden powder which is the release of energy in the form of heat.

The exothermic reaction cause the gel to set in 20 minutes at 70°F. The grout may be used in freezing conditions down to 10° F by keeping the resin warm (70° F to 90 °F) immediately prior to use. The shelf life for the grout is 6 months from the date of the lot number stamped on the can. It is recommended to store the grout at 70° F out of direct sunlight. Storage temperatures are recommended not to exceed 85° F.

Hot Weather Use:

Keep the grout cool until immediately before use. Keep containers of grout out of direct sunlight.

Cold Weather

It is recommended that two containers of hardener are used when temperature is below 45° F to initiate gel to set.

Safety Pre-Caution

Do not smoke or use near open flame or sparks.
Do not use grout in drilled holes that are ¼” larger than the anchors diameter.

Grout Specifications

- Color: Grey
- Compressive Strength: 17 ksi (ASTM D695)
- Tensile Strength: 5.5 ksi (ASTM D638)
- Temperature Range During Installation 10° F-110° F
- Temperature Range While in Use -40° F-200° F

Installation Section

Anchor Bolt Concrete Installation

The Compressor System is a self contained device which does not need to be placed directly against any object for support. The Uni-Base Platform design contains its own support system utilizing a vertical and rear angle support structure.

To attach the Compressor System to the concrete foundation fourteen 3/4" anchor bolts 5-1/2" in depth are used at the front and rear as seen in Figure 13 (or on Pg 41)

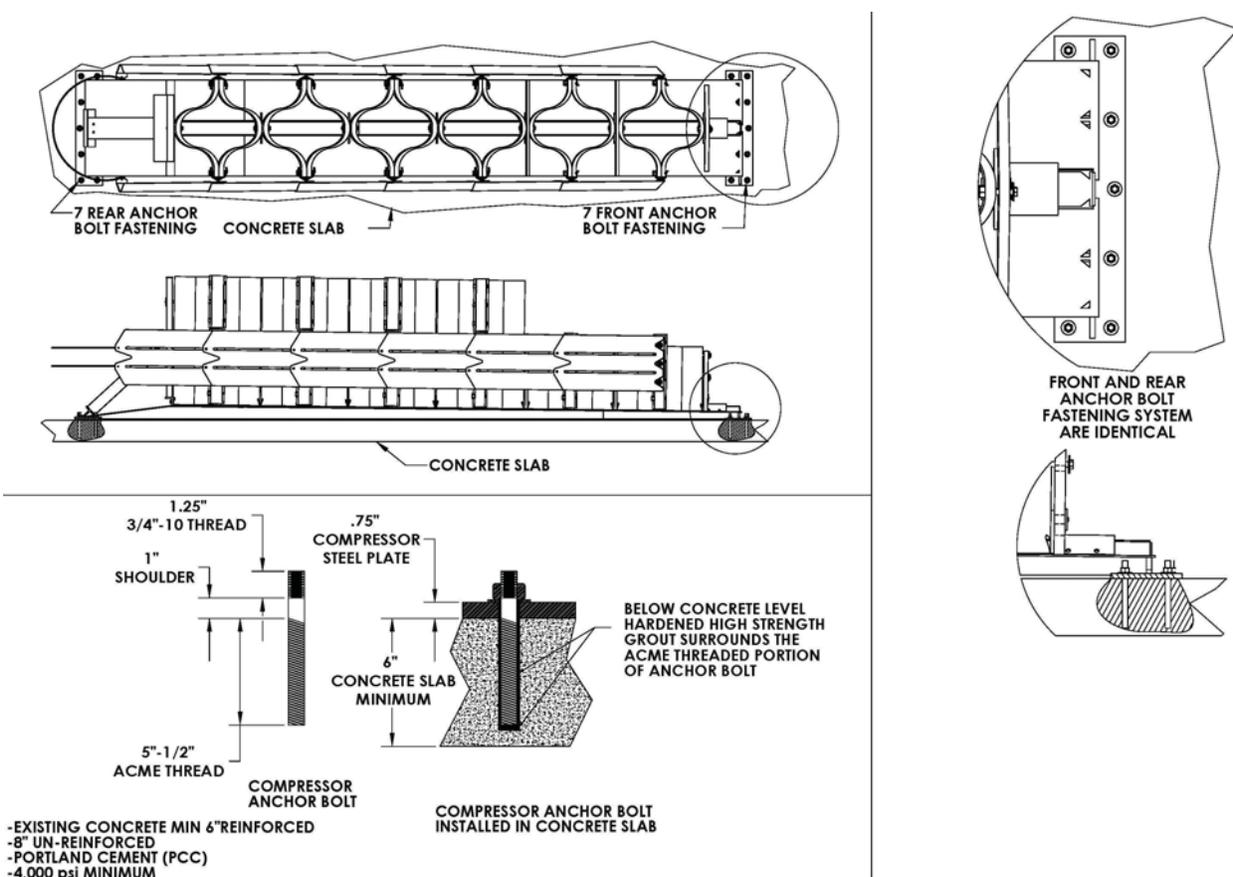


Figure 13: Anchor Bolt Installation

The threads below grade are acme square threads and must be grouted minimum 5-1/2" below grade. **All holes must be cleaned with air to remove drilled concrete dust . A small wire brush with cleaning solvent should also be used to clean the holes to remove any residual concrete dust particles. If holes are not cleaned properly, sufficient bonding between the grout and the concrete will not occur and the risk of the Compressor lifting during impact increases.**

Hole Drilling Process

The Compressor is designed to be positioned in front of a hazardous objects. The installation site is based on a pre-approved site plan from the state or local authorities. Conditions which should be approved can include but not limited to are bi-directional use, center or offset position relative to CMB position, or distance from the CMB. Each installation can be unique and local regulations should always be followed to assure proper installation. For assistances on installation or assembly of the Compressor System, the manufacture can be contacted.

The anchoring holes can be located using the Compressor as a template to mark the hole placement on the concrete. Position the Compressor System in the planned anchor position and mark each hole to be drilled. For ease of hole drilling operation move the Compressor to the side to complete the hole drilling operation. Drill the fourteen holes using a two flute concrete drill bit 1" diameter at the marked spots to a minimum depth of 5-1/2" into the concrete foundation.

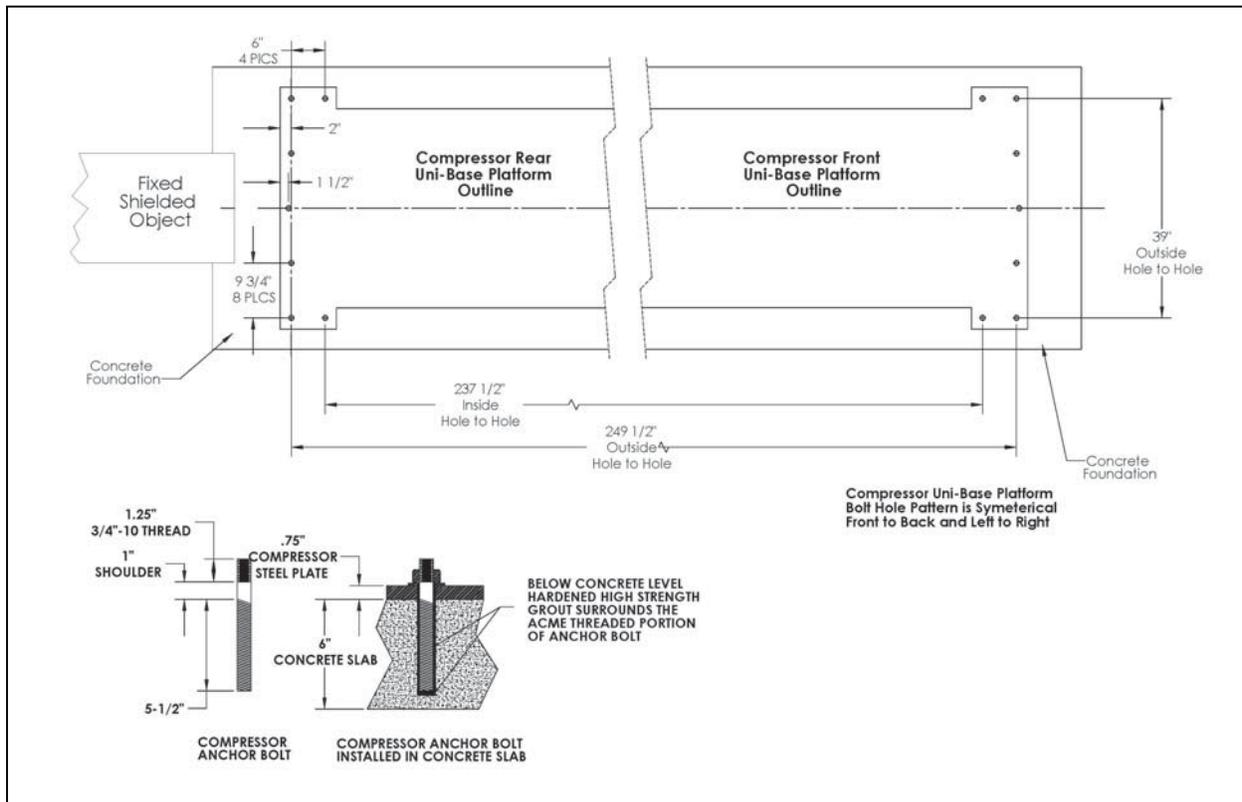


Figure 14: Hole Layout

It is recommended that pneumatic drilling tools are used whenever possible. Pneumatic drilling cleans the hole and prepares it for easy bonding. If electric drills are used each hole should be blown out with air and a wire brush used with cleaning solvent to assure the removal of concrete dust. After drilling the holes to the proper depth move the Compressor into the final installed position to begin the final anchoring procedure. When maneuvering the Compressor align the front and rear mounting plate holes with holes drilled in the concrete.

Set Anchor With Grout

Each hole must be filled with high strength grout which bonds the concrete, grout and anchor bolt together creating fourteen high strength attachment points. The fourteen anchor bolt points are used to attach the Compress Uni-Base Platform to the concrete foundation.

Grout Mixing

- Pour one pre-proportioned hardening powder into each grout can.
- Stir thoroughly with anchor for 90 seconds or until thoroughly distributed throughout resin. Resin appears grey in color when completely mixed.
- Pour mixed grout directly into bottom 1/2 of prepared hole.
- Push anchor to the bottom of hole and rotate the anchor to assure full wetting on the acme threads. If grout pools outside of the hole this indicate hole are being over filled.

Drop the anchor bolt into the hole through the mounting plate for each front and back hole location as seen in Figure 15 (or on pg 41). Repeat the process for the remaining anchor bolts.

Do not disturb the anchor bolt for one hour.

After grout has set the nuts on the anchor bolts can be torqued to 50 ft-lbs. Grout setting time can vary with temperature conditions. For colder temperature, conditions below 45°F (7.2°C), always use two hardening powder containers when mixing. Complete cure takes 24 hours.

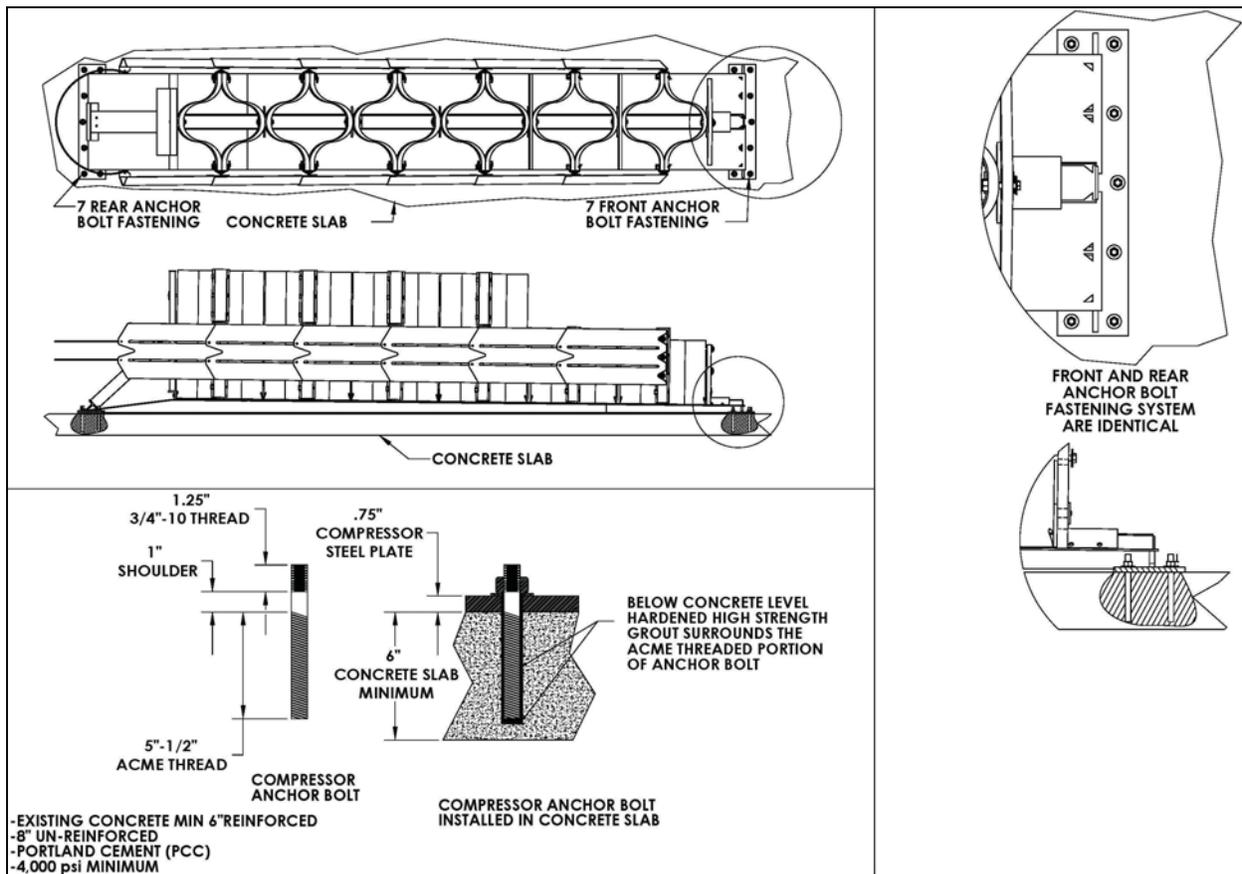


Figure 15: Bolt Layout

Transition Kit Installation

Optional Transition for Bi-Directional Traffic

Product Overview:

The Compressor System can be used in applications where traffic will travel in a reverse direction. For this application the optional rear Transition Kit will be needed as shown in Figure 16. There can be various types of hazards which will need to be protected. The specific Transition Kit will depend on site conditions. It is recommended that customer service be contacted for the correct Transition Kit.

The transition kit attaches directly to the rear fender panels and is designed to bolt directly to permanent concrete barriers as seen in Figure 16.

The entire Transition Kit is made of galvanized steel providing a high level of corrosion resistance and the strength to redirect an impacting vehicle without snagging.

The Transition Kit consists of ten major components utilizing standard thrie beam rail with an end plate which bolts directly to the CMB. All necessary hardware for the assembly is included in the kit.

Recommended Tool List:

Sockets

Open/Box End Wrenches

Sledge/Ball Pean Hammer

Drill

Drill Bits

Concrete Drill Bit

Concrete Hammer Drill

Chain and or Circular: Cut Shape of Thrie Beam Wood Block Supports

Tool list is only a recommended tool list, additional tools may be require depending on the site conditions and transition kit type.

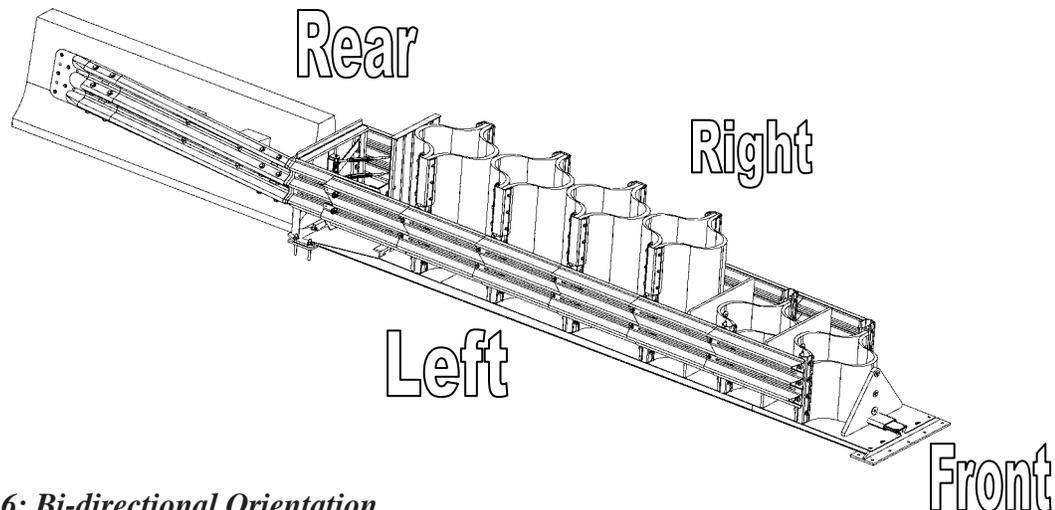
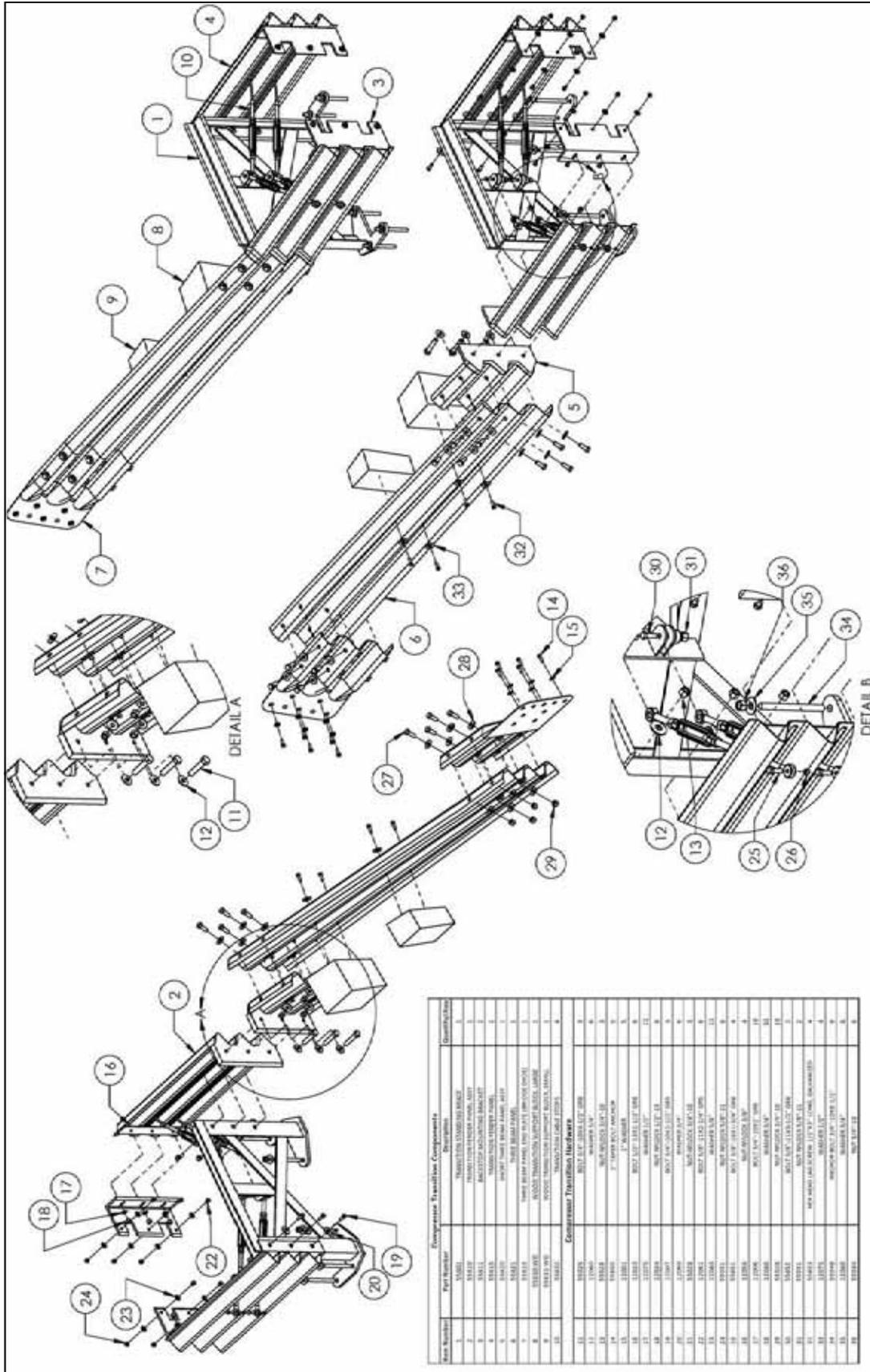


Figure 16: Bi-directional Orientation

Complete Assembly Diagram



Part Number	Description / Transmittal Components	Quantity
1	WASHER	1
2	WASHER	1
3	WASHER	1
4	WASHER	1
5	WASHER	1
6	WASHER	1
7	WASHER	1
8	WASHER	1
9	WASHER	1
10	WASHER	1
11	WASHER	1
12	WASHER	1
13	WASHER	1
14	WASHER	1
15	WASHER	1
16	WASHER	1
17	WASHER	1
18	WASHER	1
19	WASHER	1
20	WASHER	1
21	WASHER	1
22	WASHER	1
23	WASHER	1
24	WASHER	1
25	WASHER	1
26	WASHER	1
27	WASHER	1
28	WASHER	1
29	WASHER	1
30	WASHER	1
31	WASHER	1
32	WASHER	1
33	WASHER	1
34	WASHER	1
35	WASHER	1
36	WASHER	1

Installing Transition Standing Brace to the Uni-Base Platform

Remove the three rear left and three rear right anchor bolts on the Compressor. Replace with the longer anchor bolts (34). Install the Transition Standing Brace (1) to the Compressor as shown in Figure 16. Secure the Transition Standing Brace using washers (35) and nuts (36) seen in Figure 17. The installed Transition Standing Brace (1) can be seen in Figures 18 below.

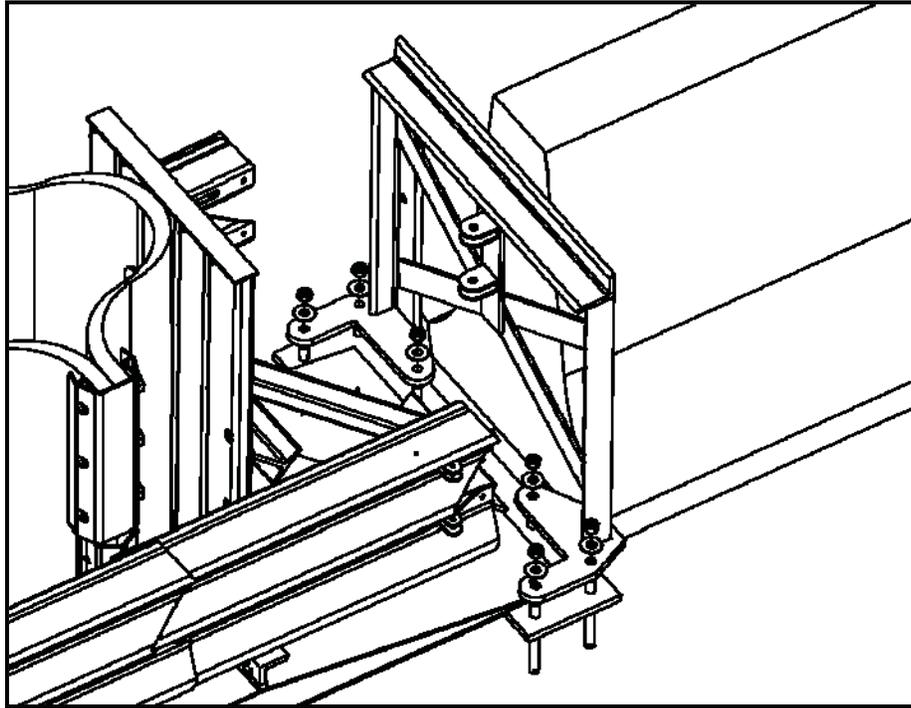


Figure 16: Standing Brace Bolt Installation to Uni-Base Platform

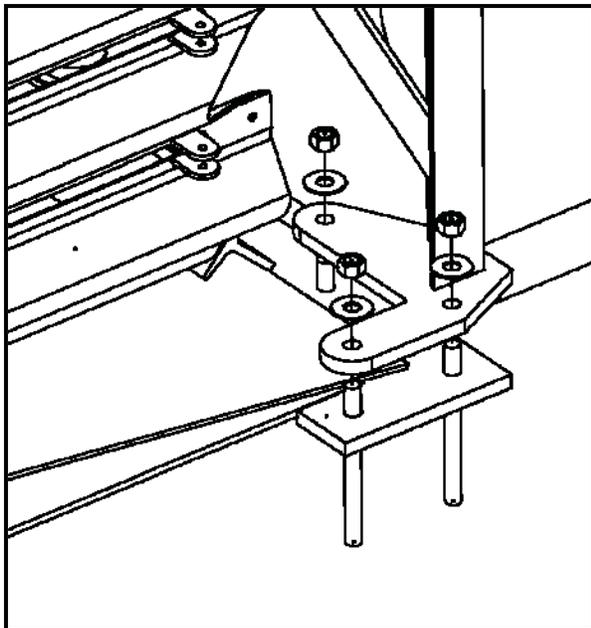


Figure 17: Standing Brace Hardware Attachment

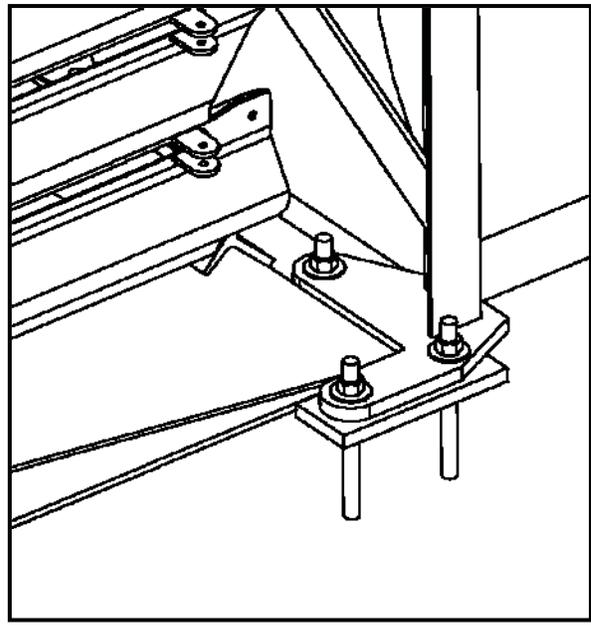


Figure 18: Installed Standing Brace

Installing the two Backstop Mounting Brackets to the Transition Standing Brace

Install the two Backstop Mounting Brackets (3) to the rear of the Compressor Backstop as seen in Figure 19 using bolts (16), nuts (18), and washers (17). Note the bolt head is facing the rear as observed in Figures 20 and 21 below. The installed Backstop Mounting Brackets (3) can be seen in Figure 22.

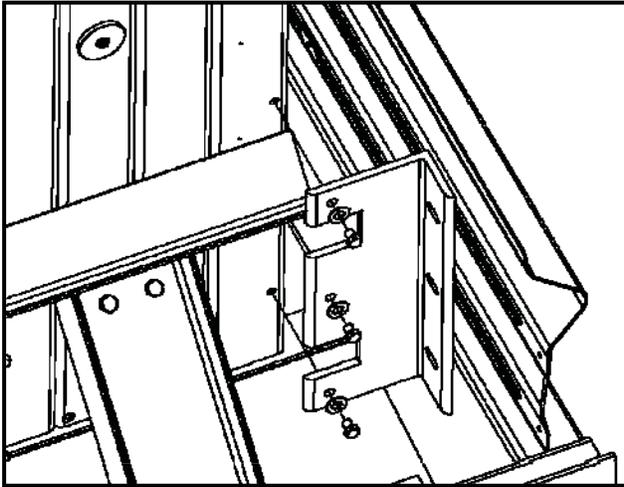


Figure 19: Rear Hardware Attachment

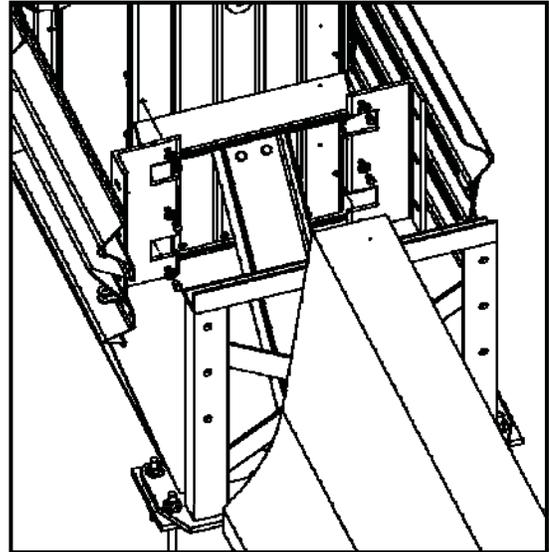


Figure 20: Identifying Backstop Mounting Brackets

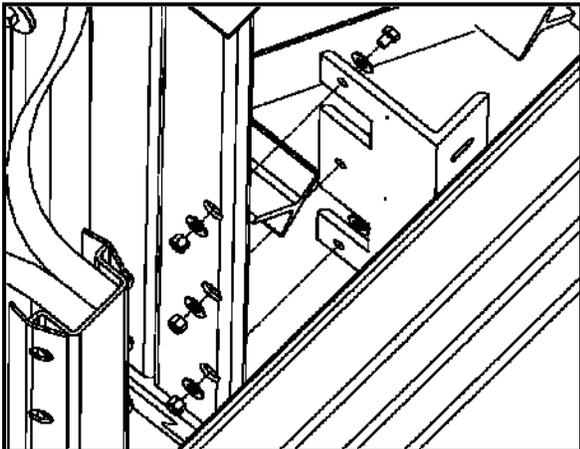


Figure 21: Front Hardware Attachment

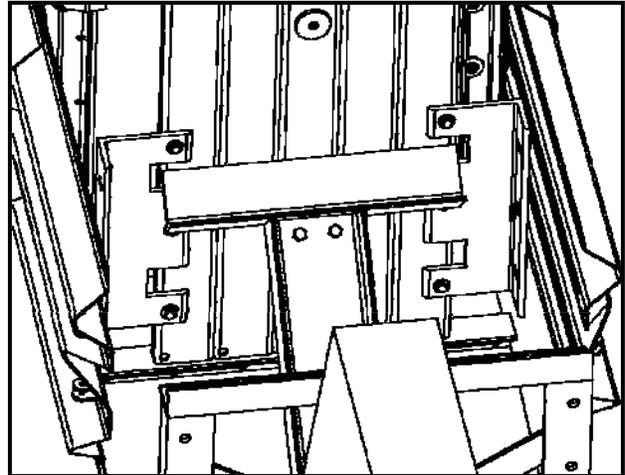


Figure 22: Installed Mounting Brackets

Installing the Transition Fender Panel Assy and Short Thrie Beam Panel Assy

Install the Transition Fender Panel Assy (2) and the Short Thrie Beam Panel Assy (5) to the rear left of the Transition Standing Brace (1) using three bolts (11), three nuts (13), and six washers (12) as shown in Figure 23. Fasten the front end of the Transition Fender Panel Assy (2) to the outside of the left Backstop Mounting Bracket (3) using three bolts (22), three nuts (24), and six washers (23) as seen in Figure 24. The installed Transition Fender Panel Assy (2) and Short Thrie Beam Panel Assy (5) is seen in Figure 25 below.

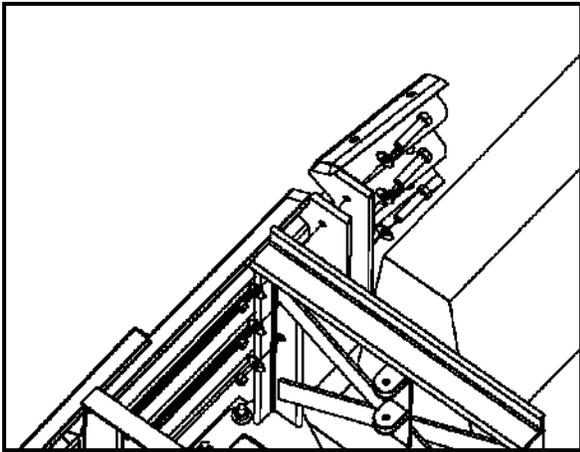


Figure 23: Transition Fender Panel Installation Assembly with Hardware

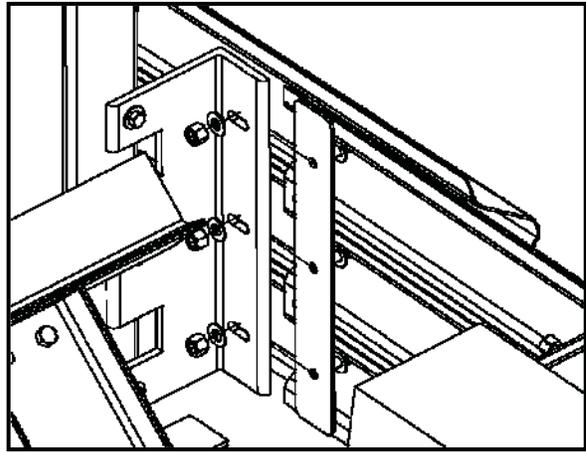


Figure 24: Transition Panel Mount Bracket Installation with Hardware

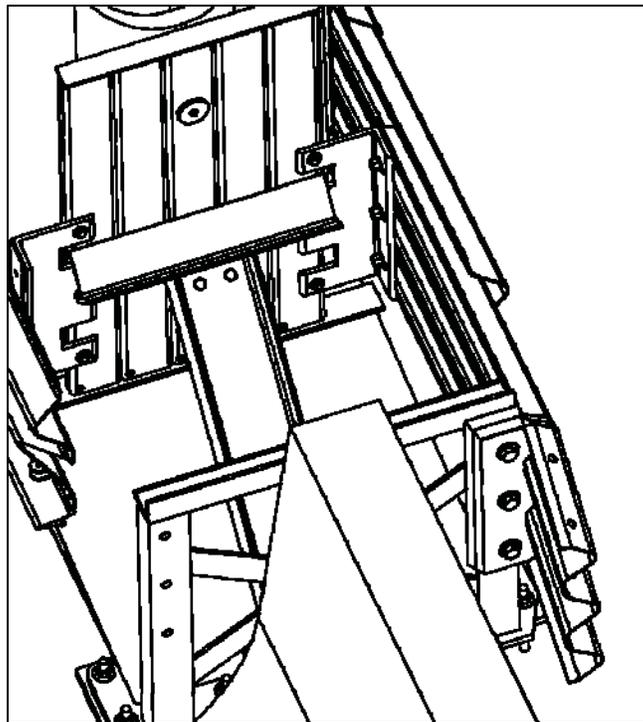


Figure 25: Installed Transition Fender Panel

Installing the Transition Fender Panel

Install the Transition Fender Panel (4) to the rear right of the Transition Standing Brace (1) using three bolts (19), three nuts (21), and six washers (20) as shown in Figures 26 and 27. Then fasten the front end of the Transition Fender Panel (4) to the outside of the right Backstop Mounting Bracket (3) using three bolts (22), three nuts (24), and six washers (23) as seen in Figure 28. The installed Transition Fender Panel (4) can be seen in Figure 29 below.

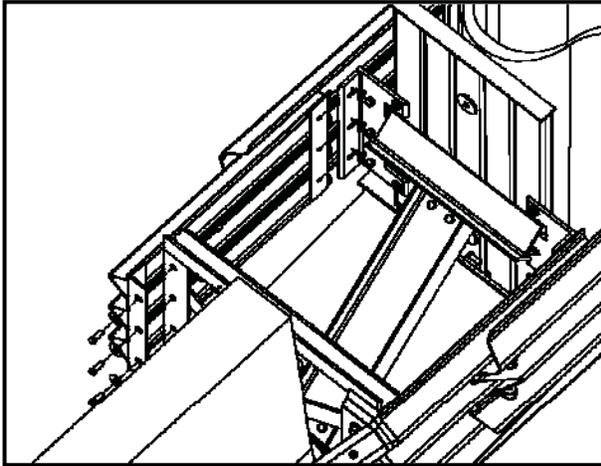


Figure 26: Transition Fender Panel Installation Assembly with Hardware

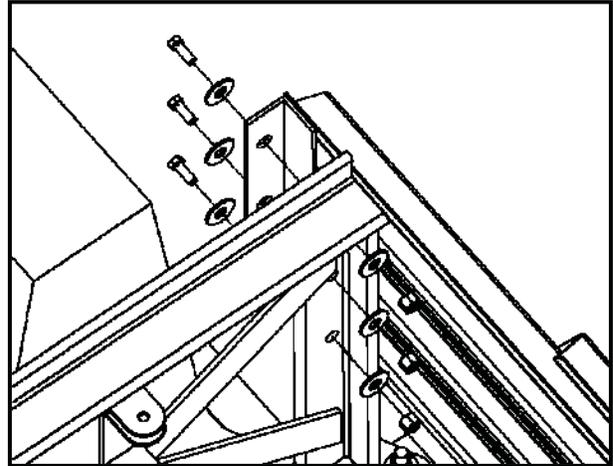


Figure 27: Transition Attachment with Hardware

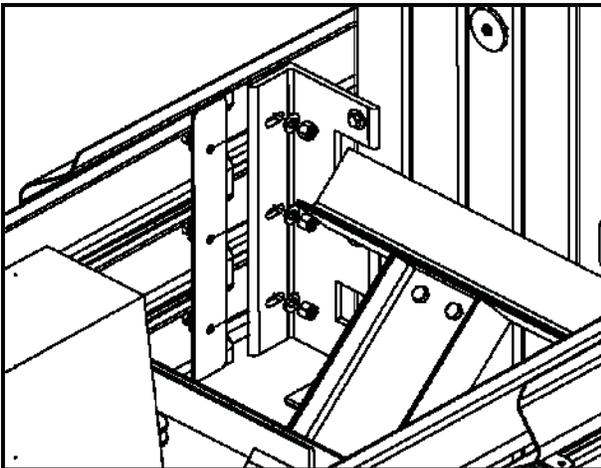


Figure 28: Transition Panel Mount Bracket Installation with Hardware

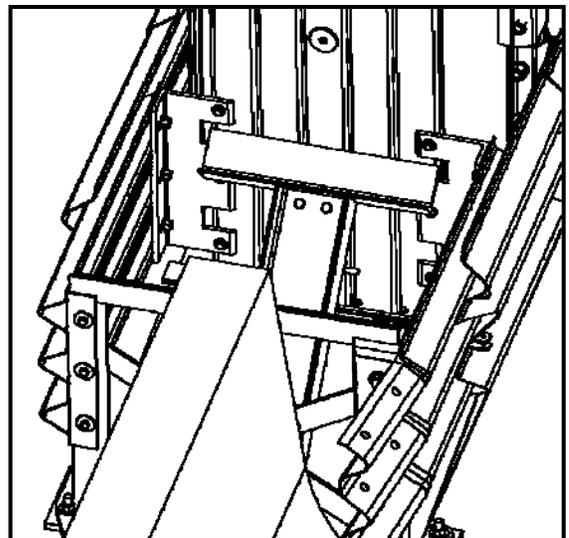


Figure 29: Installed Transition Fender Panel

Installing the Thrie Beam Panel

Position the Thrie Beam Panel (6) to the outside of the Short Thrie Beam Panel Assy (5) such that the holes for the Wood Transition Support Blocks (8 and 9) are closest to the Transition Standing Brace (1) (Figure 30) and install the Thrie Beam Panel (6) to the Short Thrie Beam Panel Assy by using eight bolts (27), eight nuts (29), and sixteen washers (28) as shown in Figures 31 and 32. The installed Thrie Beam Panel (6) can be seen in Figures 33 below.

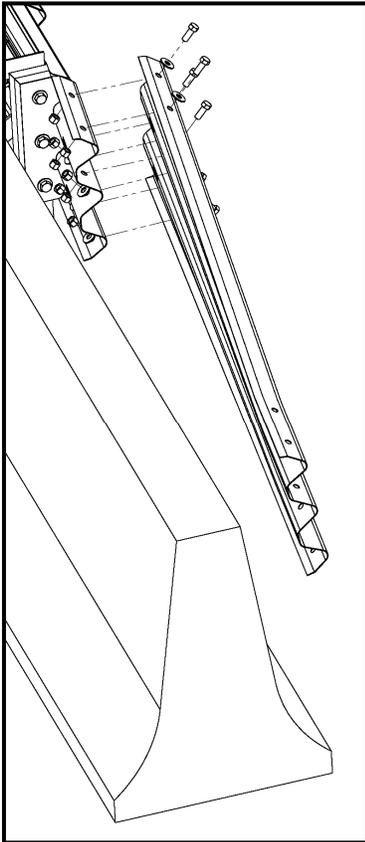


Figure 30: Thrie Beam Attachment

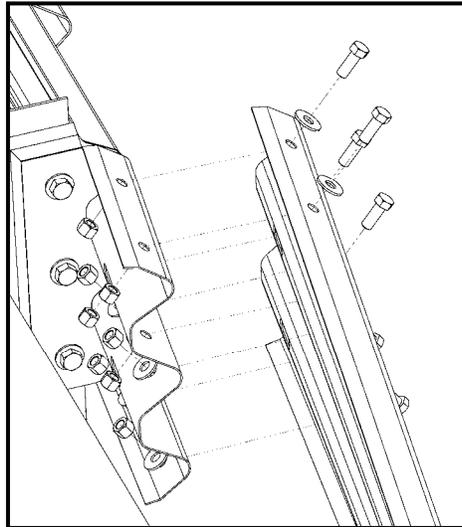


Figure 31: Thrie Beam With Hardware

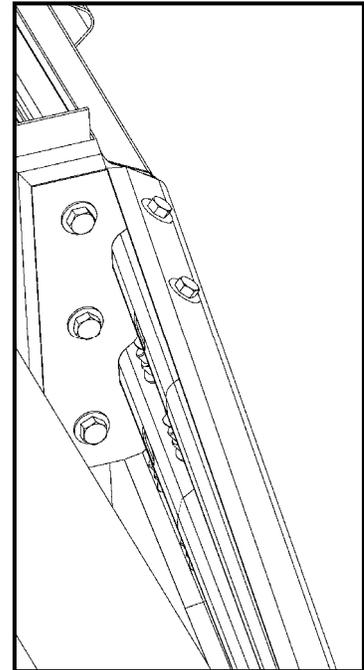


Figure 32: Installed Thrie Beam

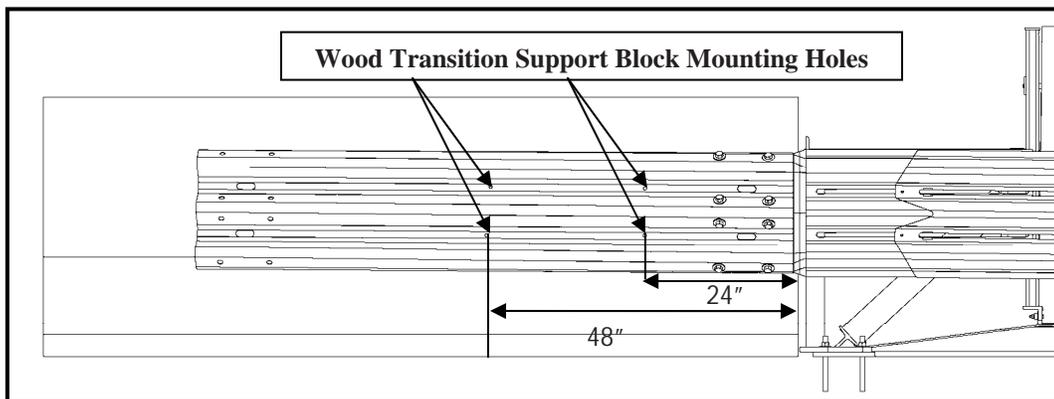


Figure 33: Wood Hole Reference Location Towards Front

Installing the Thrie Beam Panel End Plate (Bridge Shoe) to the outside of the Thrie Beam Panel

Install the Thrie Beam Panel End Plate (Bridge Shoe) (7) to the Thrie Beam Panel (6) using eight bolts (27), eight nuts (29), and sixteen washers (28) as shown in Figures 34 and 35. The installed Bridge Shoe (7) can be seen in Figure 36 below.

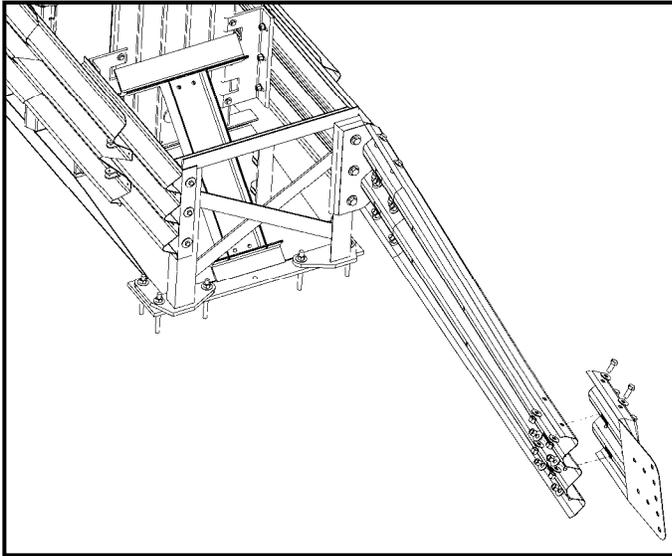


Figure 34: Shoe Attachment

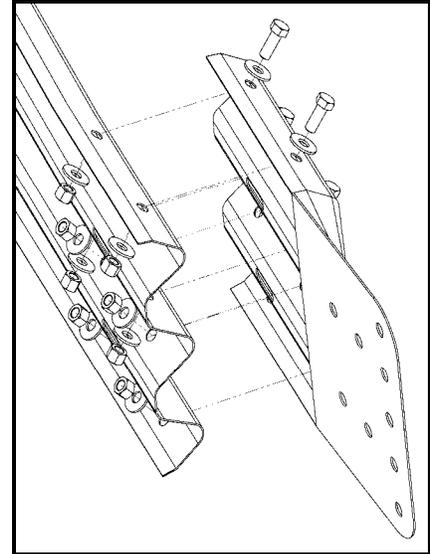


Figure 35: Shoe Attachment with Hardware

Using the five holes as a template shown in Figure 24, drill into the Concrete Median Barrier (CMB) using a 1" diameter masonry drill. Anchor the Thrie Beam Panel End Plate (Bridge Shoe) (7) to the CMB using five anchor bolts (14) and five washers (15) as shown in Figure 37. The anchored Bridge Shoe (7) can be seen in Figure 38 below. Use the anchor bolts (14) to draw the Bridge Shoe (7) flush to the CMB.

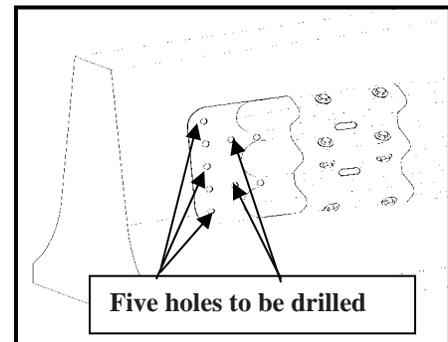


Figure 36: Shoe Positioning Against CMB

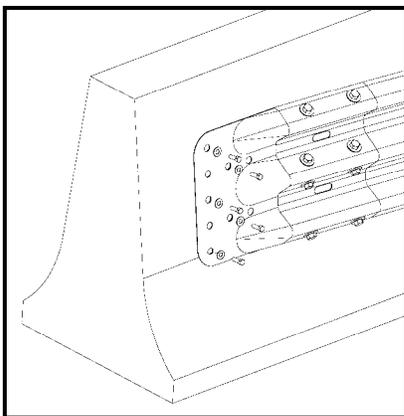


Figure 37: Shoe Attachment with Hardware

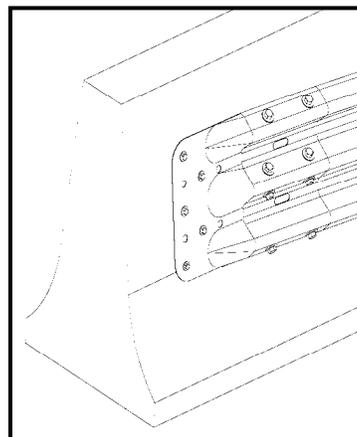


Figure 38: Shoe Installed

Installing the Large and Small Wood Transition Support Blocks to the Thrie Beam Panel

Shape the Large and Small Wood Transition Support Blocks (8 and 9) such that the spacing shown in Figure 39 is achieved as well as the being flush with the CMB and the Thrie Beam Panel (6). Drill two 3/8" diameter holes 2-1/2" deep per Block (8 and 9) using the pre drilled holes in the Thrie Beam Panel (6) and install the Blocks (8 and 9) using lag screws (32) and washers (33) as shown in Figure 40. The installed Wood Transition Blocks (8 and 9) can be seen in Figure 41.

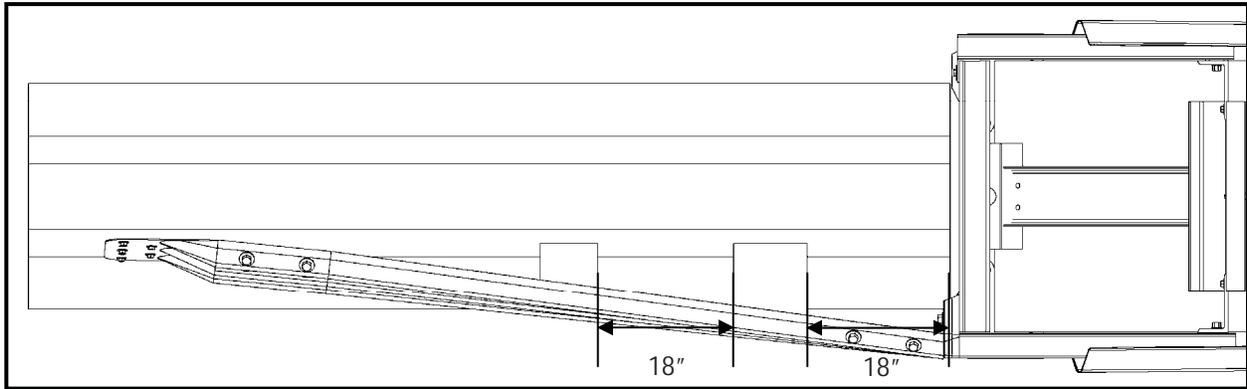


Figure 39: Wood Block Support Positions

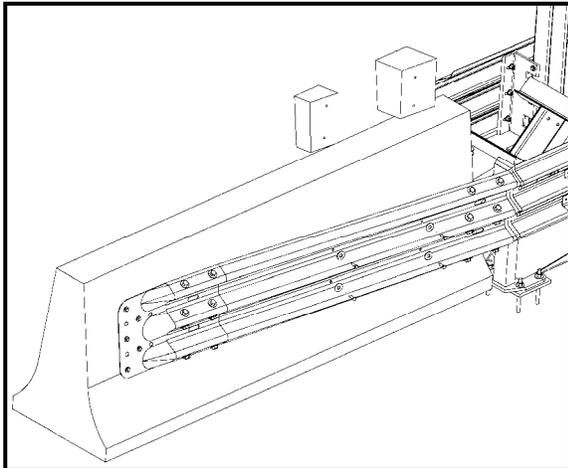


Figure 40: Wood Block with Hardware

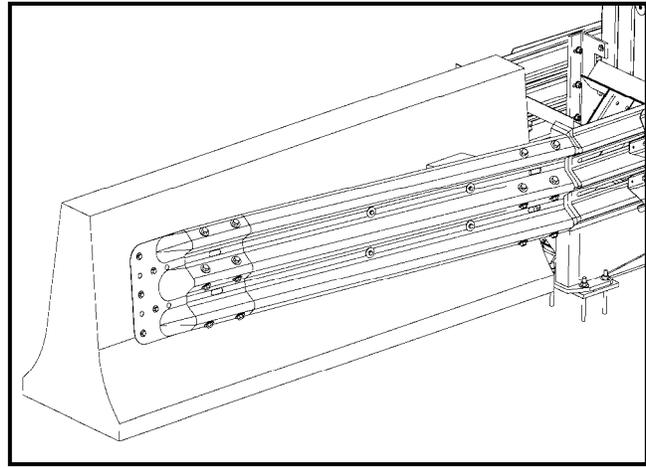


Figure 41: Wood Block Installed

Installing the Transition Cable Stops to the Transition Standing Brace and the Transition Fender Panels

Install the four Transition Cable Stops (10) to the Transition Standing Brace (1) using two bolts (30) and two nuts (31) as shown in Figures 42 and 43. Do not over tighten bolts. The Transition Cable Stops (10) must be free to swing in an impact. Observe the orientation of the Transition Cable Stops (10) as seen in Figure 43. Then fasten the cable end of the Transition Cable Stops (10) to the appropriate Transition Fender Panels (2 and 4) using four bolts (25) and four nuts (26) as shown in Figures 44 and 45. Once the Transition Cable Stops (10) have been fully fastened, loosen the jam nuts on the Transition Cable Stops (10), and tighten the turnbuckles hand tight until the cables have slight tension, tighten and lock the jam nuts in place as shown in Figure 45.

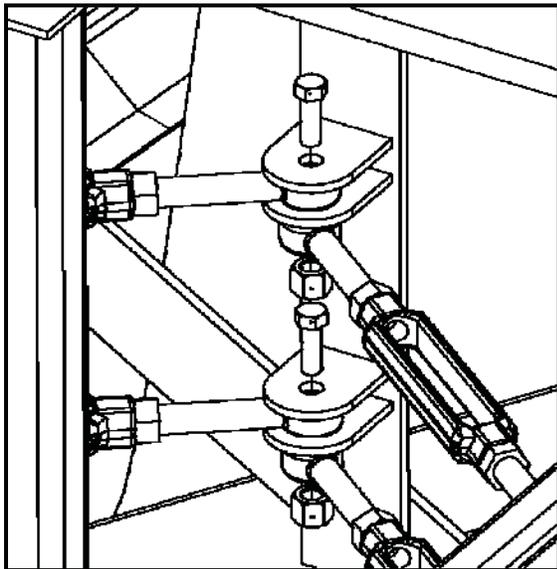


Figure 42: Cable Stops with Hardware

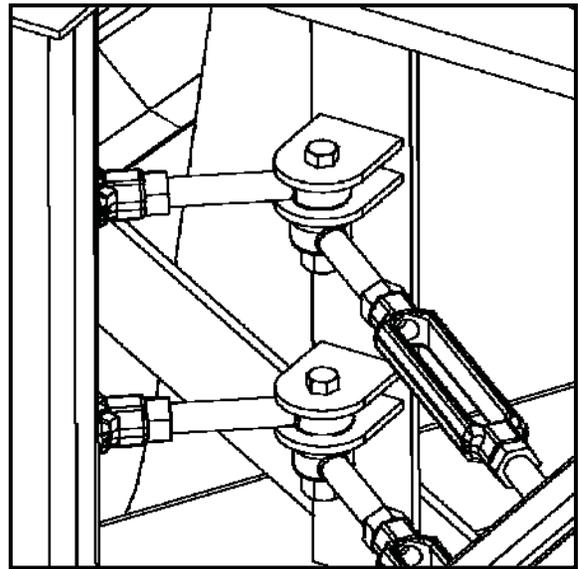


Figure 43: Installed Cable Stops

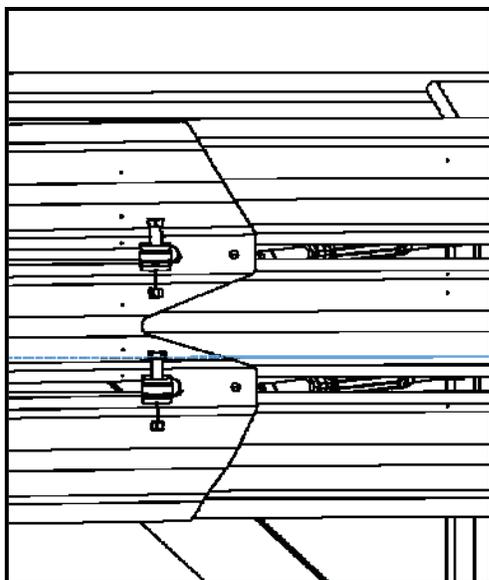


Figure 44: Transition Panels with Cable Stops

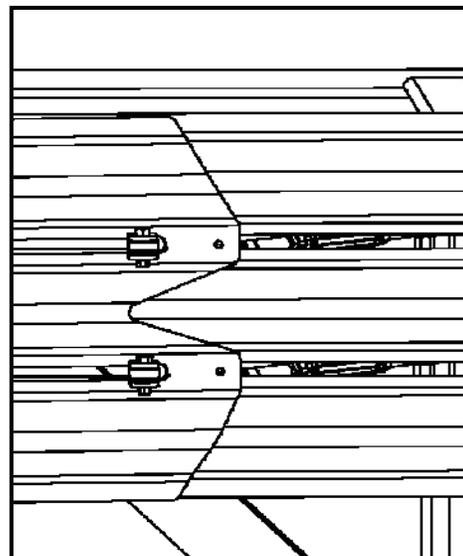
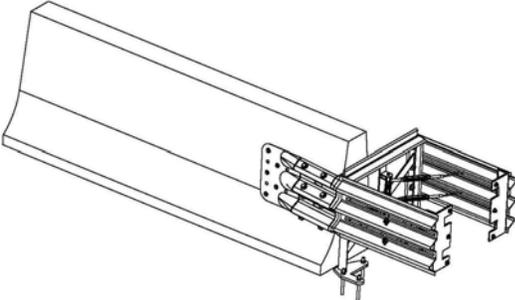
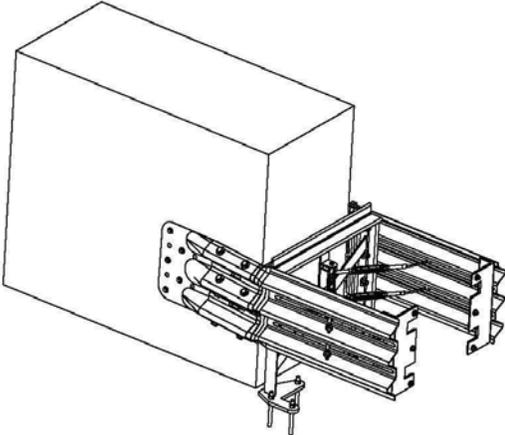


Figure 45: Installed Transition Panels with Cable Stops

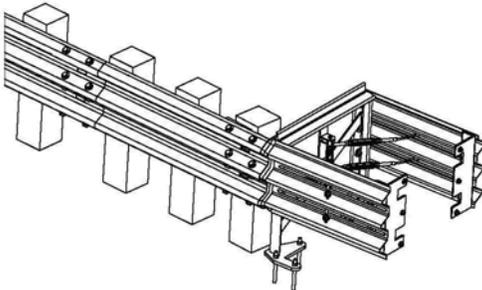
Bi-directional transition kits are always placed in locations where traffic flow will be approaching from the rear direction of the object being shielded. The shielded can vary from a CMB to a guard rail installation. Various hardware kits are used to attach to the different types of fixed objects which need to be shielded. Below are various transition kits which can be used for field installation.



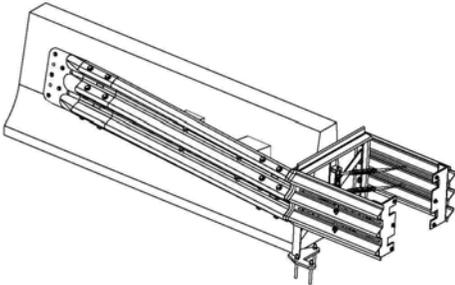
End Plate to CMB Offset Shoe



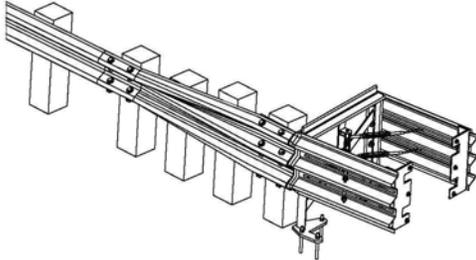
End Shoe to Block



Thrie Beam to W-Beam



Thrie Beam to CMB Centered, Single Side



Thrie Beam to Guardrail

Design of the Compressor for Longevity

All steel parts are hot dipped galvanized zinc plated to reduce the corrosion from developing in harsh environments. The steel components are expected to have a 10+ year lifespan.

The plastic Module Elements which attenuate the energy of a impacting vehicle contain a blend of heavily treated Ultra Violet (UV) inhibitors to minimize UV degradation when exposed to 12+ hours of sunlight each day. The Module life expectancy, unless reduced by severe impact damage, is expected to be 8 - 10 years.

Post Impact Inspection

After an impact, a thorough inspection should be conducted.

- Clean and remove debris from Compressor
- Inspect for Module position
- Inspect Condition of
 - Fender panels
 - Hardware
 - Modules
- Inspect Uni-Base platform Condition
 - Surface condition
 - Dovetail Surface condition
 - Backstop condition
- Inspect Anchor Bolts
 - Properly Torqued
 - Concrete Surface Condition
- Inspect Cover
 - Check for tears and damage
 - Check attachment points are secure
 - Check all shock cords are in place, and secure.
- Inspect Transition
 - Damaged components
 - Hardware Condition
 - Attachment at CMB
 - Adjustment of tension on fender panel turnbuckles.

Compressor System Product Specification

I GENERAL

The Compressor Fixed Attenuator shall be produced and manufactured solely by Traffix Devices Inc. (TDI)

Corporate Office and Manufacturing & Distribution Center, San Clemente, California

II SYSTEM DESCRIPTION

The Compressor is a narrow crash cushion with re-directive non-gating attributes made of energy absorbing plastic module array elements, designed to recover to near its original shape after being impacted. The overall dimension of the Compressor shall be 48.66" (1.119 m) wide x 53.5" (1.36 m) high x 255.25" (6.48 m) long.

III INDIVIDUAL COMPONENT DESCRIPTION

The energy attenuating module elements shall have a convex center section and concave outer ends which, when bolted together at the outer edges, form an element which is deformed flat on impact. The thickness of the module element units shall vary across the width and not remain constant. The thickness of the elements shall decrease from the outer edge at the center to a minimum near the intersection of the convex and concave curvatures. The Module Elements thickness shall vary between 1 -1/2" to 2". All Module Elements shall be made of high density polyethylene (HDPE) and shall be black in color.

Individual Module Elements overall dimensions shall be 33" x 34-1/2" x 24" and 33" x 34-1/2" x 48"

Compressor Attenuators shall utilize six assembled Module Elements to make the complete energy attenuating crash cushion array. Each Module Element contains two individual halves which are bolted together at the outer ends and form the complete Module Element assembly.

The Compressor shall have corrugated fender panels, which telescope and slide on top of each other when impacted. The fender panels shall bolt directly to each module element. The panels shall be made of high tensile strength steel that provides a high level of impact resistance through a Thrie-beam design, and have a minimum strength of 80 ksi. Each fender panel shall contain two flat valley shapes which contain a full length slot in each flat valley section of the panel which slide within each other through sliding fender panel buttons. The overall dimensions of the individual corrugated fender panels shall be 6" x 18" x 36". When bolted to the complete assembly twelve individual panels shall be used six per side and have overall dimensions of 6" x 18" x 255".

The Compressor's energy absorbing Module Elements shall have a wedged shaped dovetail molded into the bottom of each element, which engages the mating steel dovetail which shall be welded and formed onto the steel base plate referred to as the "Uni-Base Platform". The function of the mating steel dovetail is to provide structural strength during lateral and vertical vehicle impacts.

The Uni-Base Platform structure consists of formed steel plates, which form a “box” section to a vertical rising dovetail running the full longitudinal distance. The Uni-Base Platform shall provide mounting for a rear vertical support back-up and diagonal support brace. The Uni-Base Platform shall be capable of being installed in concrete using a minimum of fourteen high strength anchor bolts. Anchor bolts shall be installed through the Uni-Base Platform’s front and rear anchor mounting plates which contain seven anchor bolt holes per end.

All steel components shall be domestically produced steel meeting the standards of ASTM A-36, A500, and A572. All metal work shall contain corrosive resistant finishes. Welding shall be done per good commercial practice.

IV Performance Testing Specifications

The Compressor shall be tested and performance results shall act as a re-directive, non-gating crash cushion meeting the acceptable pass test criteria as specified in the National Cooperative Highway Research Project, Report 350.

All Compressor testing shall be of Test Level 3 (TL-3), at an impact speed of 100 kph (62.5 mph) criteria.

The Compressor shall have been tested, and met the pass criteria for the following NCHRP 350 tests using the indicated impact test vehicles and meeting the Occupant Risk Criteria as specified in NCHRP 350 Report.

V Installation and Maintenance

Installation and maintenance shall be based on the directions of Traffix Devices Inc. contained in the Installation and Maintenance Manual produced by Traffix Devices Inc. Engineering.

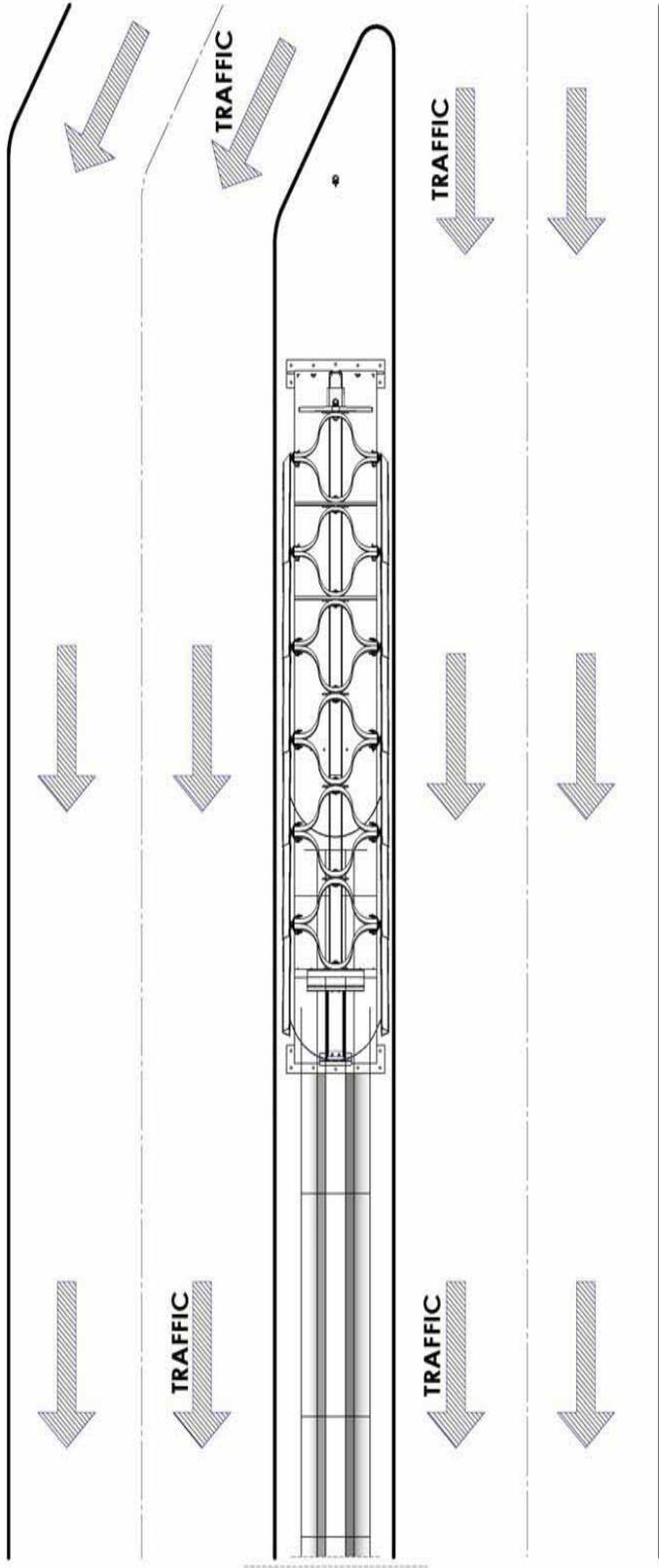
**TraFFix
Devices Inc.**



Typical Field Installations

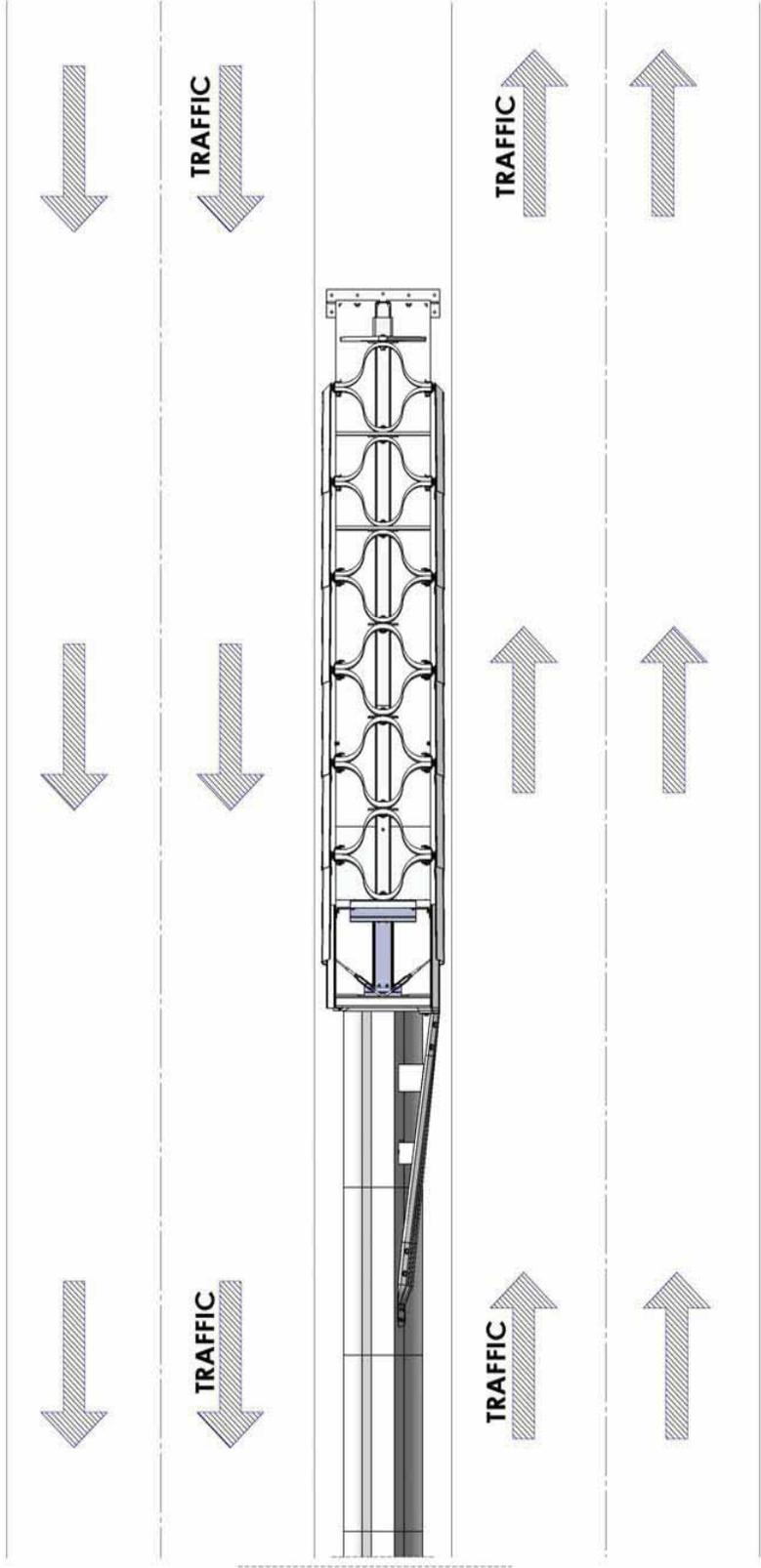
160 Ave. La Pata
San Clemente, California 92673
(949) 361-5663
FAX (949) 361-9205
www.traffixdevices.com

COMPRESSOR UNI-DIRECTIONAL



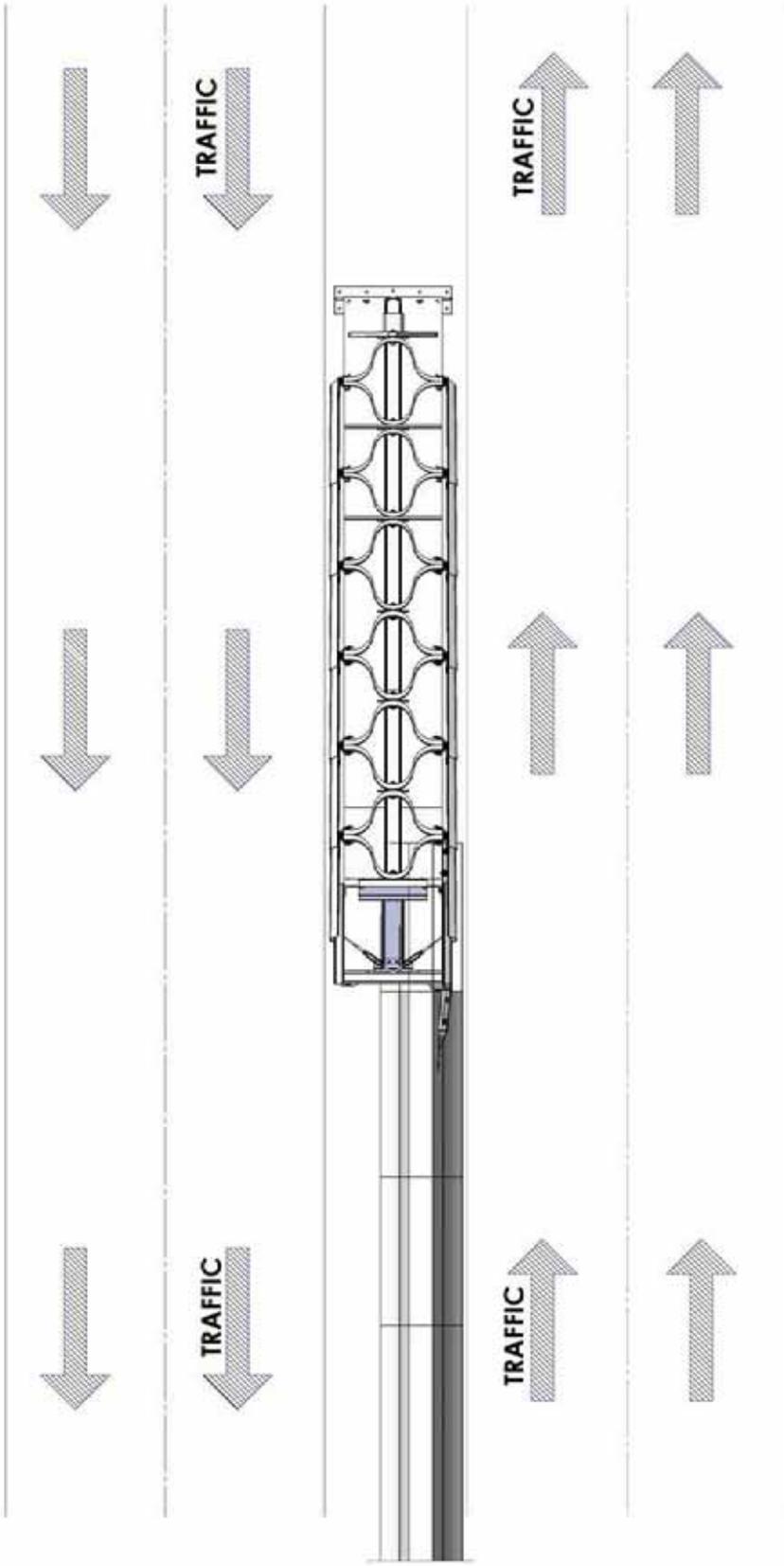
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO CMB, CENTERED



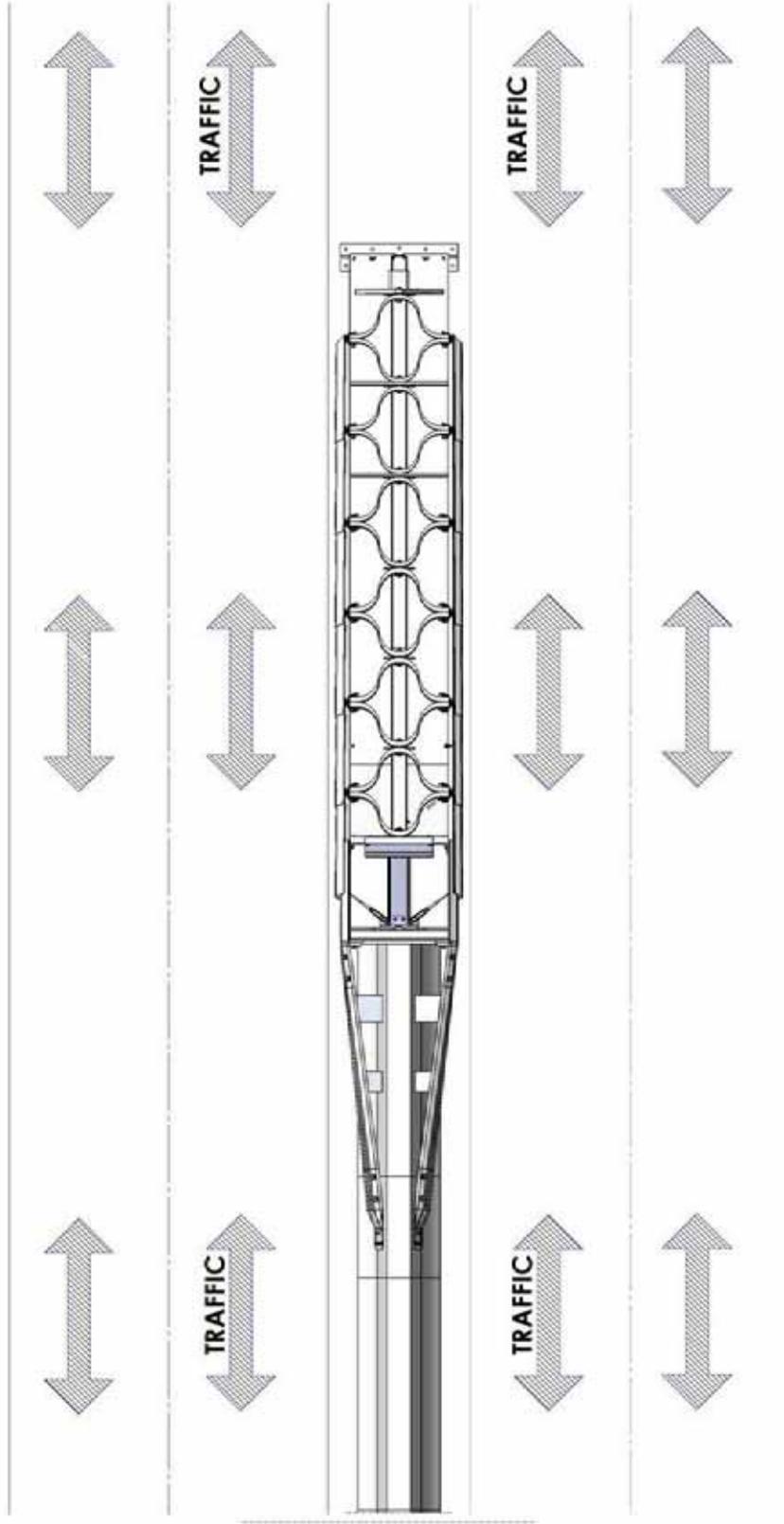
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO CMB, OFFSET



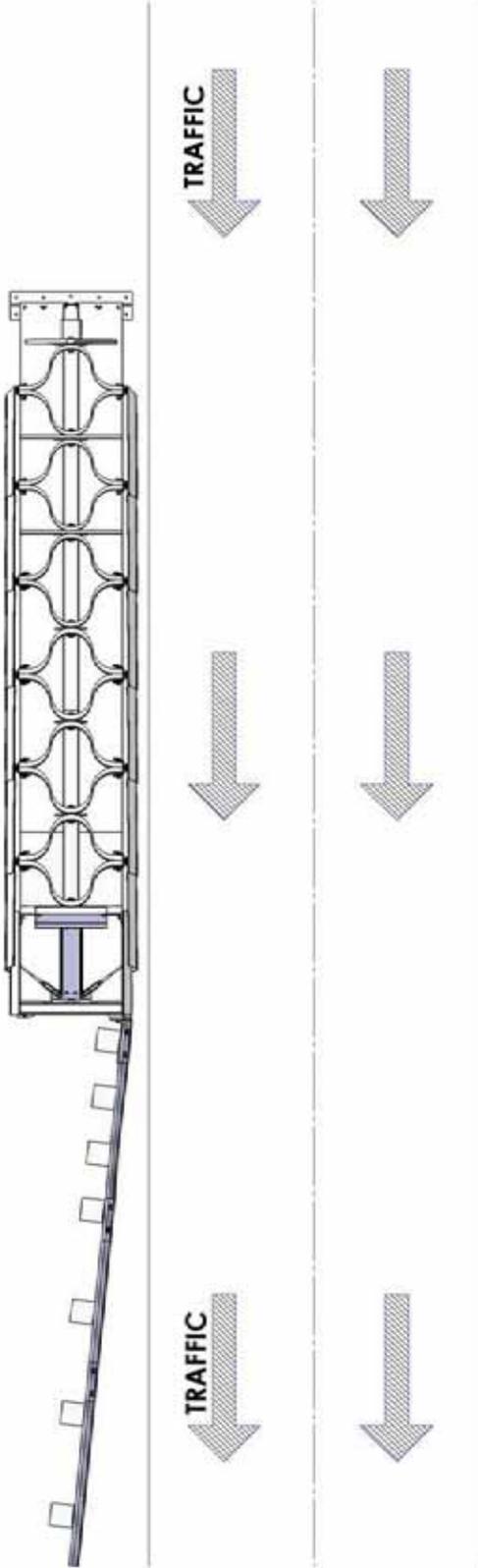
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO CMB, TWO SIDED



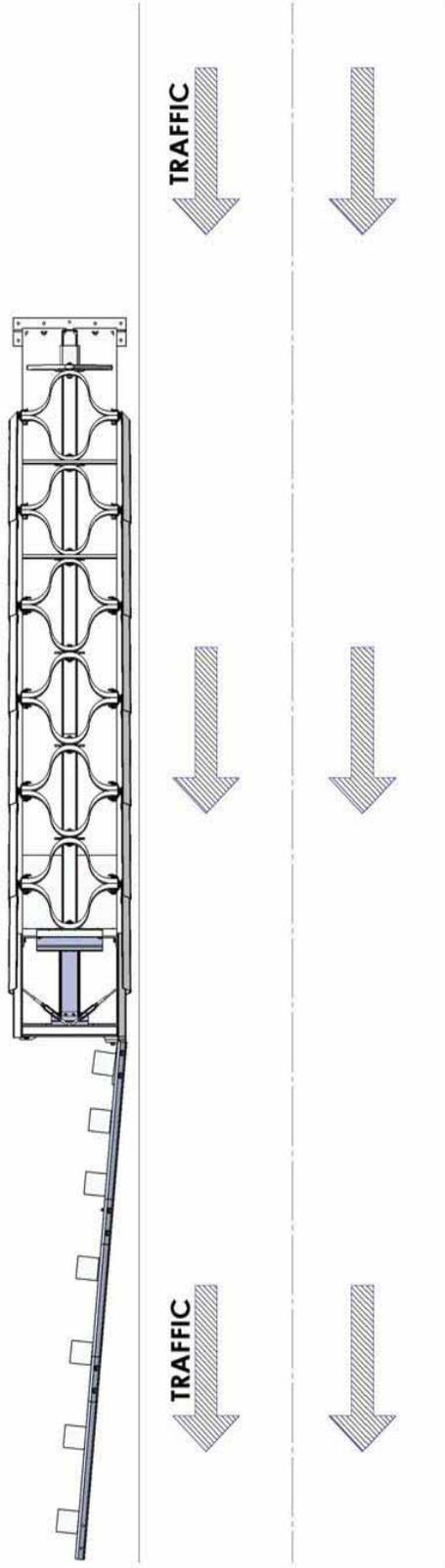
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO W BEAM



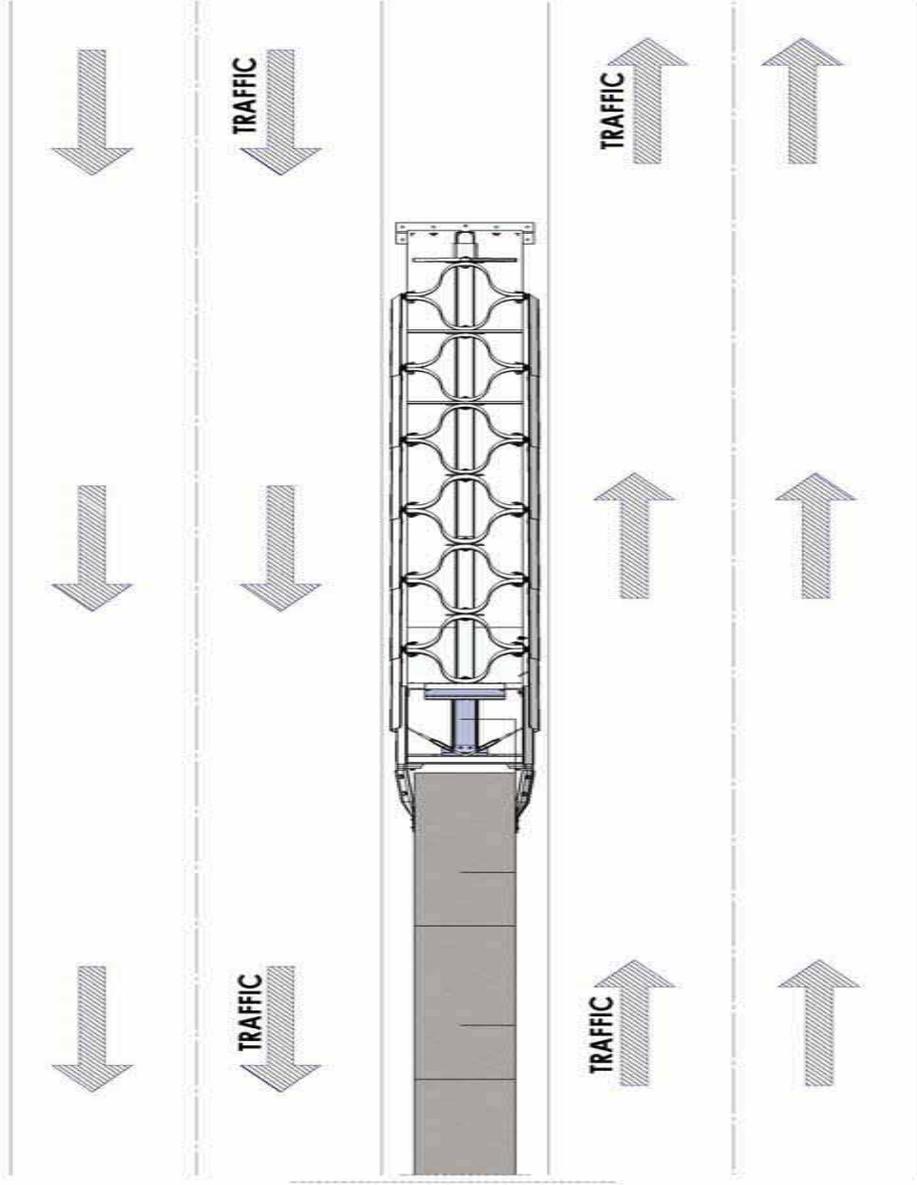
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO THRIE BEAM



THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

TRANSITION TO CONCRETE BLOCK



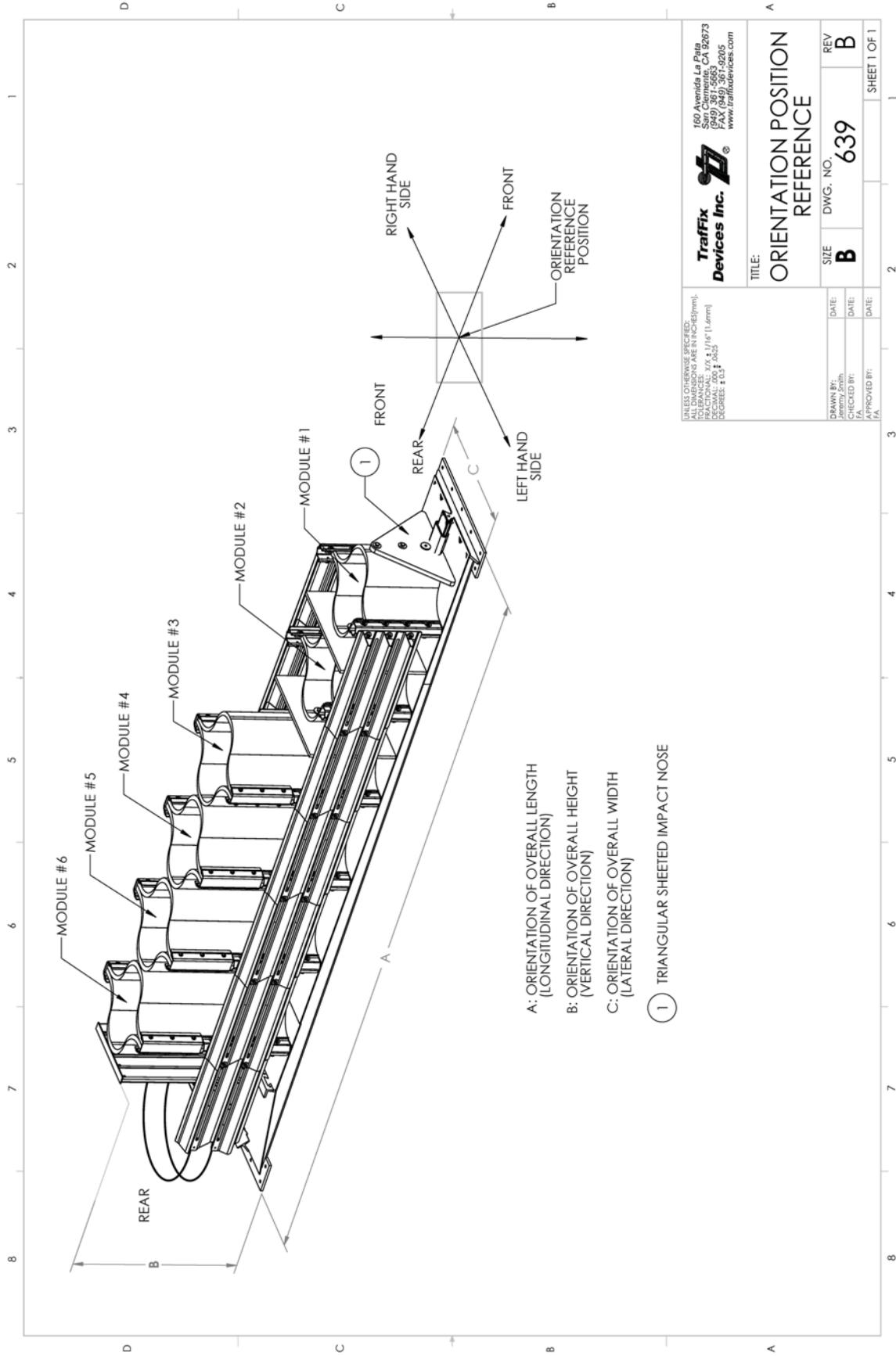
THE INSTALLATION CONFIGURATION SHOWN IS AN EXAMPLE. ALWAYS REFER TO LOCAL REGULATIONS AND ROAD AUTHORITY FOR FINAL CONFIGURATION APPROVAL.

**TraFFix
Devices Inc.**



Appendix A: Drawings

160 Ave. La Pata
San Clemente, California 92673
(949) 361-5663
FAX (949) 361-9205
www.traffixdevices.com



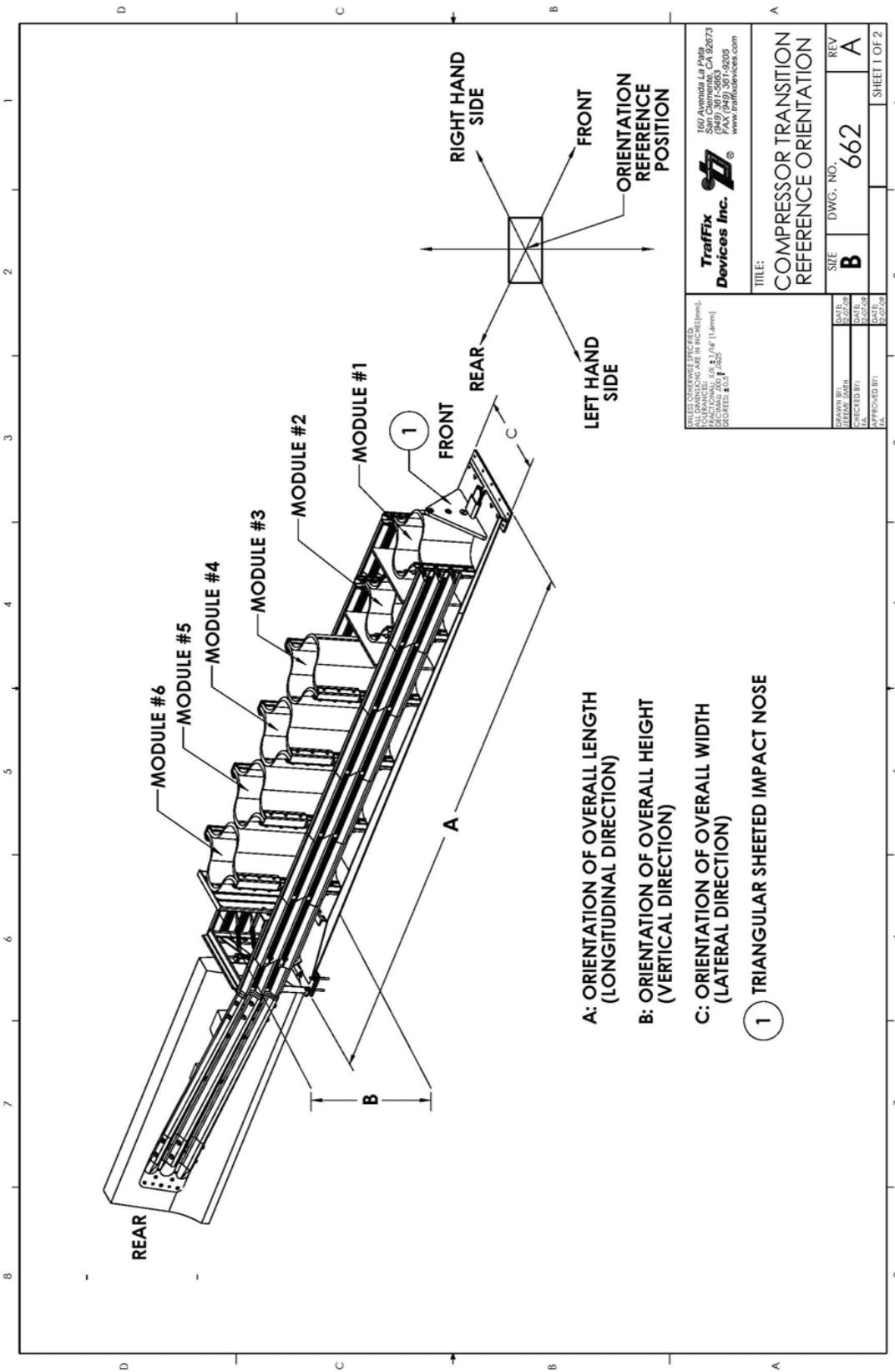
- A: ORIENTATION OF OVERALL LENGTH (LONGITUDINAL DIRECTION)
- B: ORIENTATION OF OVERALL HEIGHT (VERTICAL DIRECTION)
- C: ORIENTATION OF OVERALL WIDTH (LATERAL DIRECTION)

1 TRIANGULAR SHEETED IMPACT NOSE

UNLESS OTHERWISE SPECIFIED:
 ALL DIMENSIONS ARE IN INCHES (mm);
 FRACTIONAL: 1/16" & 1/8" (1.6mm);
 DECIMALS: .001 & .005
 ANGLES: ± 0.1

Traffix Devices Inc.
 160 Avenida La Plata
 San Clemente, CA 92673
 TEL: (949) 361-9205
 FAX: (949) 361-9205
 www.traffixdevices.com

TITLE: ORIENTATION POSITION REFERENCE		REV B	SHEET 1 OF 1
SIZE B	DWG. NO. 639		
DRAWN BY: Jeremy Smith	DATE:		
CHECKED BY:	DATE:		
APPROVED BY:	DATE:		

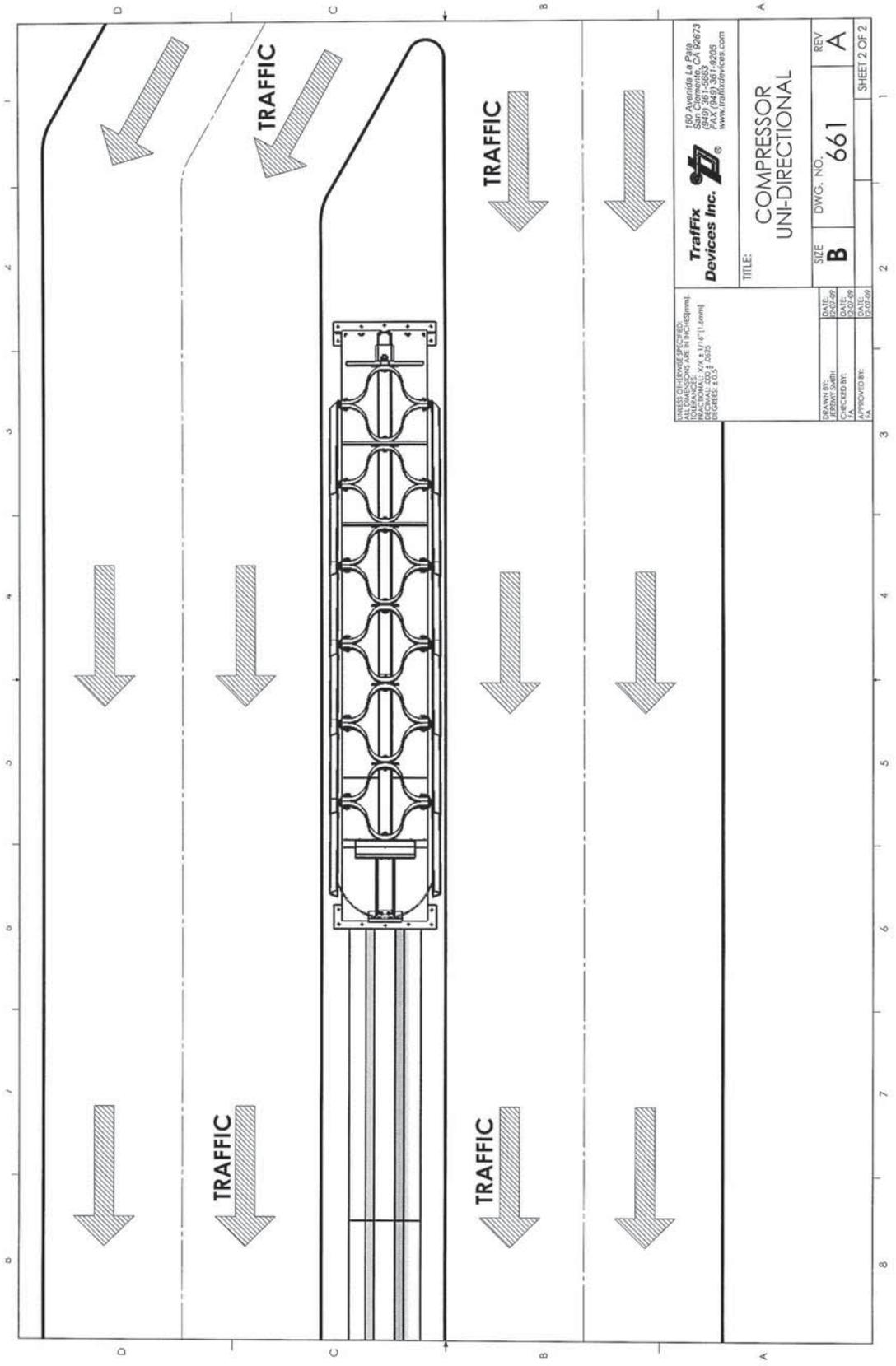


- A: ORIENTATION OF OVERALL LENGTH
(LONGITUDINAL DIRECTION)
- B: ORIENTATION OF OVERALL HEIGHT
(VERTICAL DIRECTION)
- C: ORIENTATION OF OVERALL WIDTH
(LATERAL DIRECTION)

1 TRIANGULAR SHEETED IMPACT NOSE

TRAFFIX DEVICES INC.
 100 Avenida La Plata
 San Dimas, CA 92673
 (949) 361-6863
 FAX (949) 361-9205
 www.traffixdevices.com

TITLE:		COMPRESSOR TRANSITION REFERENCE ORIENTATION	
DATE:	2/27/02	SIZE:	DWG. NO. 662
DESIGNED BY:	U	REV:	A
CHECKED BY:	U	SHEET 1 OF 2	
APPROVED BY:	U	DATE:	2/27/02



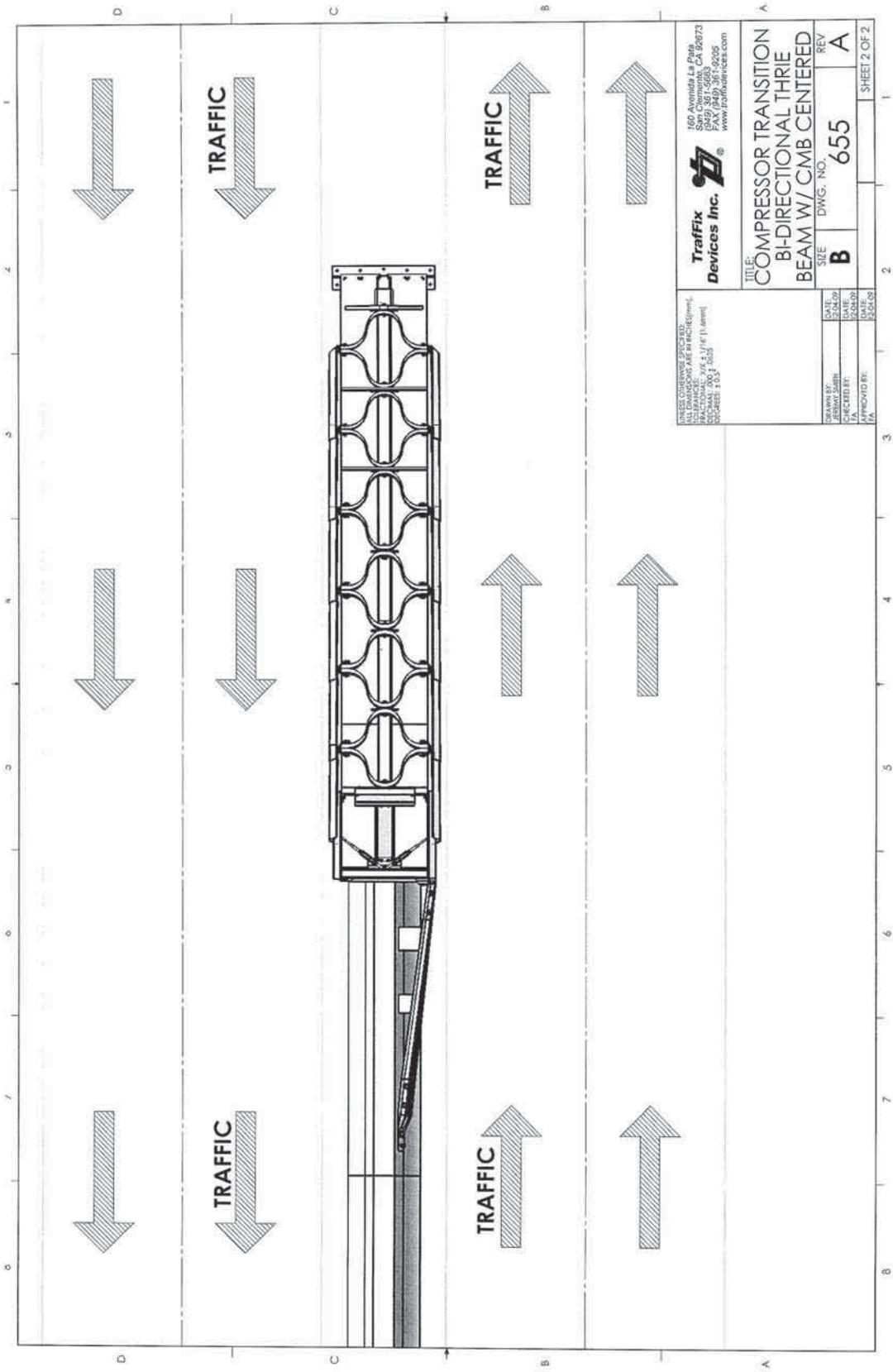
UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN INCHES (mm).
 TOLERANCES: FRACTIONS: ± 1/16 (1.5mm)
 DECIMALS: ± 0.031 (0.8mm)
 DECIMALS: ± 0.015 (0.38mm)

Traffix Devices Inc.
 160 Avenida Le Prie
 (949) 361-5853
 FAX: (949) 361-5853
 www.traffixdevices.com

TITLE: COMPRESSOR UNI-DIRECTIONAL

DRAWN BY:	DATE:	REV
DESIGNED BY:	2/25/09	A
CHECKED BY:	2/25/09	
APPROVED BY:	2/25/09	

SIZE: **B** DWG. NO.: **661** SHEET 2 OF 2



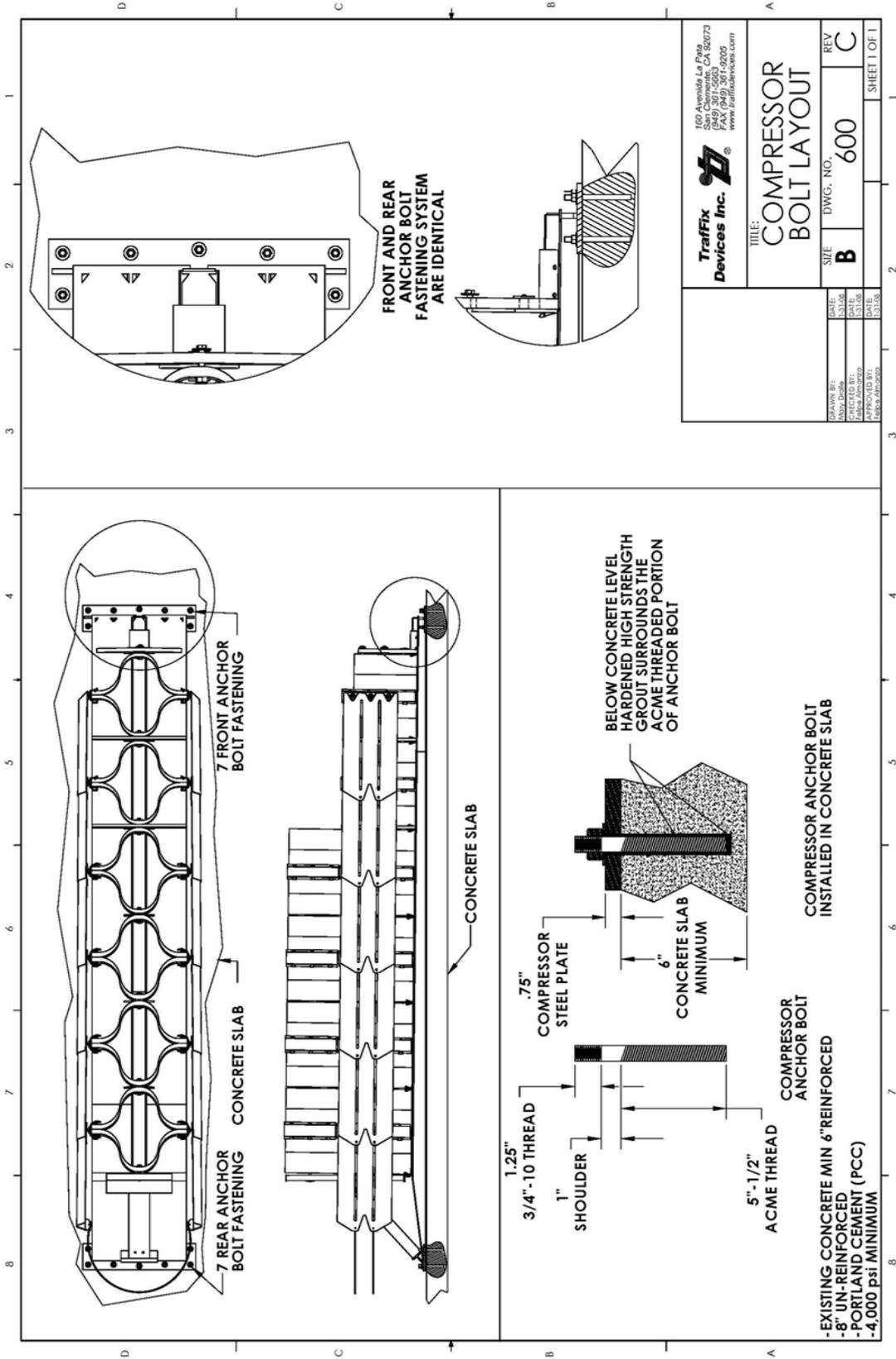
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN DECIMALS, DECIMALS TO 0.00 (1/32") UNLESS NOTED OTHERWISE.

Trafix Devices Inc.
 500 Avenida La Brea
 Los Angeles, CA 90073
 (310) 361-5653
 (800) 737-5653
 www.trafixdevices.com

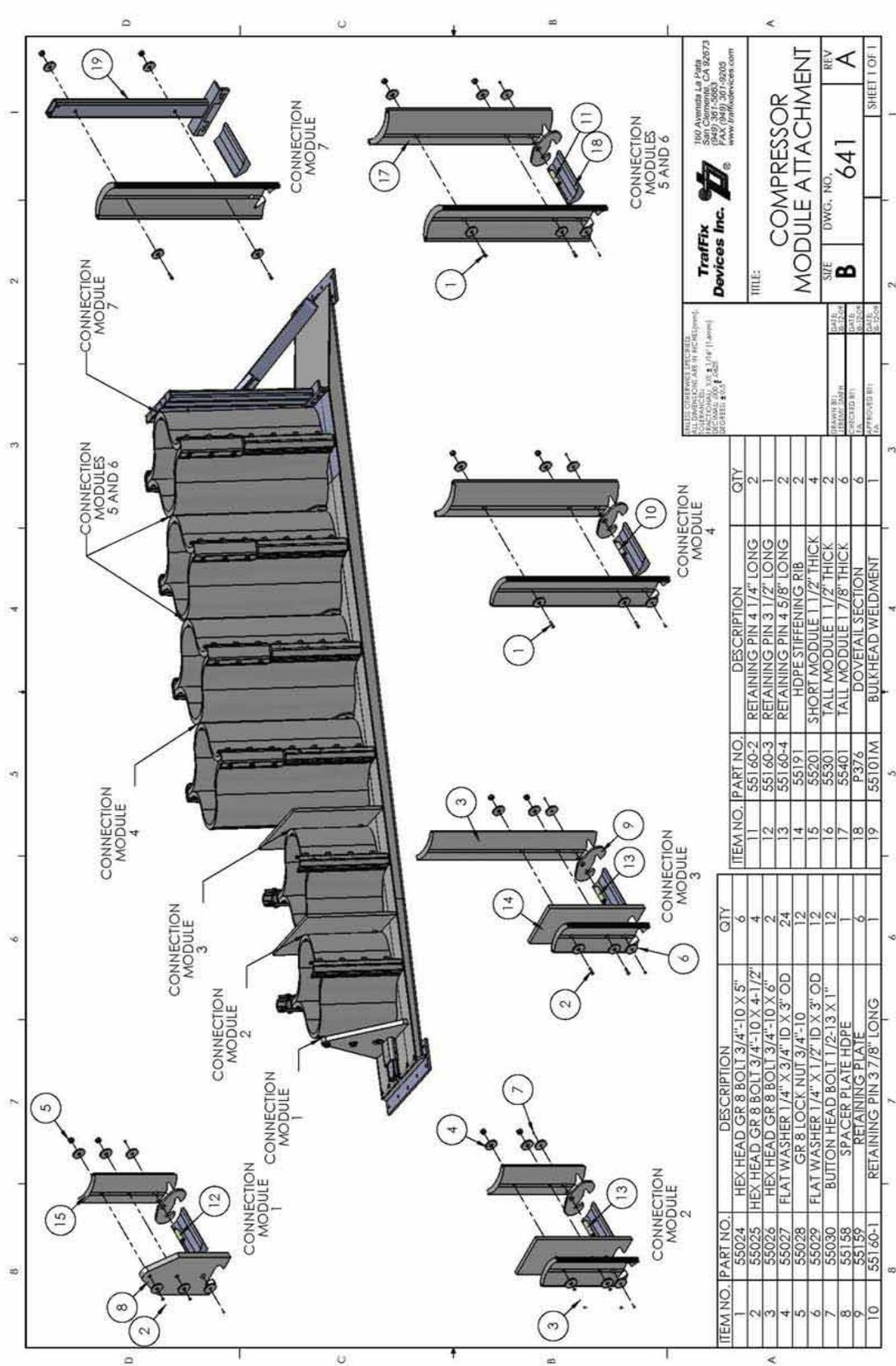
TITLE: COMPRESSOR TRANSITION
 BI-DIRECTIONAL THRIE
 BEAM W/ CMB CENTERED

DATE:	2/24/09	REV:	A
DRAWN BY:	JEREMY SMITH	DATE:	2/24/09
CHECKED BY:	DAVID HARRIS	DATE:	2/24/09
APPROVED BY:	DAVID HARRIS	DATE:	2/24/09

SIZE: **B** DWG. NO.: **655** SHEET 2 OF 2



Traffix Devices Inc. 169 Avenida La Playa San Clemente, CA 92073 (949) 381-5000 Fax: (949) 381-5005 www.traffixdevices.com		DATE: 12/15/08 CHECKED BY: [Signature] DRAWN BY: [Signature]	DWG. NO: 600 SIZE: B REV: C	SHEET 1 OF 1
TITLE: COMPRESSOR BOLT LAYOUT				



Traffix Inc.
 100 Avenida La Plata
 San Dimas, CA 92673
 (949) 361-9853
 FAX (949) 361-9200
 www.traffixinc.com

**COMPRESSOR
 MODULE ATTACHMENT**

SIZE: **B** DWG. NO.: **641** REV: **A**

DATE: 05-25-04
 DRAWN BY: JEREMY BARN
 CHECKED BY: [blank]
 APPROVED BY: [blank]

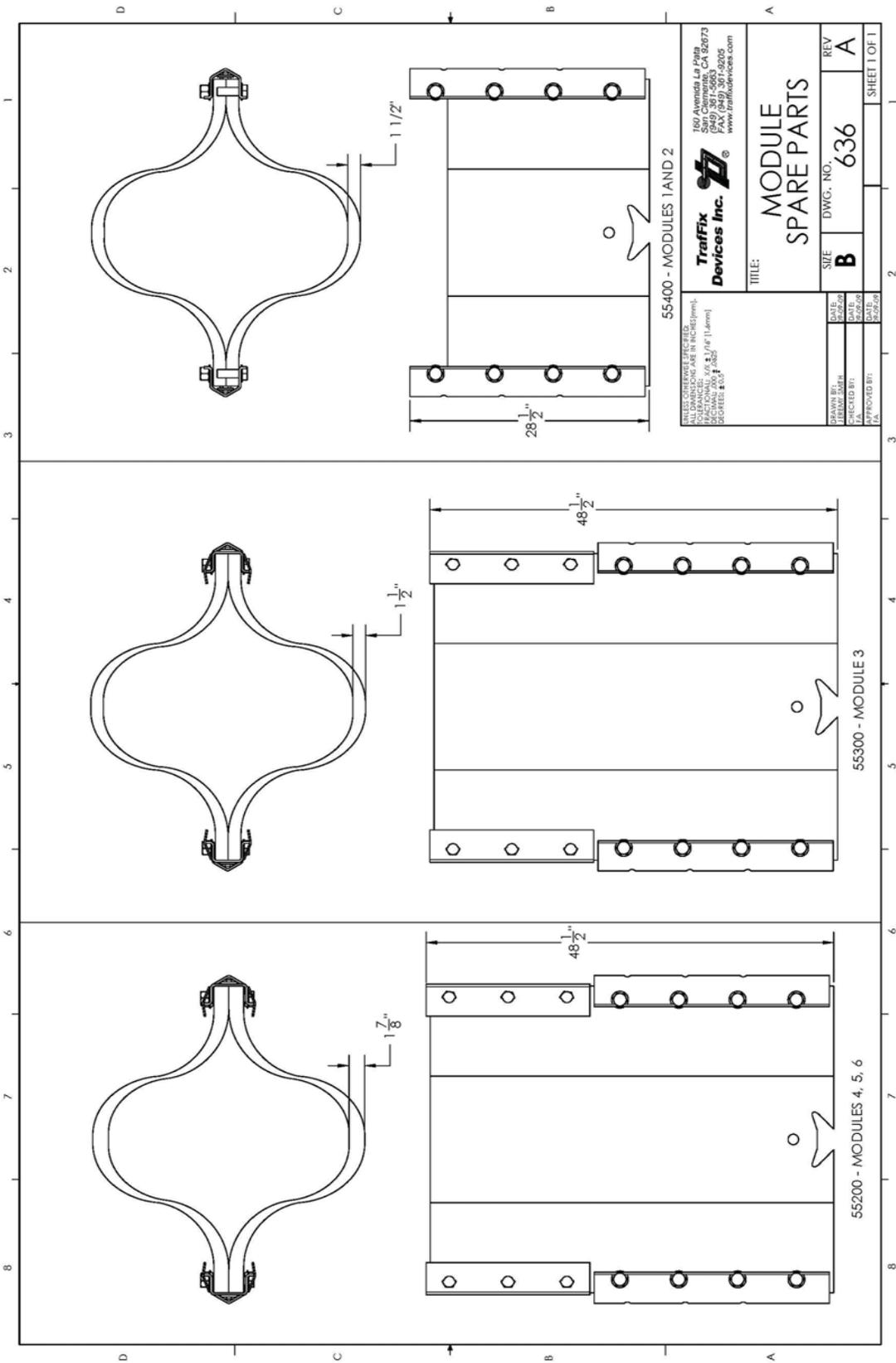
SCALE: 1/2"=1'-0"

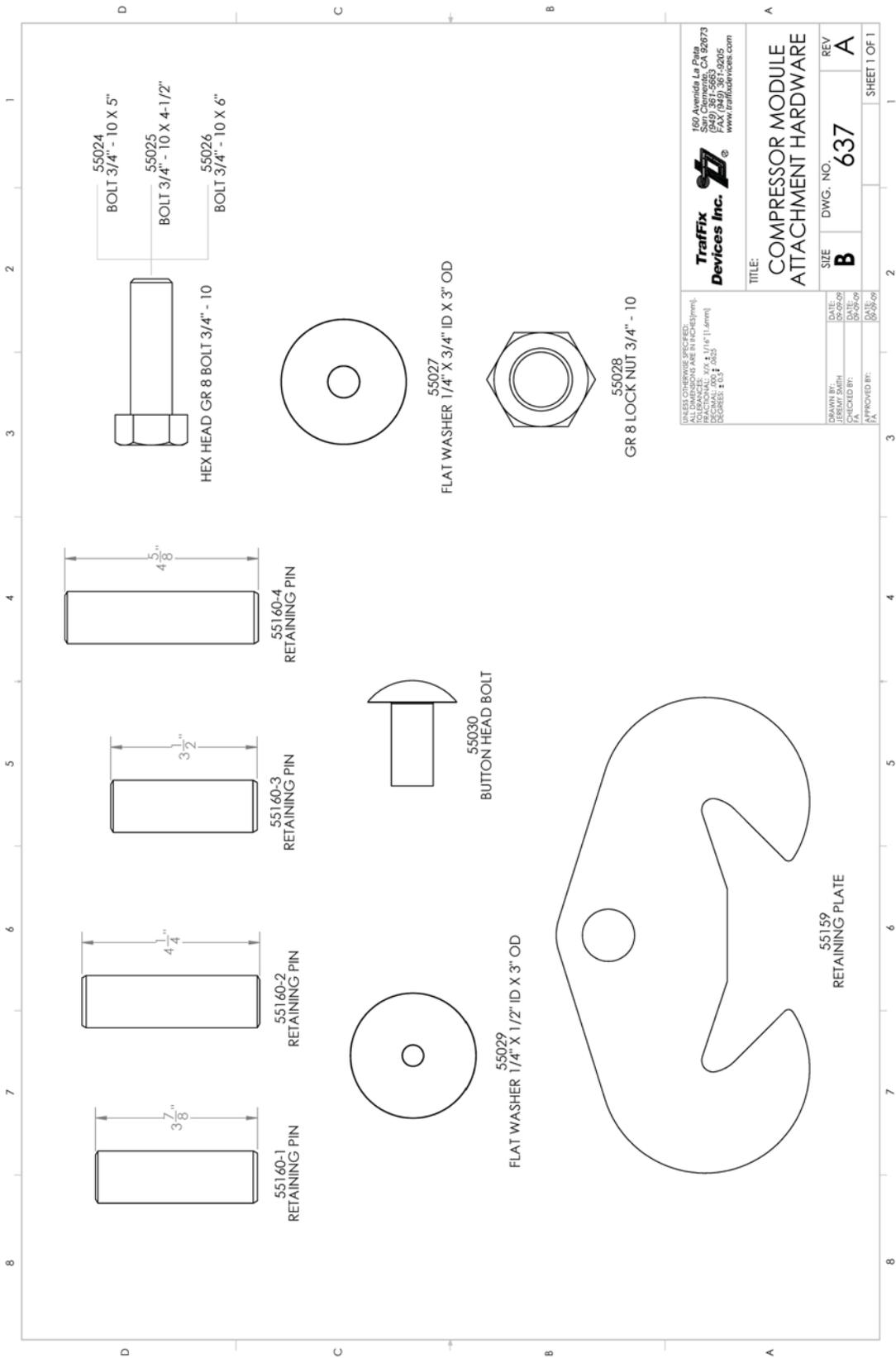
SHEET 1 OF 1

FILES OR REVISED:
 1. DATE: 05-25-04
 2. DATE: 05-25-04
 3. DATE: 05-25-04
 4. DATE: 05-25-04
 5. DATE: 05-25-04
 6. DATE: 05-25-04
 7. DATE: 05-25-04
 8. DATE: 05-25-04
 9. DATE: 05-25-04
 10. DATE: 05-25-04

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	55160-2	RETAINING PIN 4.1/4" LONG	2
2	55160-3	RETAINING PIN 3.1/2" LONG	1
3	55160-4	RETAINING PIN 4.5/8" LONG	2
4	55191	HDPE STIFFENING RIB	2
5	55201	SHORT MODULE 1.1/2" THICK	4
6	55301	TALL MODULE 1.1/2" THICK	2
7	55401	TALL MODULE 1.7/8" THICK	2
8	P376	DOVETAIL SECTION	6
9	55101M	BULKHEAD WELDMENT	1

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	55024	HEX HEAD GR 8 BOLT 3/4"-10 X 5"	6
2	55025	HEX HEAD GR 8 BOLT 3/4"-10 X 4.1/2"	4
3	55026	HEX HEAD GR 8 BOLT 3/4"-10 X 6"	2
4	55027	FLAT WASHER 1/4" X 3/4" ID X 3" OD	24
5	55028	GR 8 LOCK NUT 3/4"-10	12
6	55029	FLAT WASHER 1/4" X 1/2" ID X 3" OD	12
7	55030	BUTTON HEAD BOLT 1/2"-13 X 1"	12
8	55158	SPACER PLATE HDPE	1
9	55159	RETAINING PLATE	6
10	55160-1	RETAINING PIN 3.7/8" LONG	1





Traffix Devices Inc.
160 Avenida La Pata
San Clemente, CA 92673
(949) 361-3000
(949) 361-3005
www.traffixdevices.com

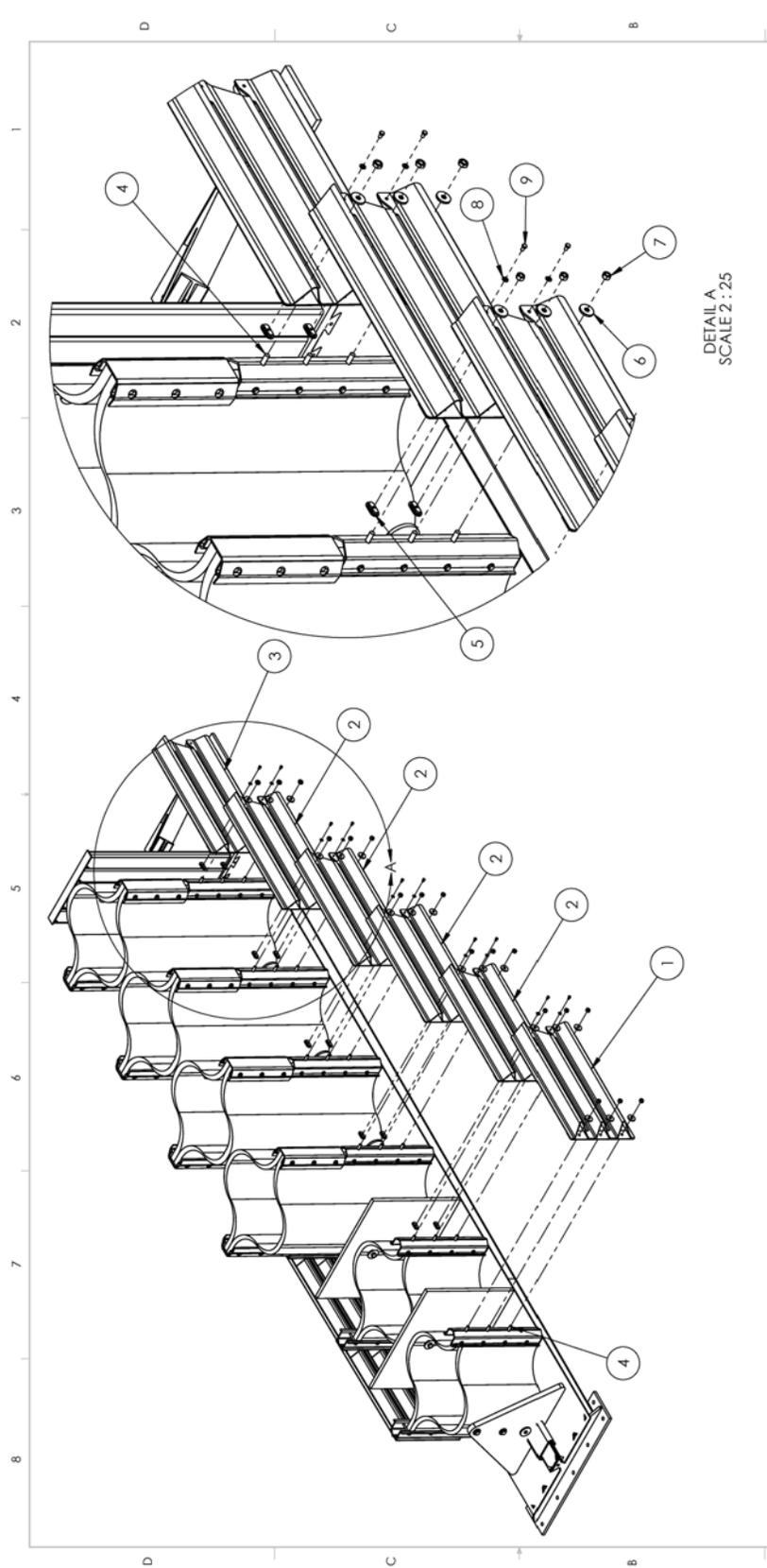
TITLE:
COMPRESSOR MODULE ATTACHMENT HARDWARE

SIZE: **B** DWG. NO. **637** REV **A**

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN INCHES (mm).
FRACTIONAL: 1/8" (1.6mm)
DECIMAL: .001 (0.025)
DECIMAL: .010 (0.254)

DRAWN BY:	DATE:	REV:
CHECKED BY:	DATE:	REV:
APPROVED BY:	DATE:	REV:

SHEET 1 OF 1



DETAIL A
SCALE 2 : 25

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES(MM).
TOLERANCES: ±.015" (±.381mm)
DECIMALS: .015" (±.381mm)
DEGREES: ± 0.5°

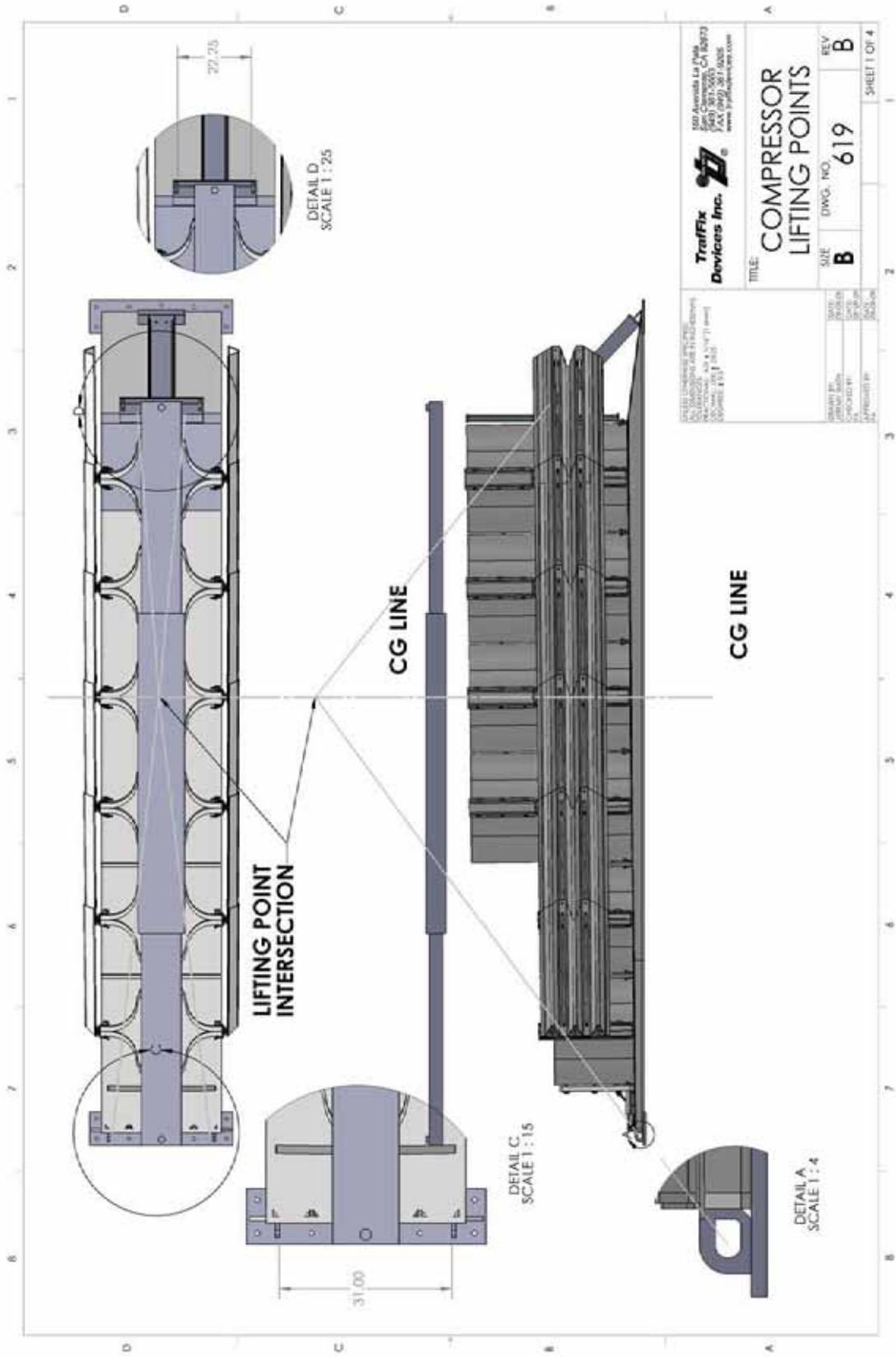
Traffix Inc.
600 Avenida La Playa
San Marcos, CA 92073
(949) 361-6553
FAX (949) 361-9205
www.traffixinc.com

TITLE:
**COMPRESSOR FENDER
ATTACHMENT**

SIZE **B** DWG. NO. **644** REV **A**

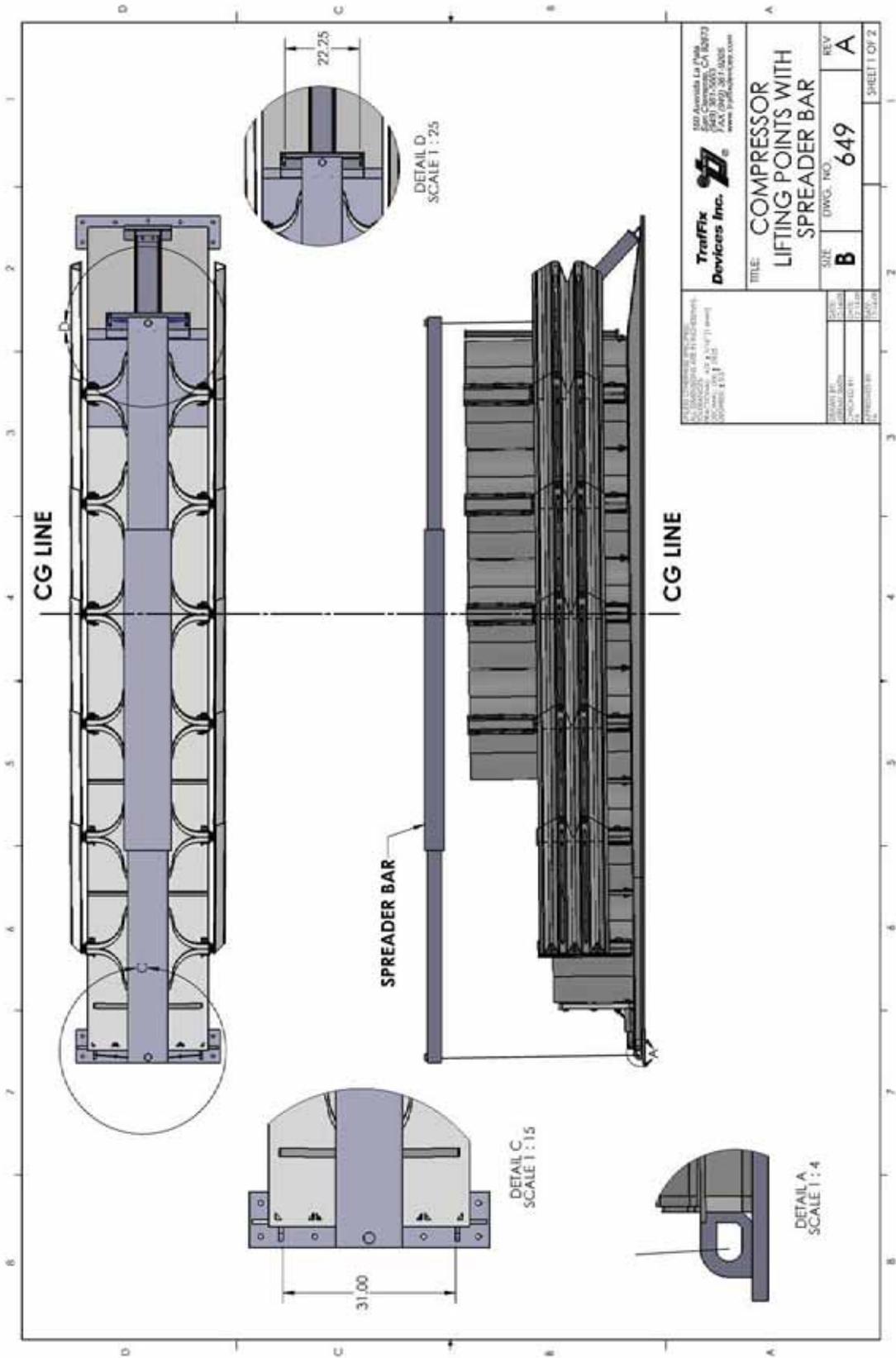
DRAWN BY: JEREMY SMITH DATE: 09/08/09
CHECKED BY: DATE: 09/08/09
APPROVED BY: DATE: 09/08/09

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	55511	CHAMFERED FRONT PANEL	2
2	55134	FENDER PANEL CRASH	8
3	55530	REAR FENDER PANEL	2
4	55163	FENDER PANEL STUD	36
5	55135	FENDER SLIDER CRASH TERMINAL	20
6	55542	WASHER 2IN OD, 3/4IN ID	36
7	55031	HEX NUT .578IN-11	36
8	55033	FLAT WASHER 3/8IN-10 X 13/16OD GR5	20
9	55032	HEX BOLT 3/8IN X 1.6IN	20



Traffix Devices Inc.
 100 Avenida La Puma
 San Clemente, CA 92673
 FAX (949) 361-0025
 www.traffixdevices.com

TITLE: COMPRESSOR LIFTING POINTS		REV: B
SIZE: B	DWG. NO.: 619	REV: B
DESIGNED BY:	DATE:	SCALE:
CHECKED BY:	DATE:	SCALE:
APPROVED BY:	DATE:	SCALE:



TrafFix Devices Inc.
 100 Avenida La Pasa
 San Clemente, CA 92673
 (949) 381-3000
 www.traffixdevices.com

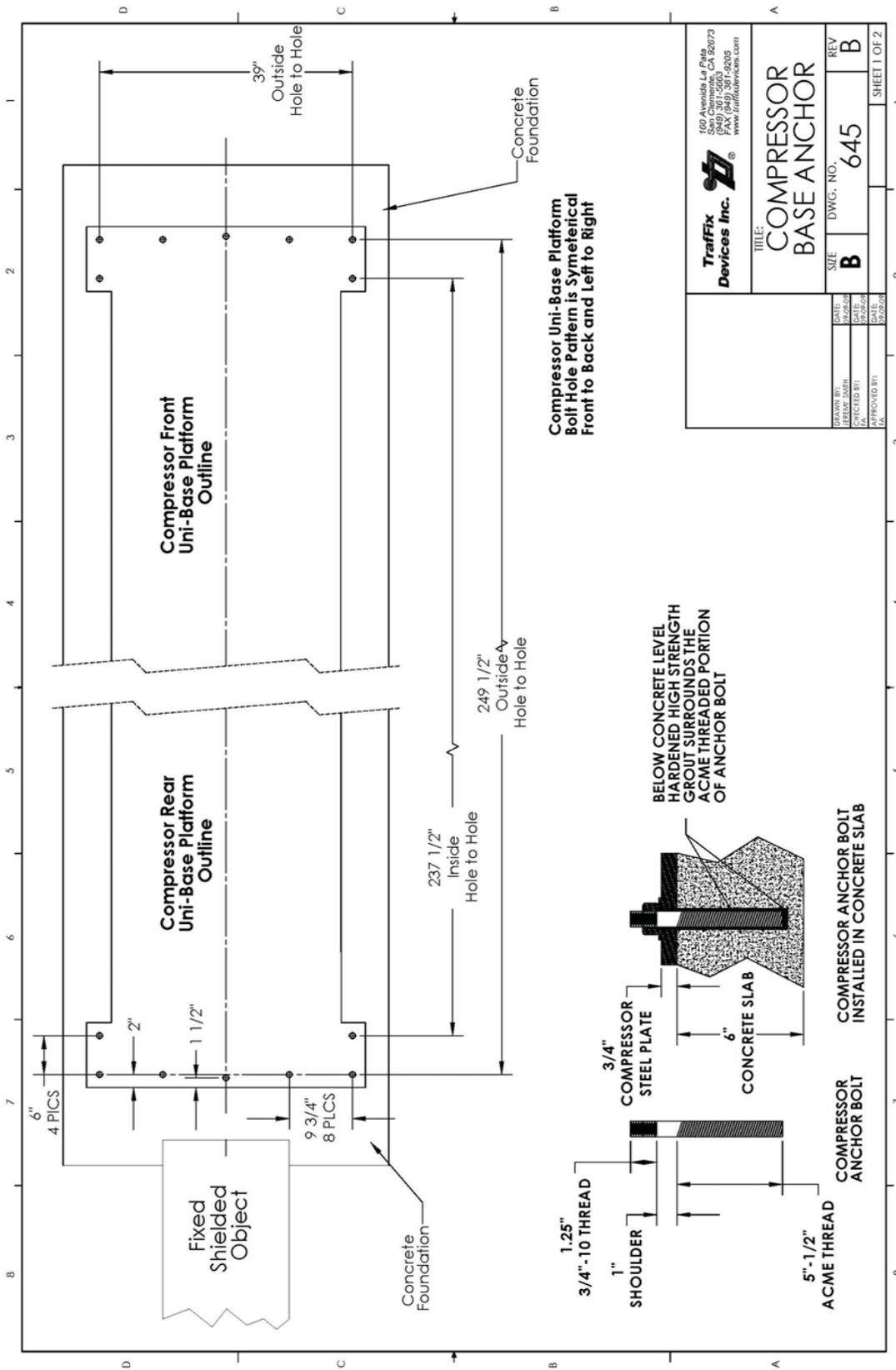
TRAFFIX DEVICES INC. 100 AVENIDA LA PASA, SAN CLEMENTE, CA 92673
 TEL: (949) 381-3000 FAX: (949) 381-3005
 WWW.TRAFFIXDEVICES.COM

DATE: 01/14/15
 DRAWN BY: [redacted]
 CHECKED BY: [redacted]
 IN CHARGE BY: [redacted]

TITLE: COMPRESSOR LIFTING POINTS WITH SPREADER BAR

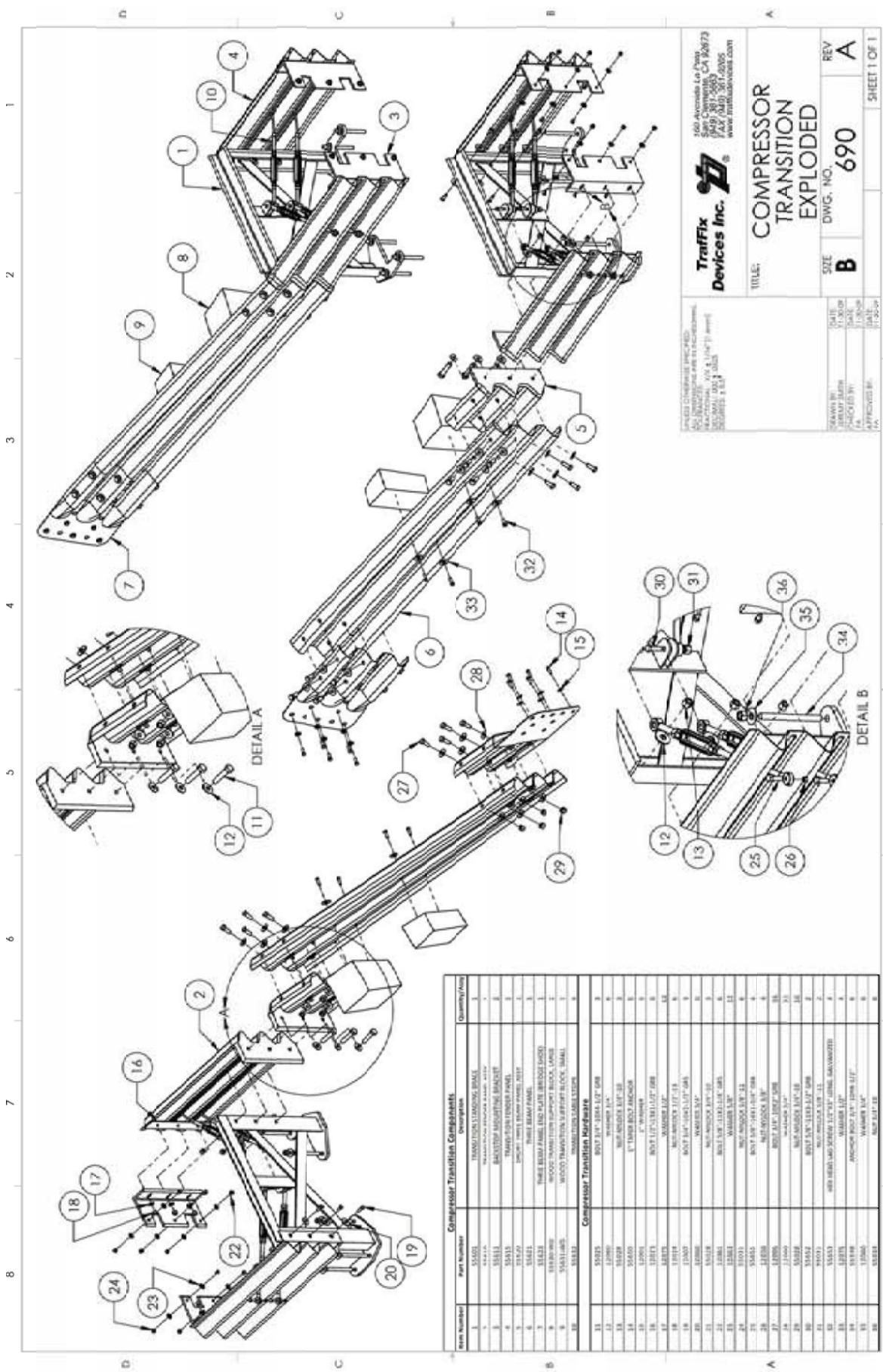
SIZE: B DWG. NO: 649 REV: A

SHEET 1 OF 2



TrafFix Devices Inc.
 100 Avenida La Parg
 San Jose, CA 95128
 (408) 307-9200
 FAX: (408) 307-9205
 www.traffixdevices.com

DATE: _____		DATE: _____	REV: _____
DRAWN BY: _____		DATE: _____	REV: _____
CHECKED BY: _____		DATE: _____	REV: _____
APPROVED BY: _____		DATE: _____	REV: _____
PA: _____		DATE: _____	REV: _____
TITLE: COMPRESSOR BASE ANCHOR		SIZE: B	DWG. NO.: 645
SHEET 1 OF 2			



Traffix Devices Inc.
 1600 Avenida Le Panto
 San Clemente, CA 92673
 (949) 425-1000
 FAX (949) 301-2805
 www.traffixdevices.com

TRAFFIX DEVICES INC. (PREFERRED) PARTS TO EXISTING TRAFFIX TRANSITION, 1/14/14 (1) sheet
 20250015 1/14

DATE: 1/20/14
 DRAWN BY: JEREMY BARN
 CHECKED BY: JEREMY BARN
 IN REVISION: 1/20/14
 REV: 1/20/14

TITLE: COMPRESSOR TRANSITION EXPLODED
 SIZE: B
 DWG. NO.: 690
 REV: A

SHEET 1 OF 1

Part Number	Description	Quantity/Unit
1	TRANSITION LANDING BEAM	1
2	TRANSITION LANDING BEAM	1
3	TRANSITION LANDING BEAM	1
4	TRANSITION LANDING BEAM	1
5	TRANSITION LANDING BEAM	1
6	TRANSITION LANDING BEAM	1
7	TRANSITION LANDING BEAM	1
8	TRANSITION LANDING BEAM	1
9	TRANSITION LANDING BEAM	1
10	TRANSITION LANDING BEAM	1
11	TRANSITION LANDING BEAM	1
12	TRANSITION LANDING BEAM	1
13	TRANSITION LANDING BEAM	1
14	TRANSITION LANDING BEAM	1
15	TRANSITION LANDING BEAM	1
16	TRANSITION LANDING BEAM	1
17	TRANSITION LANDING BEAM	1
18	TRANSITION LANDING BEAM	1
19	TRANSITION LANDING BEAM	1
20	TRANSITION LANDING BEAM	1
21	TRANSITION LANDING BEAM	1
22	TRANSITION LANDING BEAM	1
23	TRANSITION LANDING BEAM	1
24	TRANSITION LANDING BEAM	1
25	TRANSITION LANDING BEAM	1
26	TRANSITION LANDING BEAM	1
27	TRANSITION LANDING BEAM	1
28	TRANSITION LANDING BEAM	1
29	TRANSITION LANDING BEAM	1
30	TRANSITION LANDING BEAM	1
31	TRANSITION LANDING BEAM	1
32	TRANSITION LANDING BEAM	1
33	TRANSITION LANDING BEAM	1
34	TRANSITION LANDING BEAM	1
35	TRANSITION LANDING BEAM	1
36	TRANSITION LANDING BEAM	1

Regional Sales Managers, Key Contacts & Customer Service

➤ Regional Sales Managers

Northeast Territory Office

VA, WV, DL, MD, NJ, NY, PA, CT, MA, RI, NH, VT, ME, D.C.

John D. Risley

Philadelphia, PA

(610) 337-9556 office

(949) 573-9239 fax

jrisley@traffixdevices.com

Southeast Territory Office

TN, NC, SC, GA, MS, AL, FL

David L. Evans

Atlanta, GA

(770)794-7338 office

(949) 573-9289 fax

devans@traffixdevices.com

Northwest Territory Office

MT, UT, ID, WA, OR, NV, CO, WY

Cary LeMonds

Salt Lake City, UT

(801) 446-4450 office

(949) 573-9290 fax

clemonds@traffixdevices.com

Midwest Territory Office

OH, MI, IN, KY, IL, WI, MN, ND, SD, IA, MO

Dave H. Lindquist

Chicago, IL

(630) 406-0760 office

(949) 573-9240 fax

dlindquist@traffixdevices.com

Western Territory Office

CA, HI, AK, AZ

Eric Jones

San Clemente, CA

(949) 350-7048 office

(949) 573-9267 fax

ejones@traffixdevices.com

Southwest Territory Office

TX, OK, KS, NE, NM, AR, LA

John Gense

Dallas, TX

(214)704-1476 office

(949) 573-9291 fax

jgense@traffixdevices.com

International Sales

Brent Kulp

San Clemente, CA

(949) 361-5663 office

(949) 573-9264 fax

bkulp@traffixdevices.com

To Place Orders

Email : orders@traffixdevices.com

Fax: (949) 573-9250

Office: (949) 361-5663

➤ Key Contacts

Brent Kulp	VP Int. Sales & Marketing	bkulp@traffixdevices.com	Ph: (949) 573-9214	Fax: (949) 573-9264
Frank Cain	VP Operations	fcain@traffixdevices.com	Ph: (949) 573-9204	Fax: (949) 573-9254
Scott Ryan	VP North American Sales	sryan@traffixdevices.com	Ph: (949) 573-9216	Fax: (949) 573-9266
Jan Miller	Business Development	jmiller@traffixdevices.com	Ph: (607) 732-5698	Fax: (949) 573-9241

➤ Customer Service Department

Yvette Cervantes	Customer Service Manager	ycervantes@traffixdevices.com	Ph:(949) 573-9220	Fax: (949) 573-9270
Jessica Pearcy	Customer Service Rep.	jpearcy@traffixdevices.com	Ph: (949) 573-9221	Fax: (949) 573-9271
Alyson Crowe	Customer Service Rep.	acrowe@traffixdevices.com	Ph: (949) 573-9222	Fax: (949) 573-9272
Jim Abercrombie	Inside Sales Specialist	jabercrombie@traffixdevices.com	Ph: (949) 573-9217	Fax: (949) 361-9205

Traffix Devices, Inc. Headquarters

160 Ave. La Pata, San Clemente, CA 92679 - (949) 361-5663 - Fax (949) 361-9205

www.traffixdevices.com

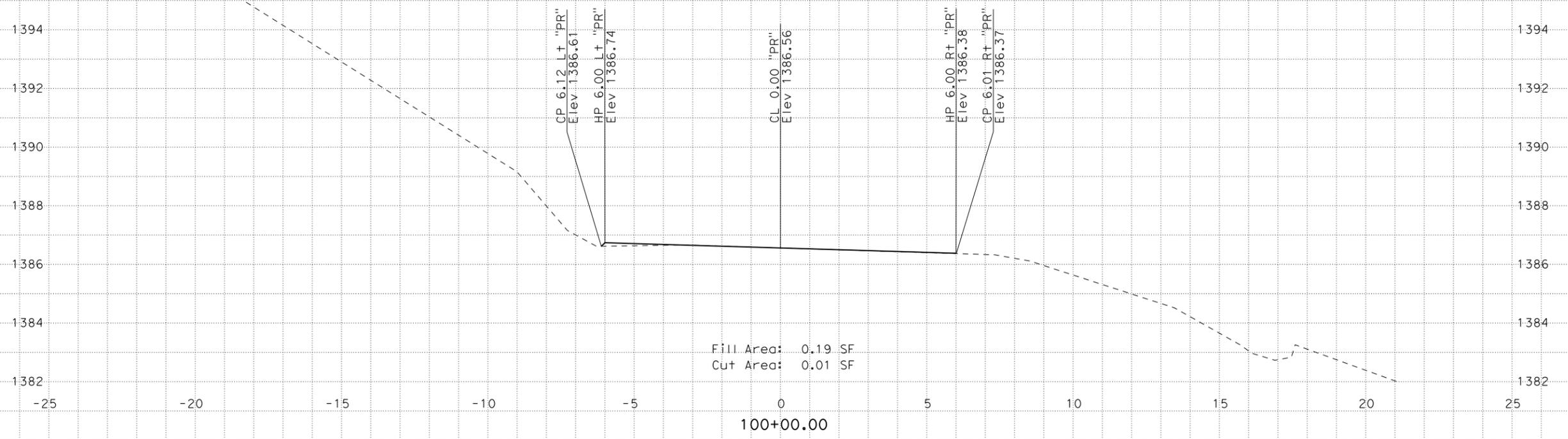
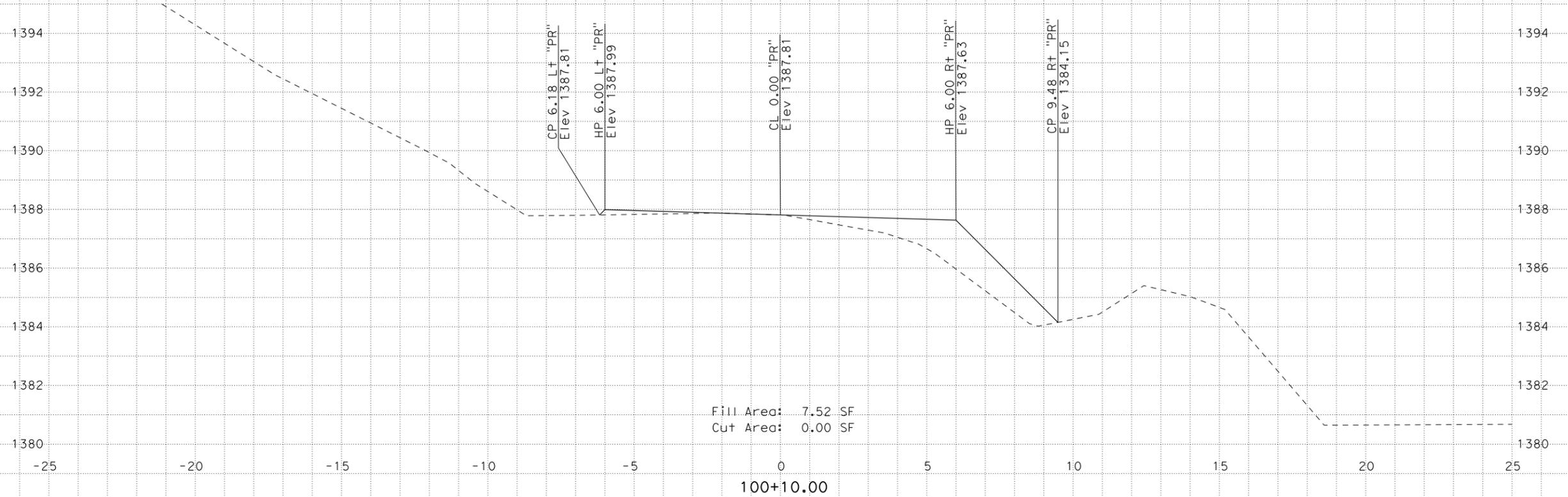
**TraFFix
Devices Inc.**



*160 Ave. La Pata
San Clemente, California 92673
(949) 361-5663
FAX (949) 361-9205
www.traffixdevices.com*

Distributed By:

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

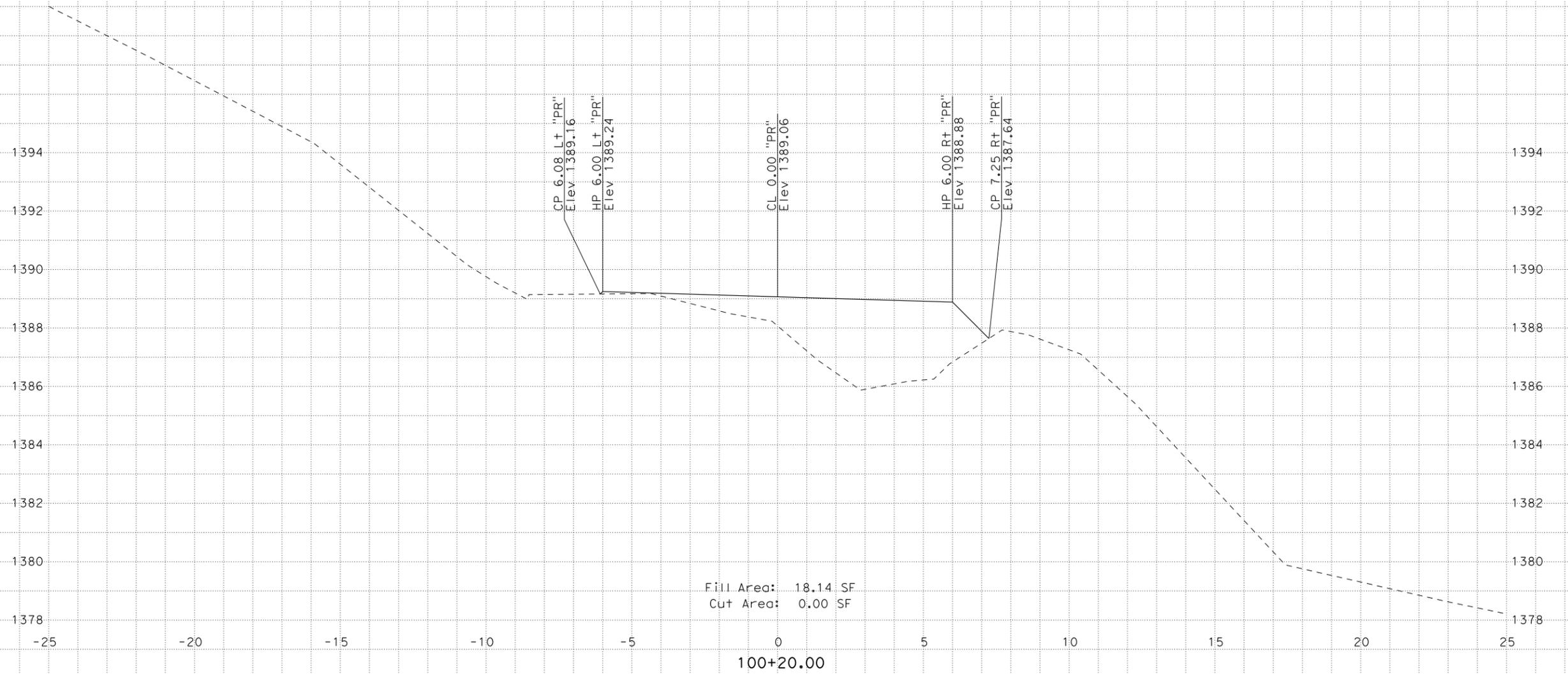
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 1 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

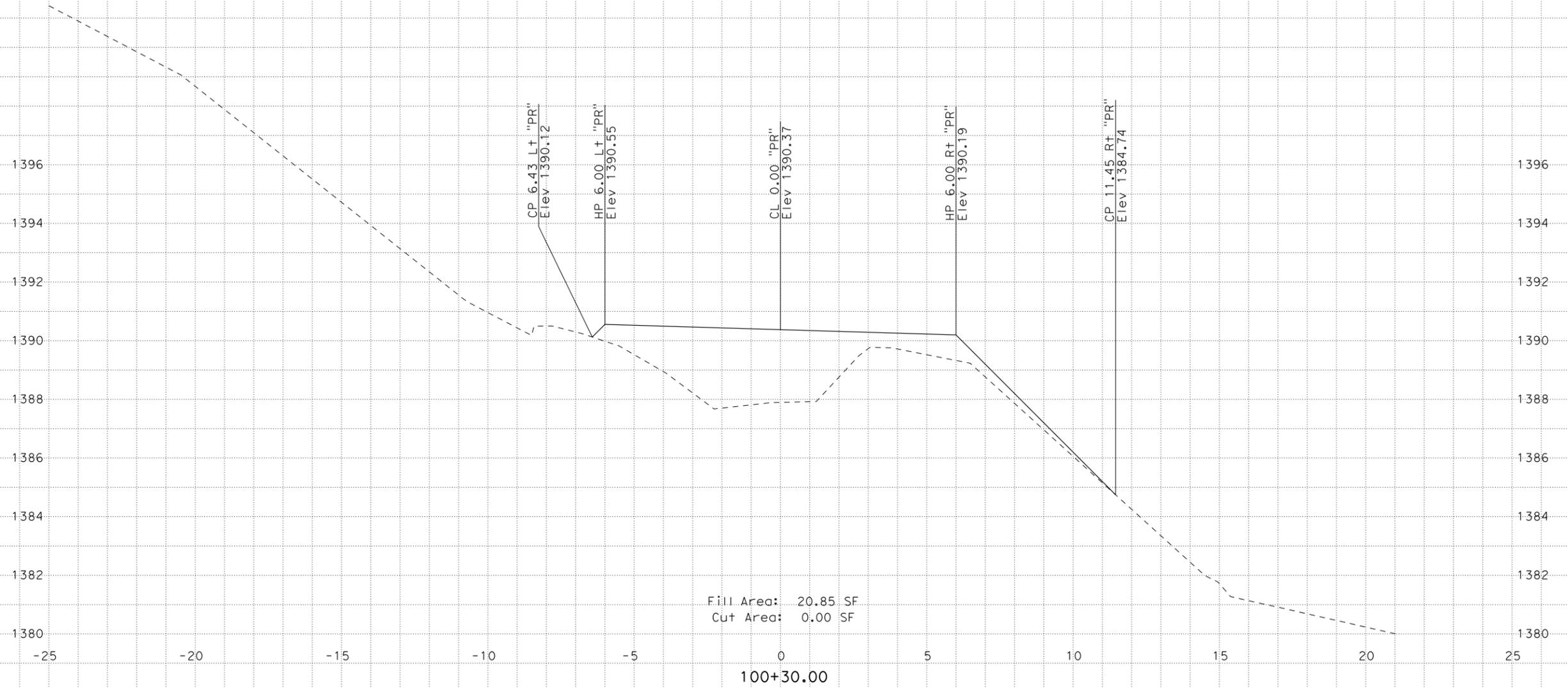
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 2 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

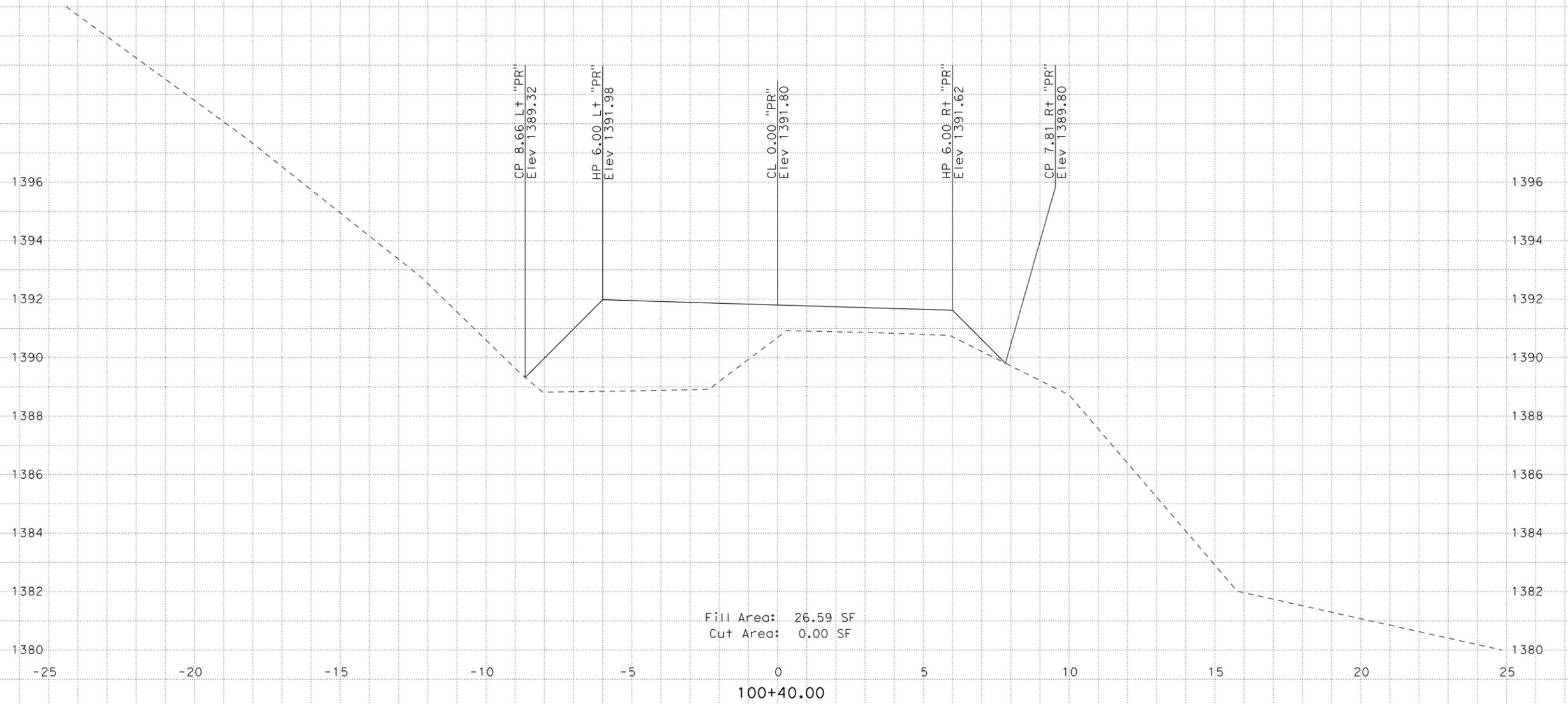
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 3 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

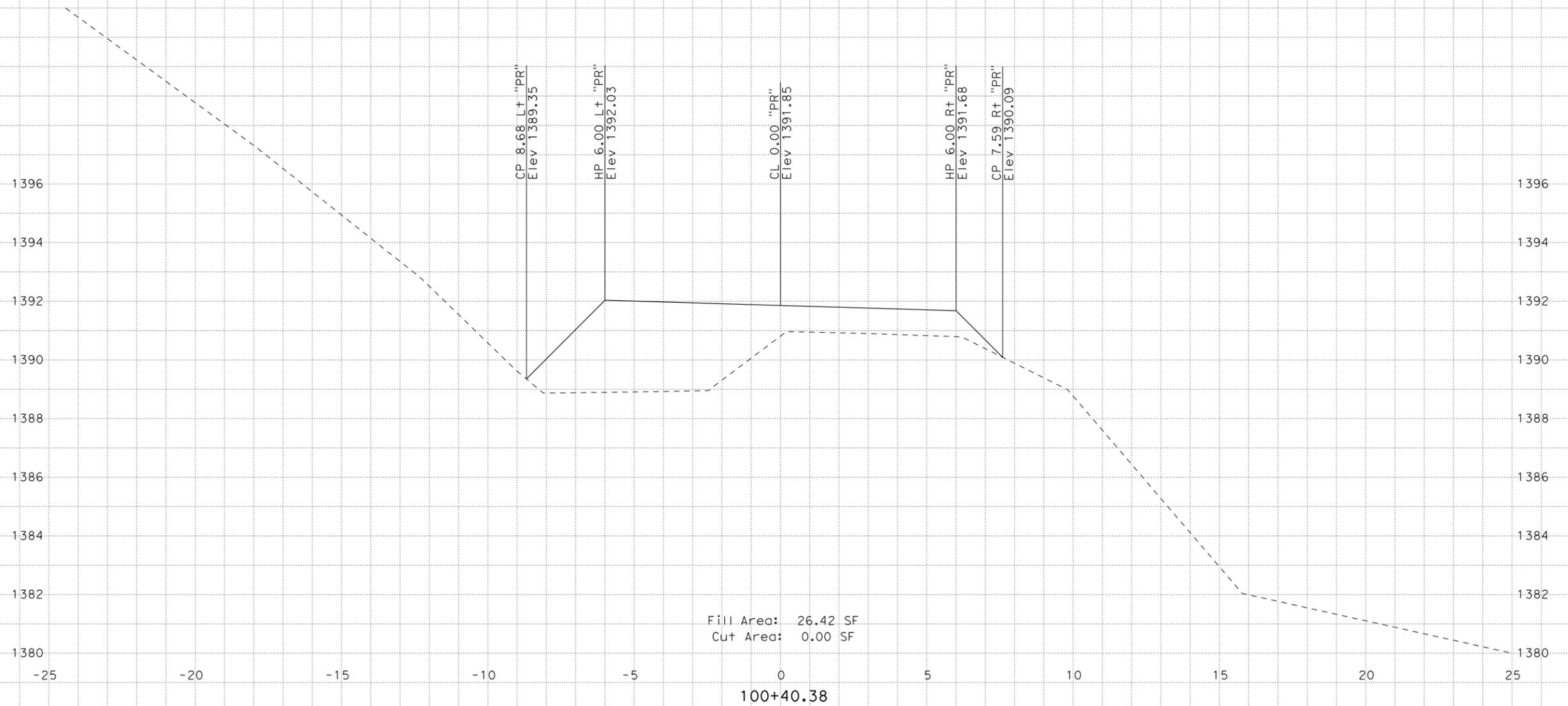
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 4 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

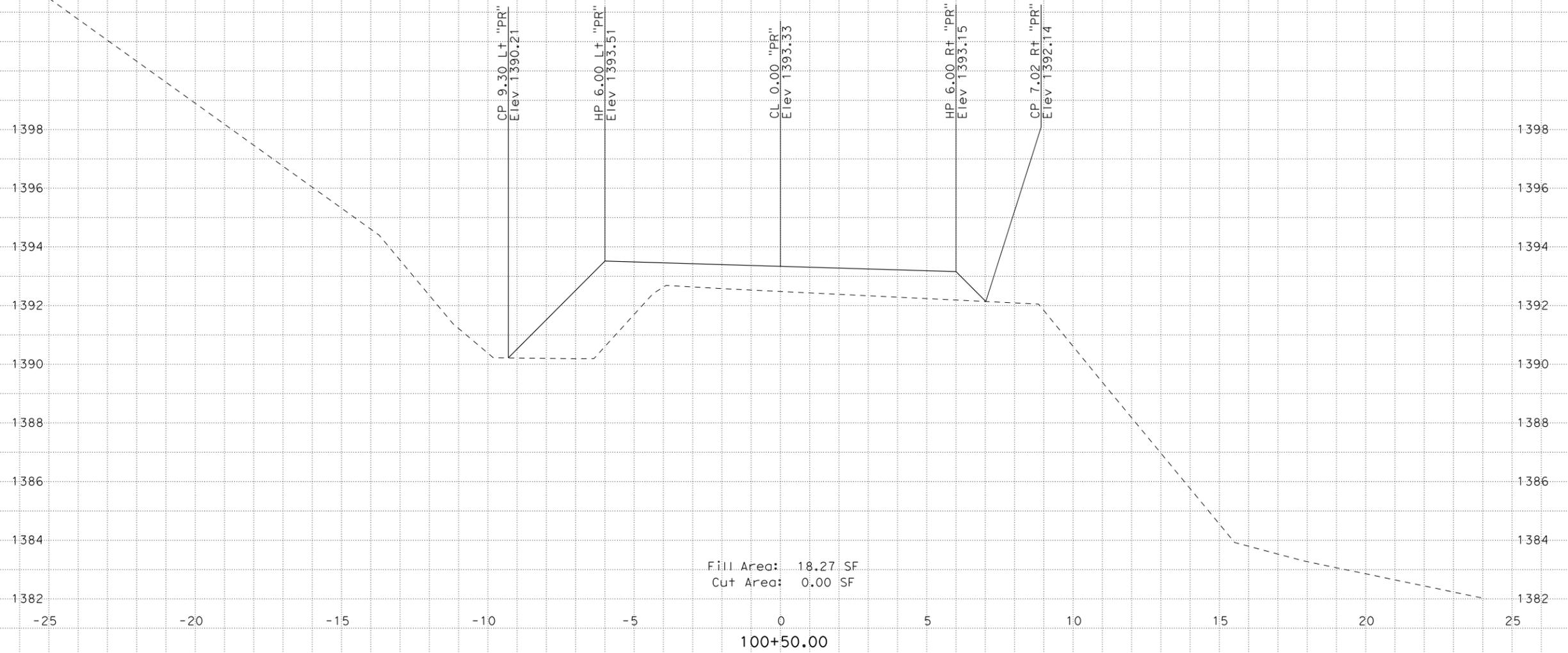
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 5 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

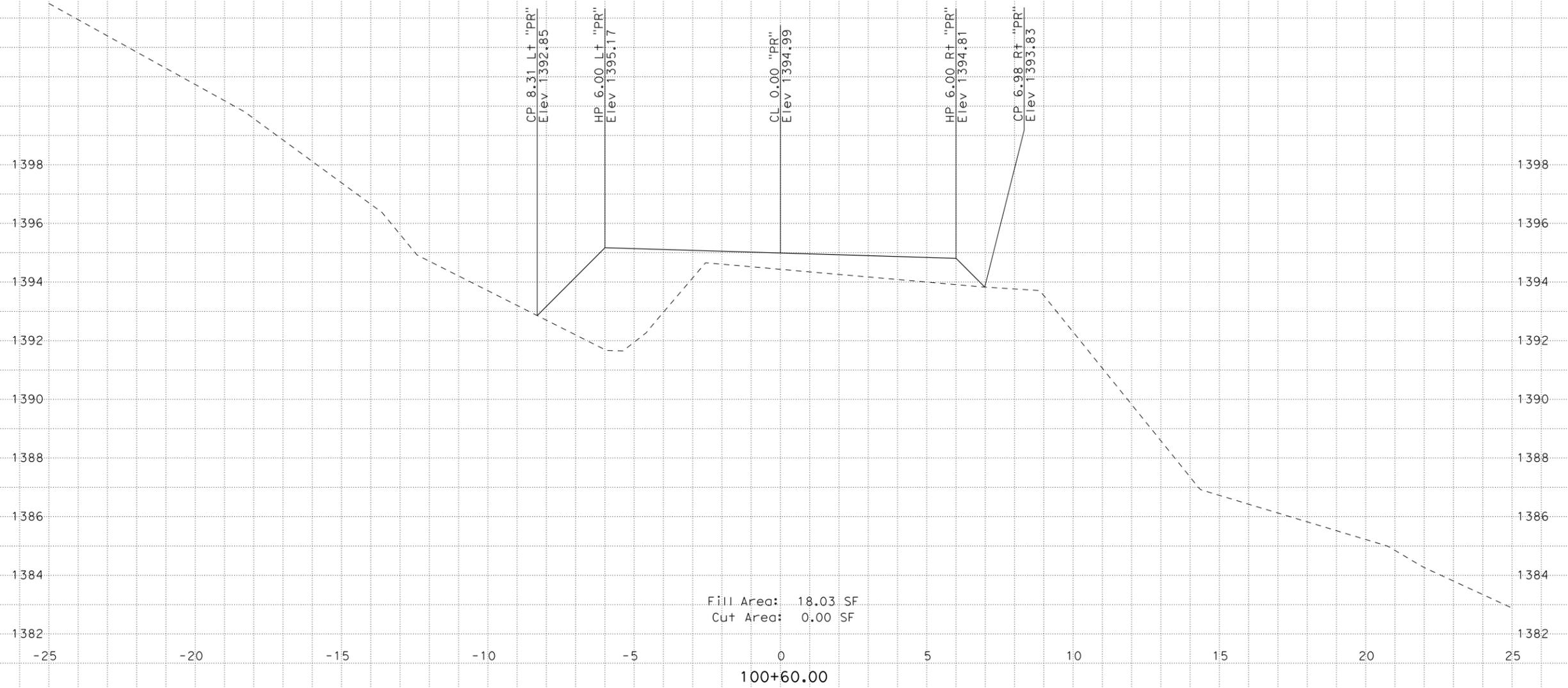
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 6 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

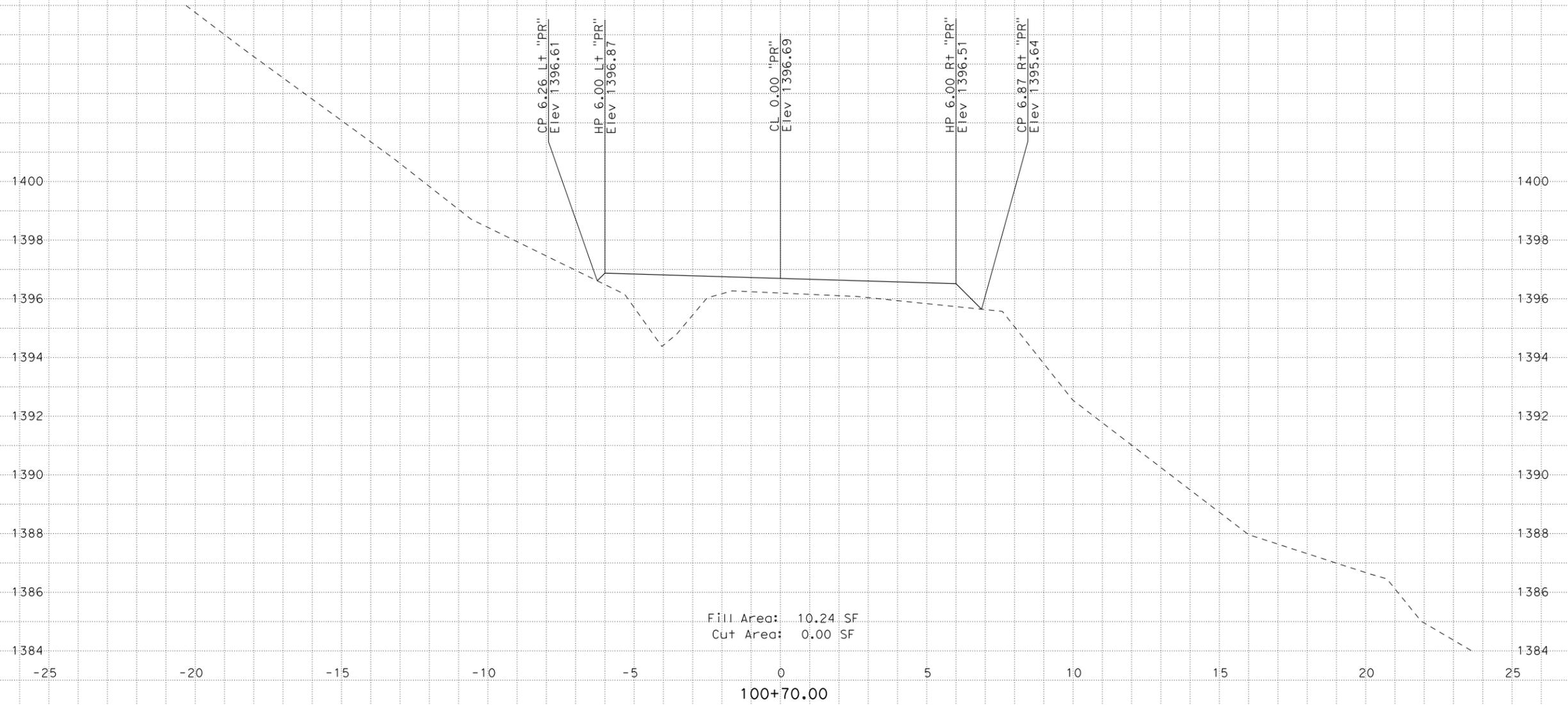
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 7 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

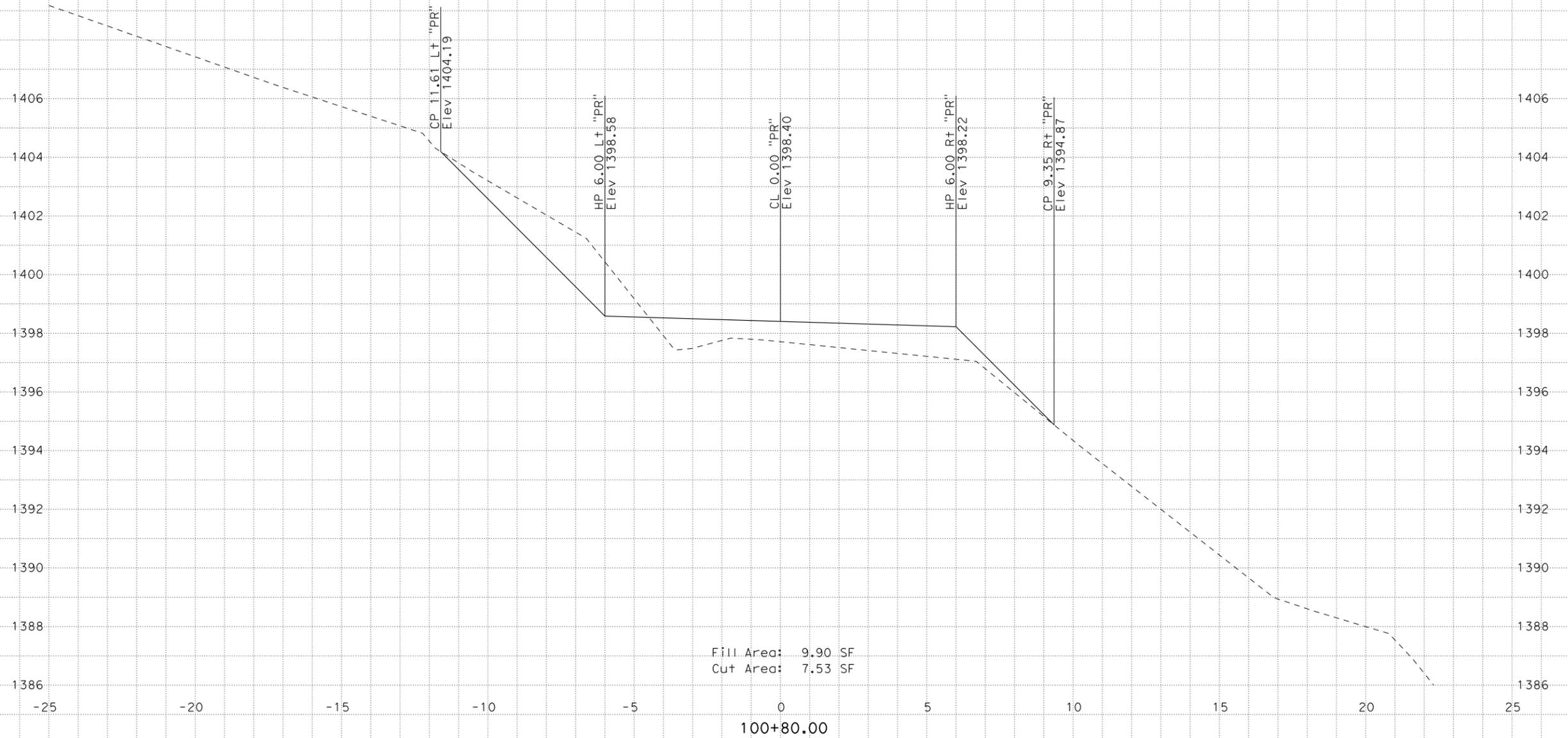
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 8 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

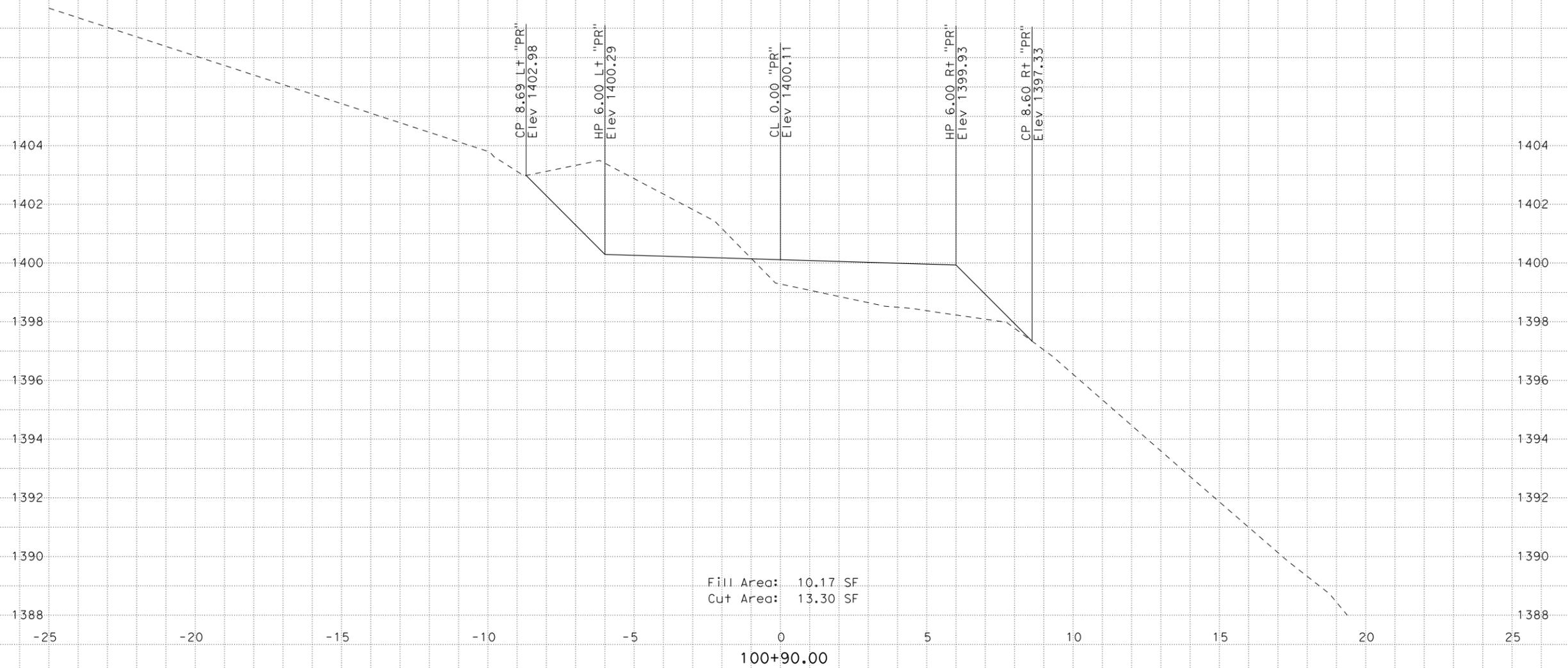
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 9 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

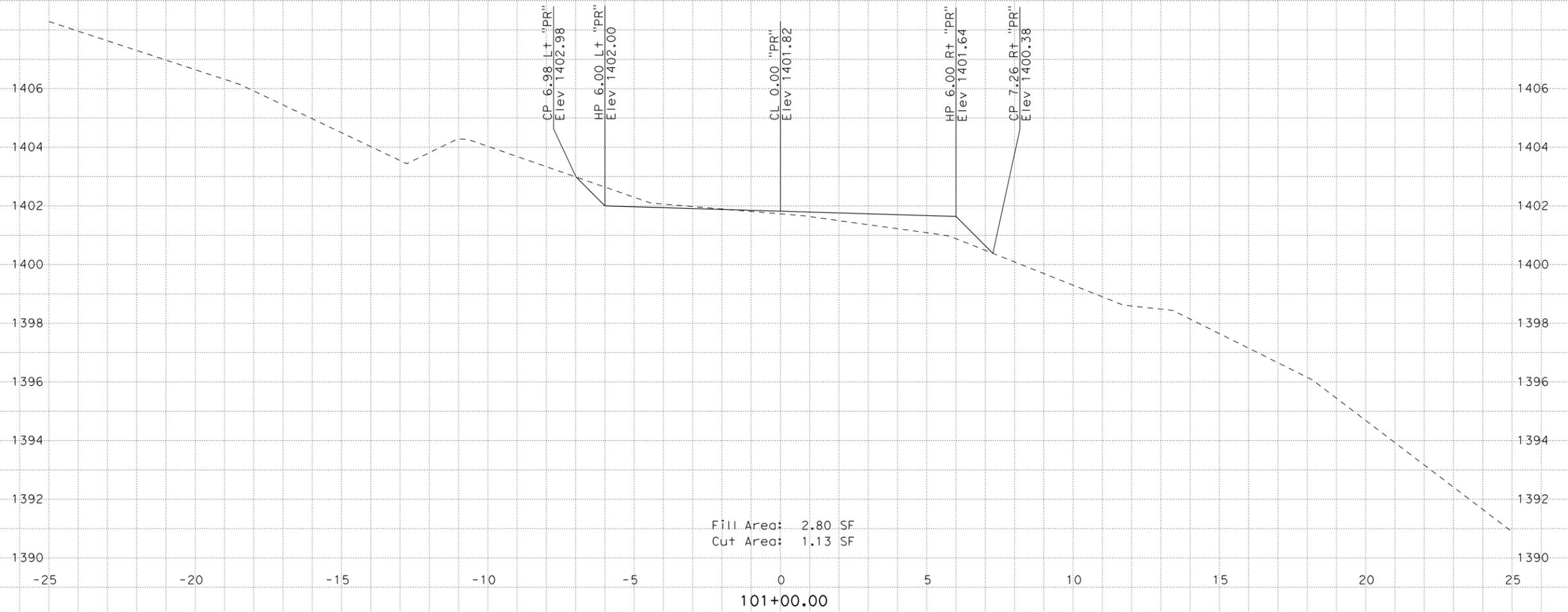
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 10 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

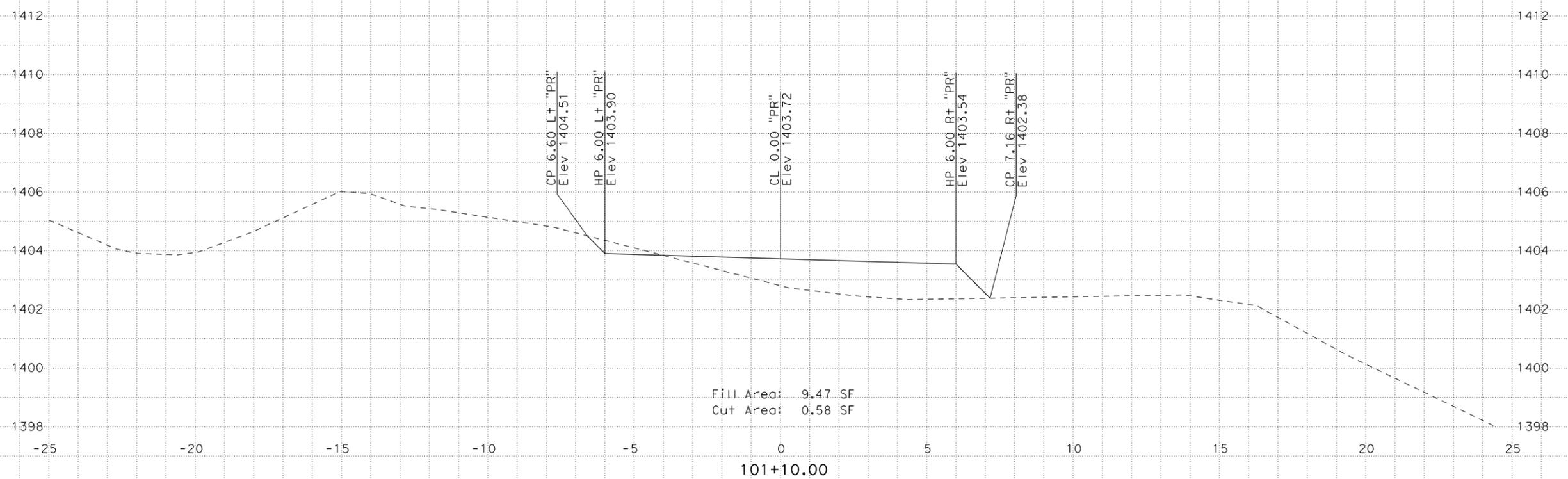
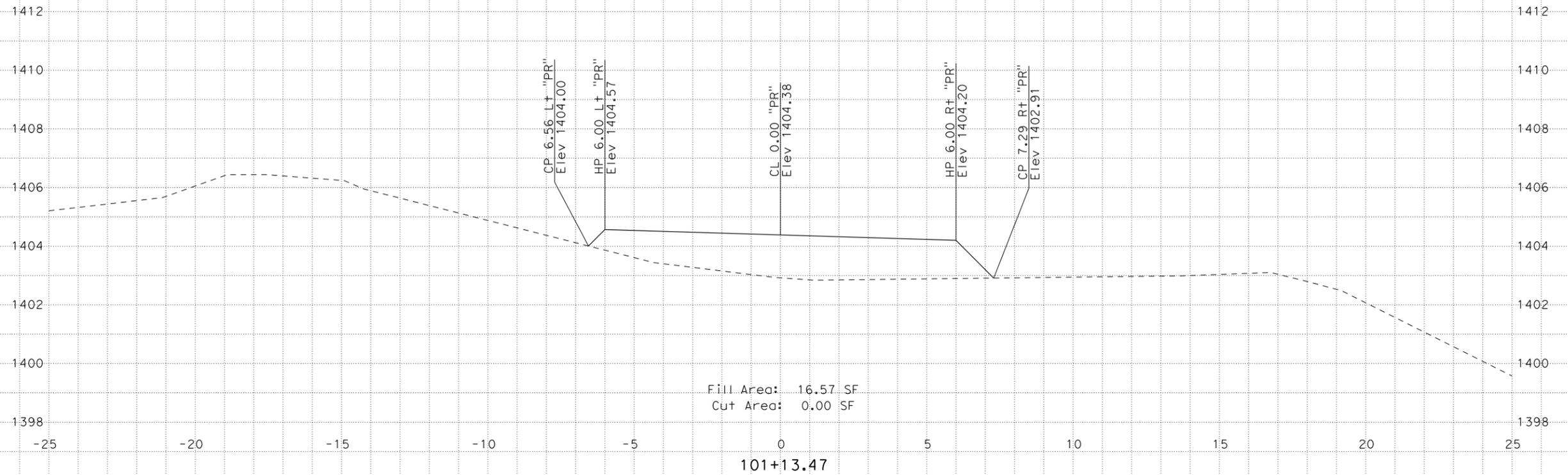
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 11 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: 0L701
05-Scr-RTE 17 PM8.9/PM9.9

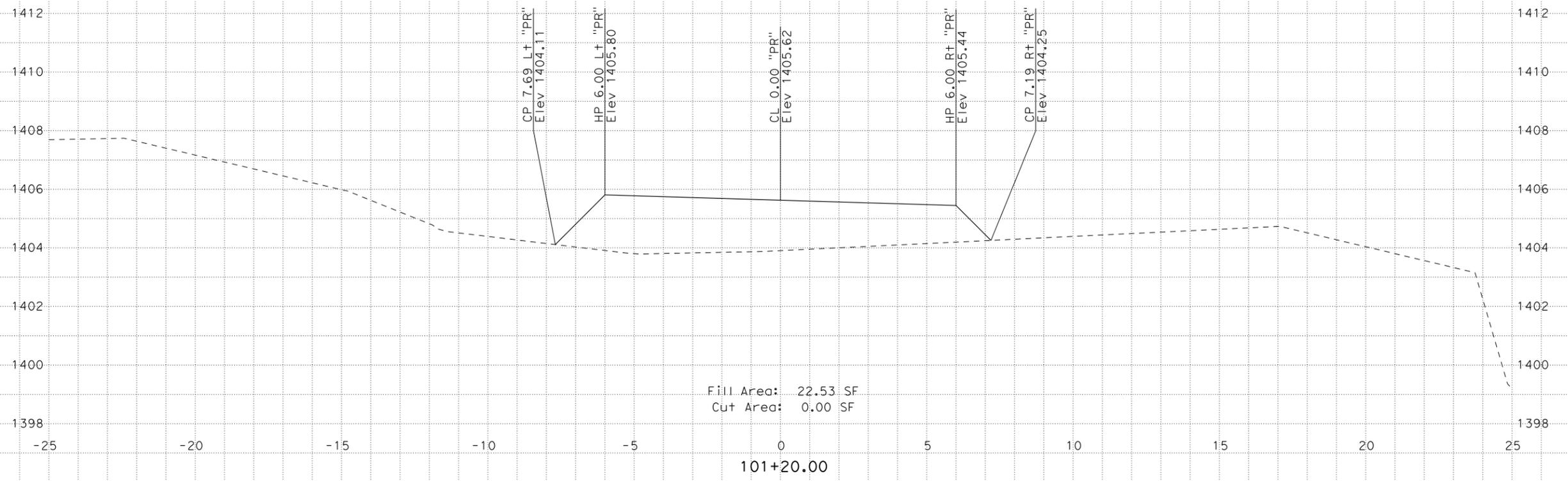
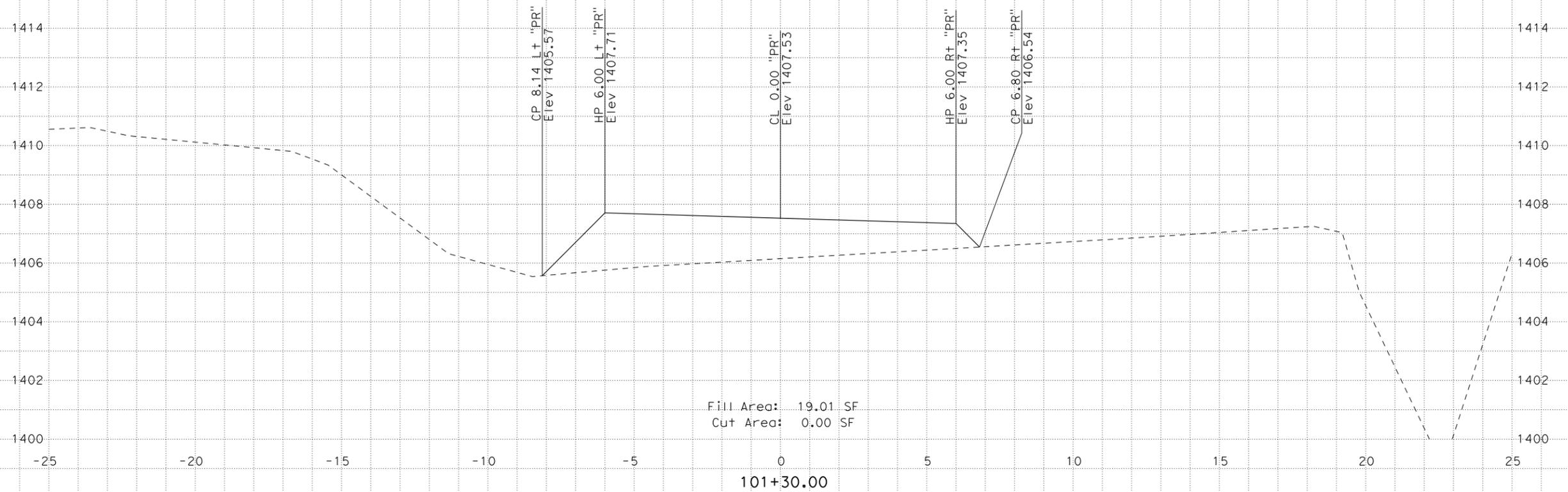
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD

SHEET 12 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

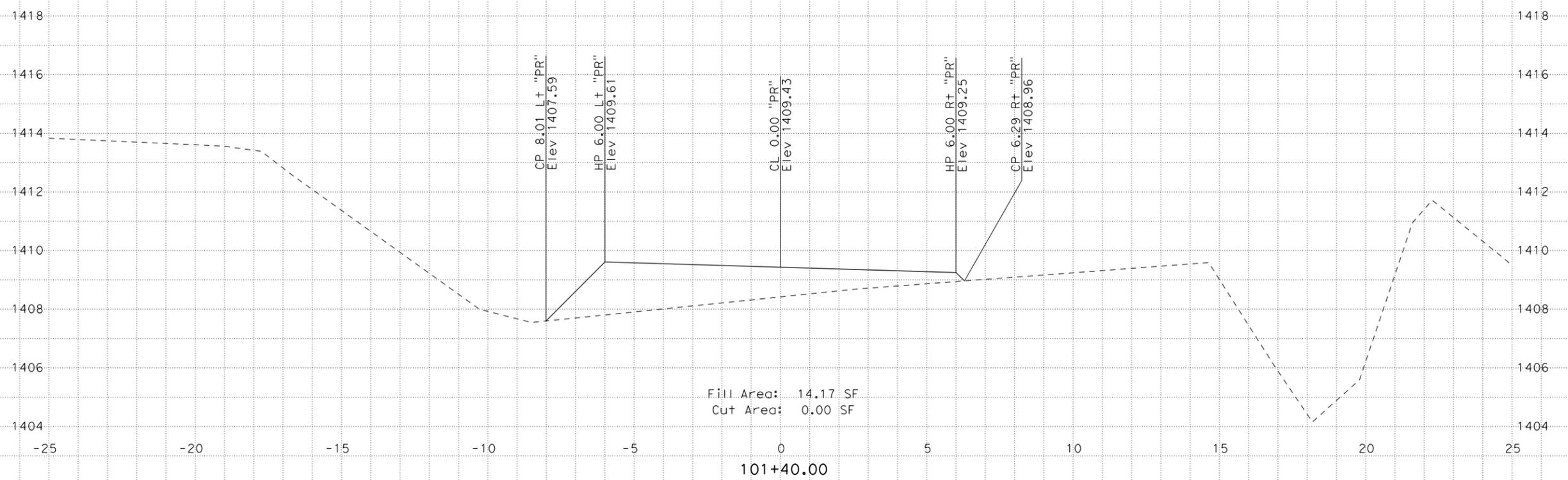
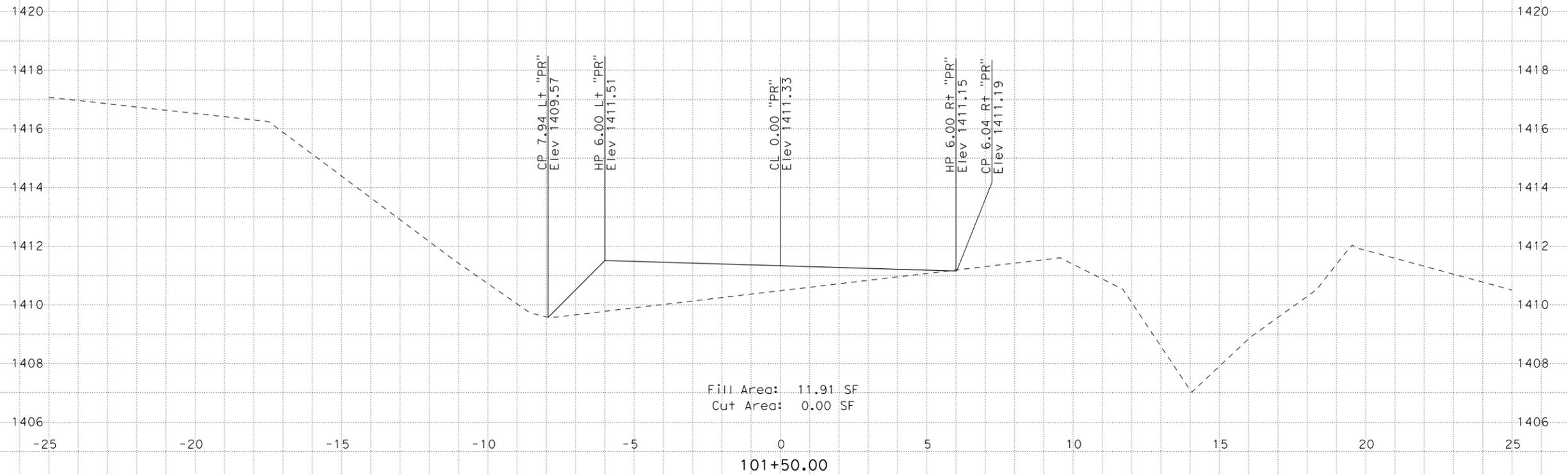
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 13 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

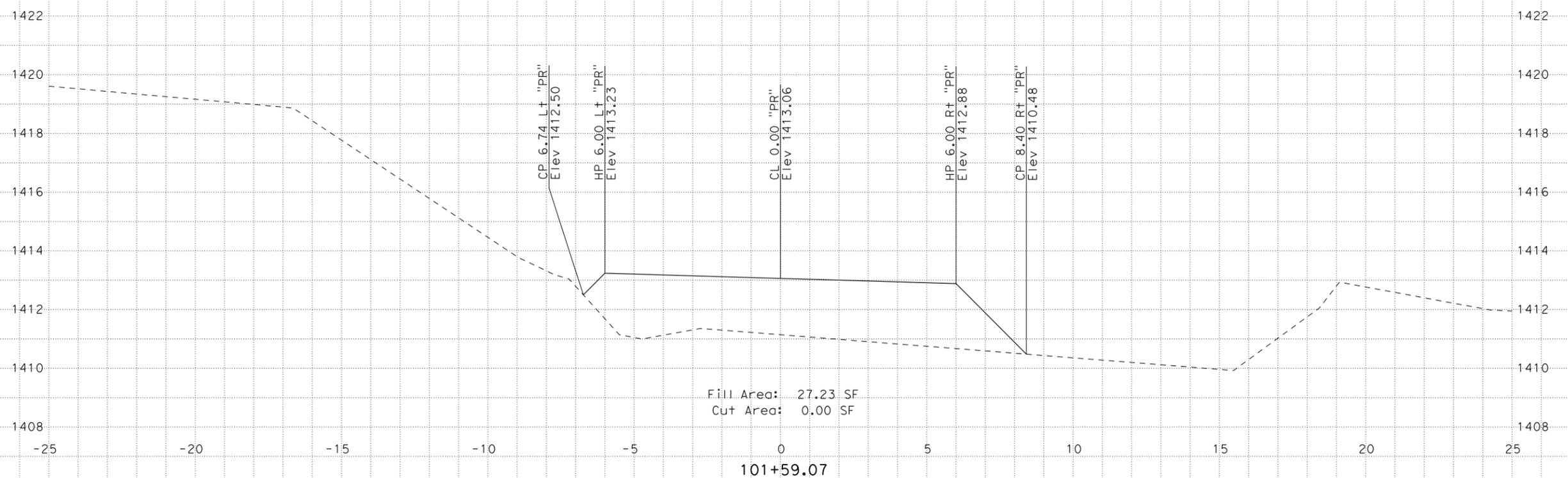
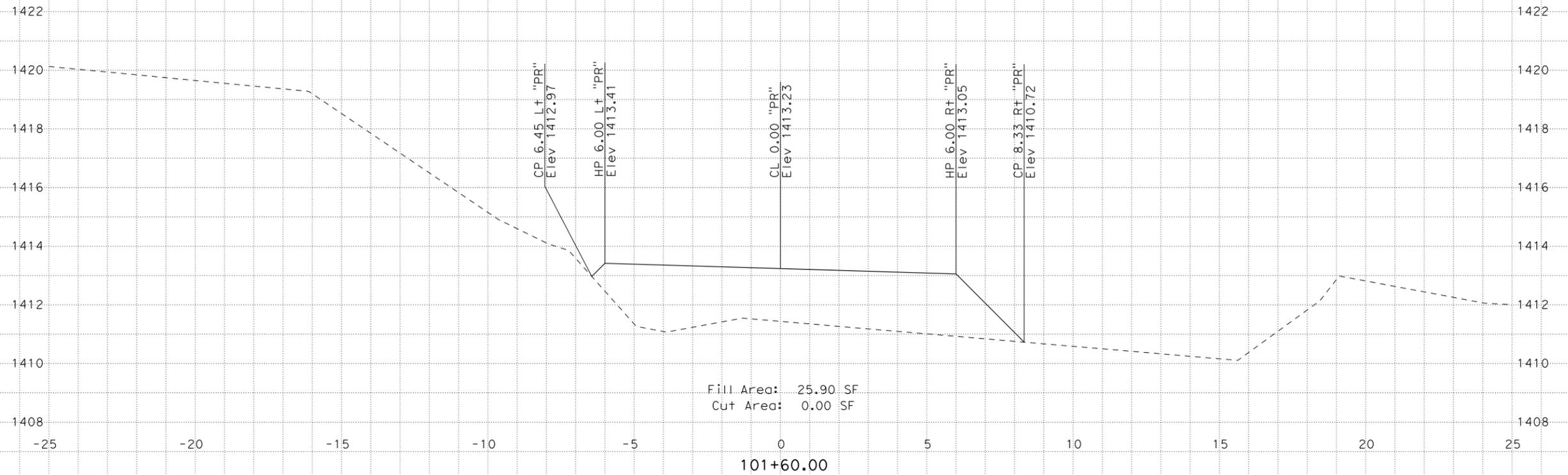
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 14 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

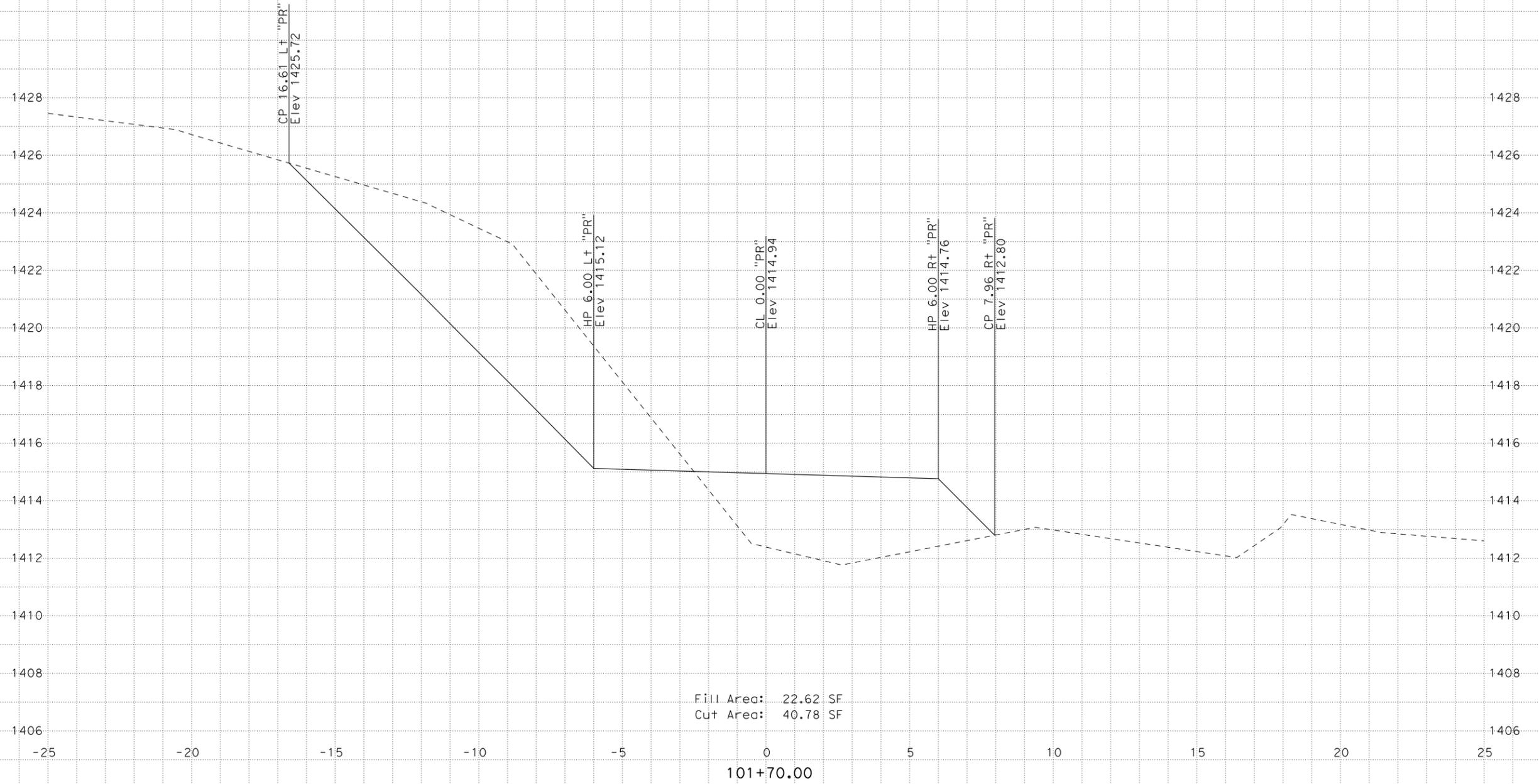
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 15 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

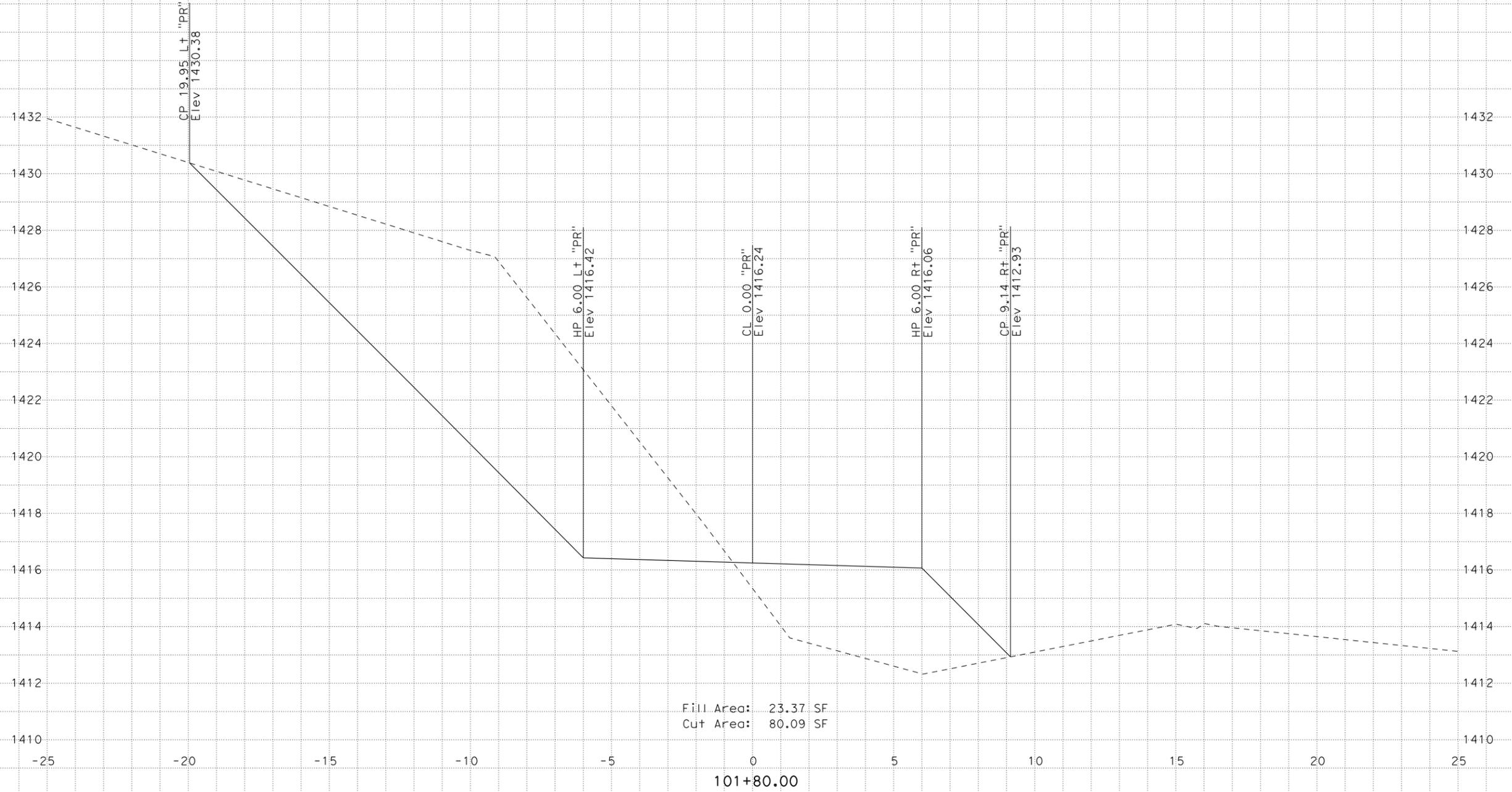
EA: 0L701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 16 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

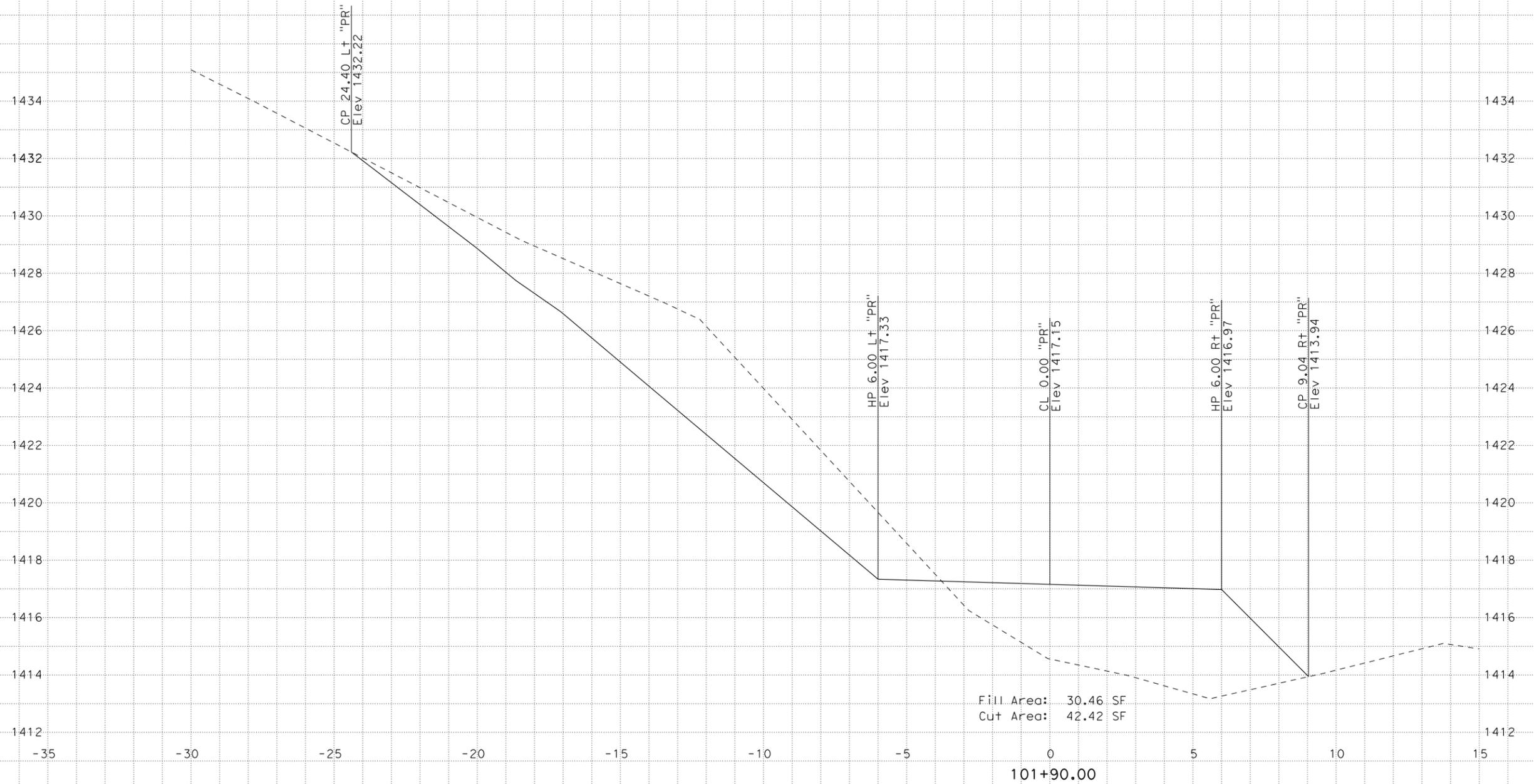
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 17 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

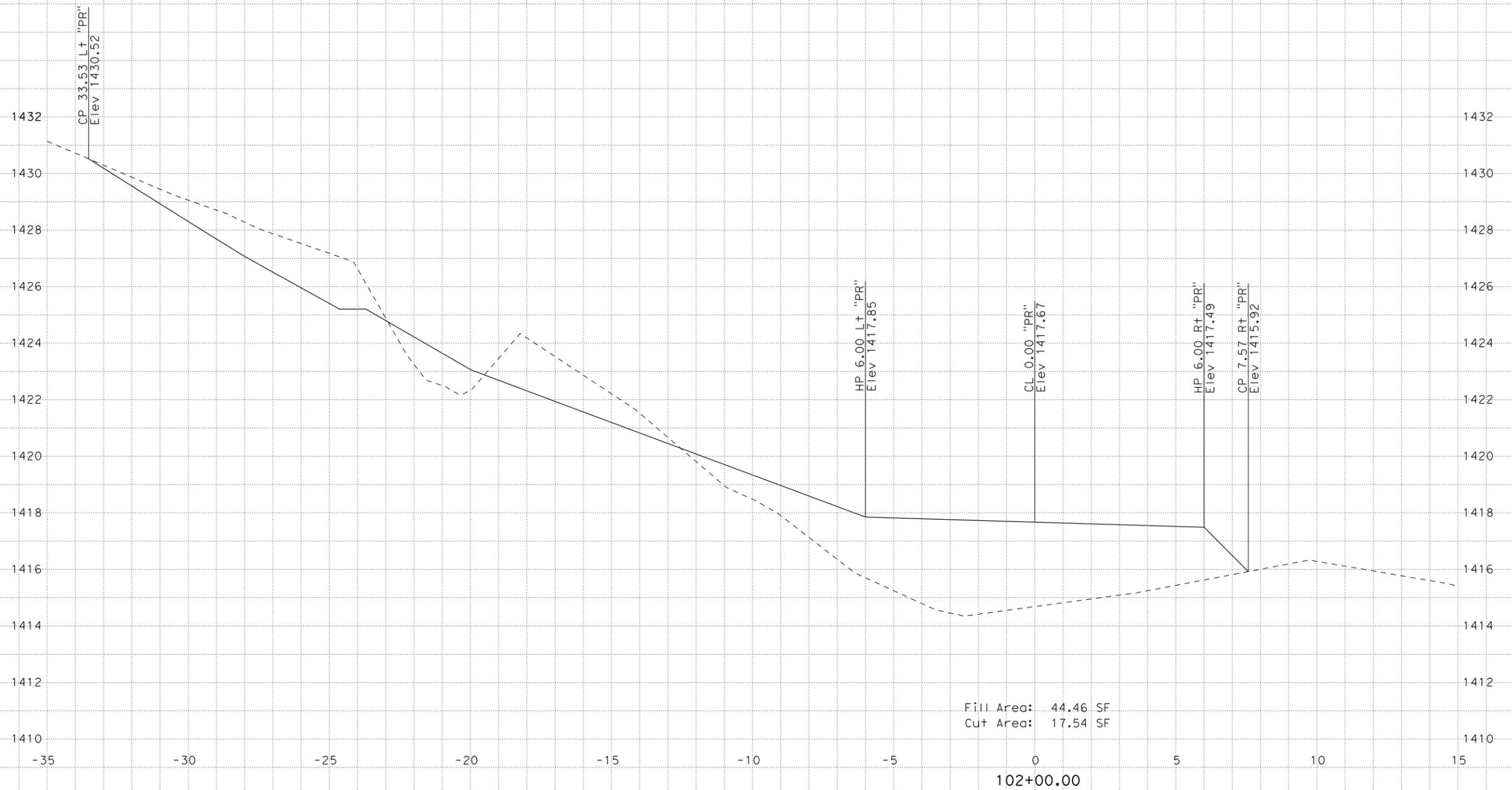
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 18 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

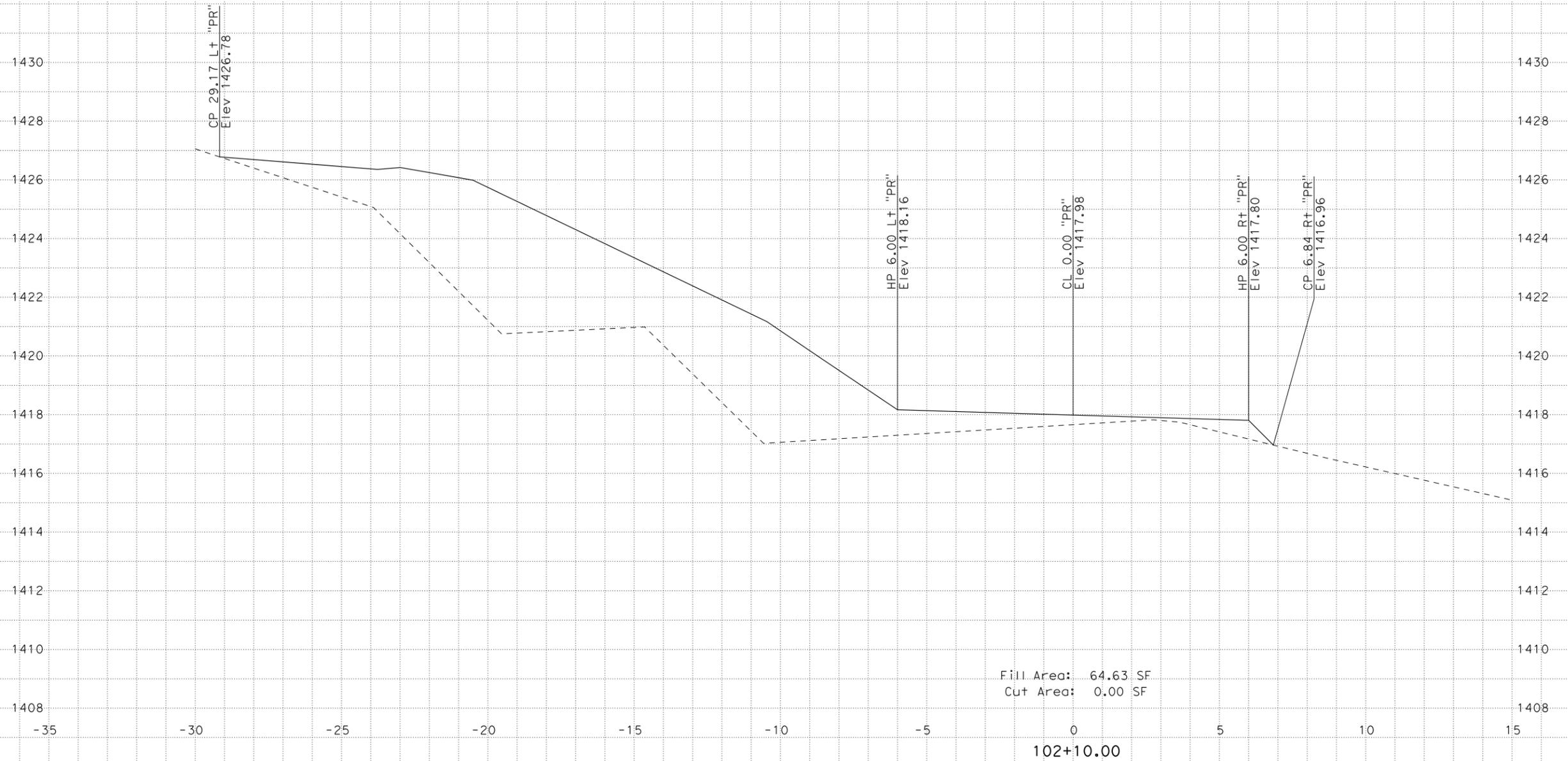
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 19 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

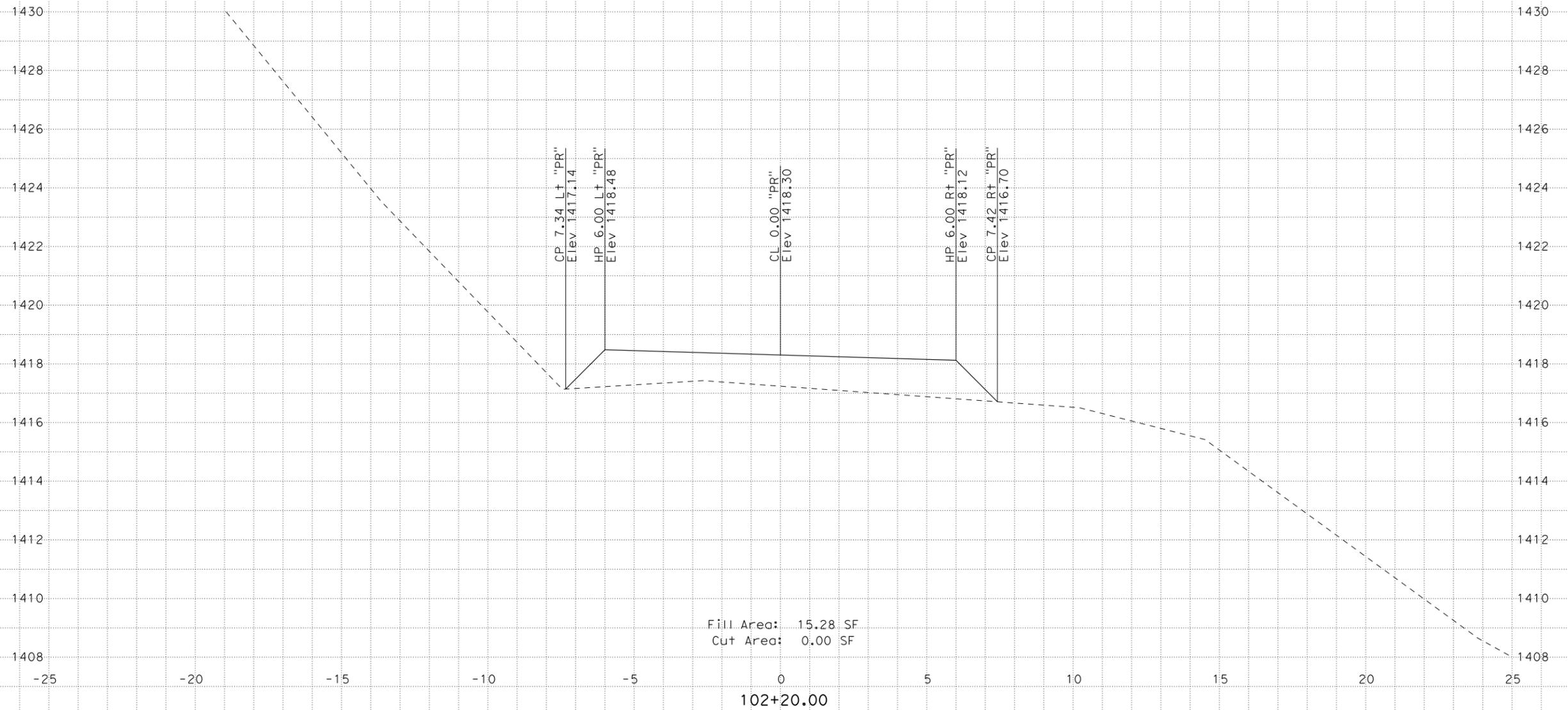
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 20 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

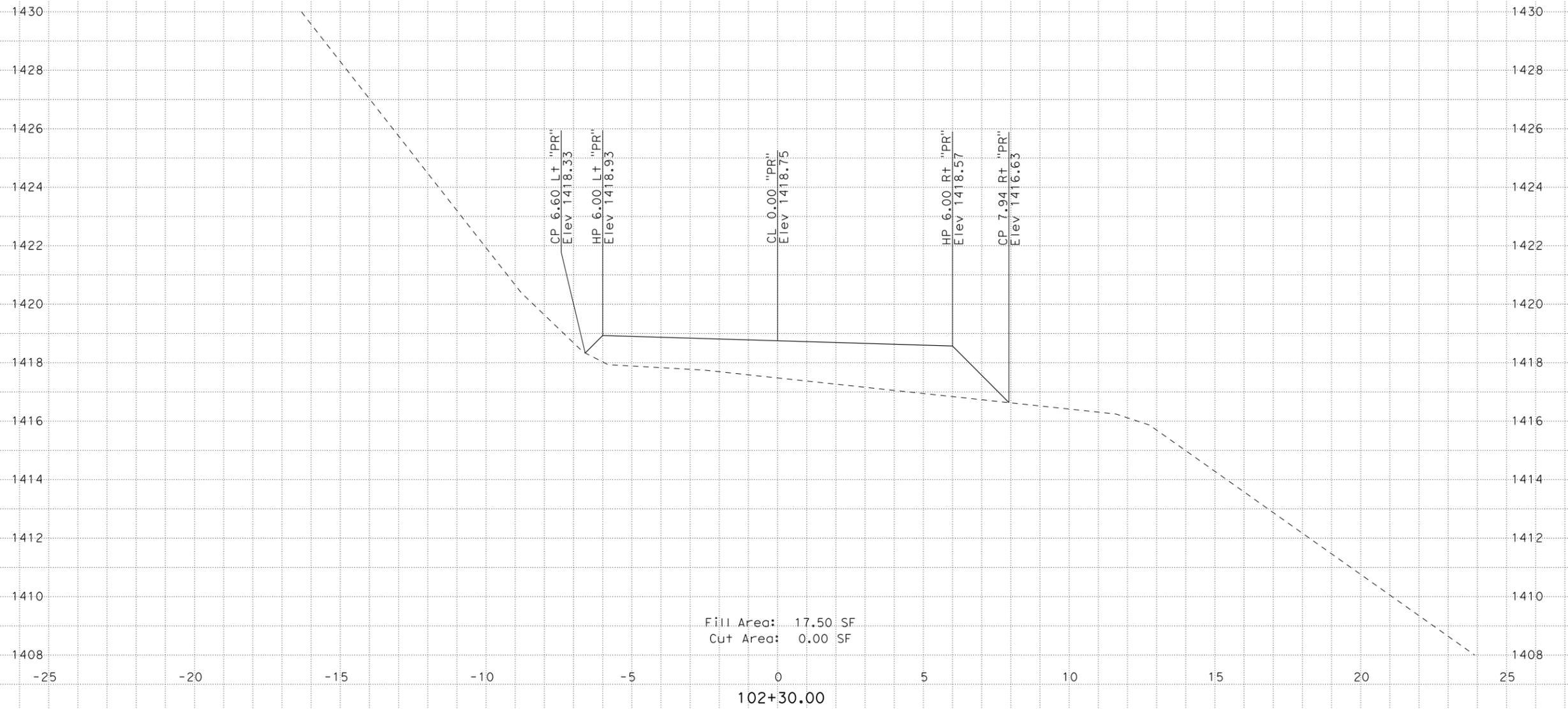
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 21 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

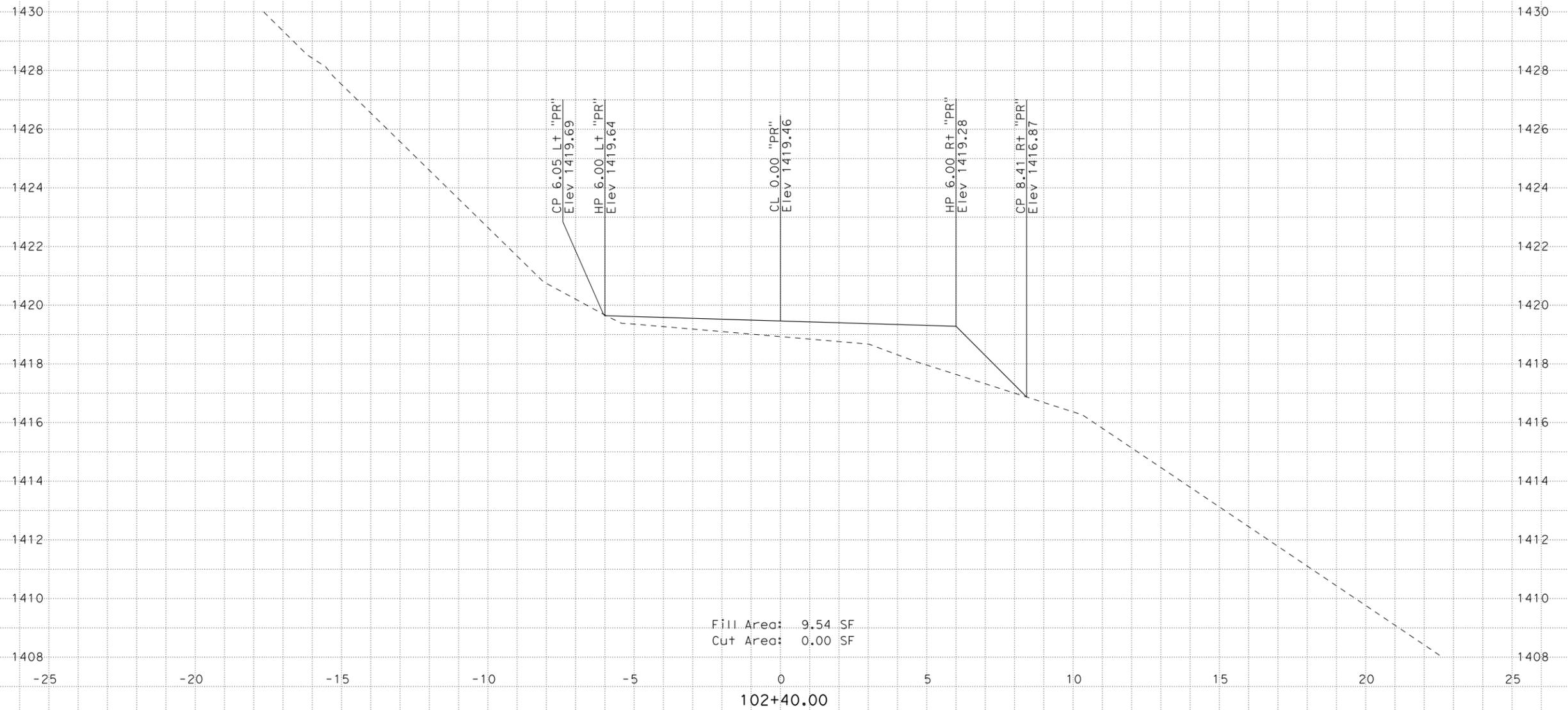
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 22 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

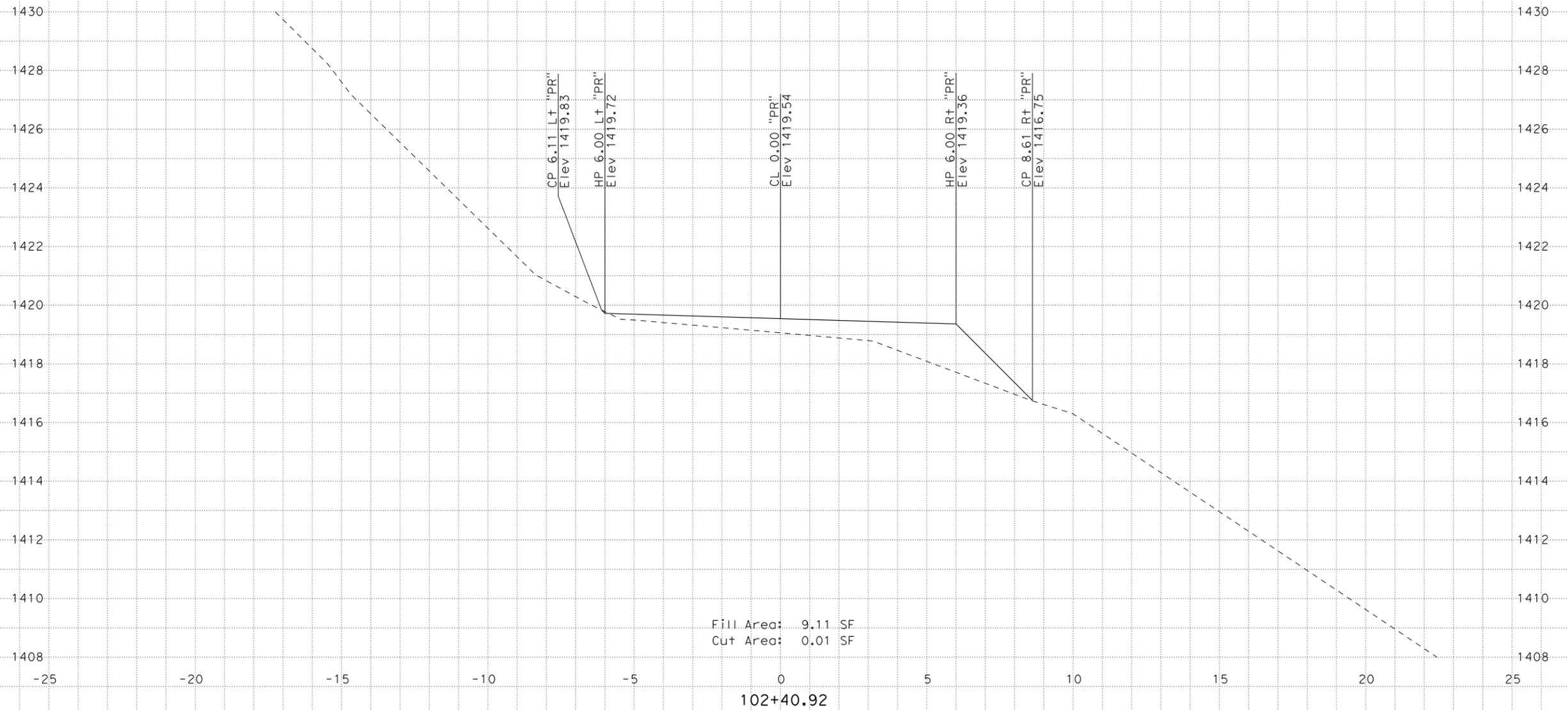
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 23 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

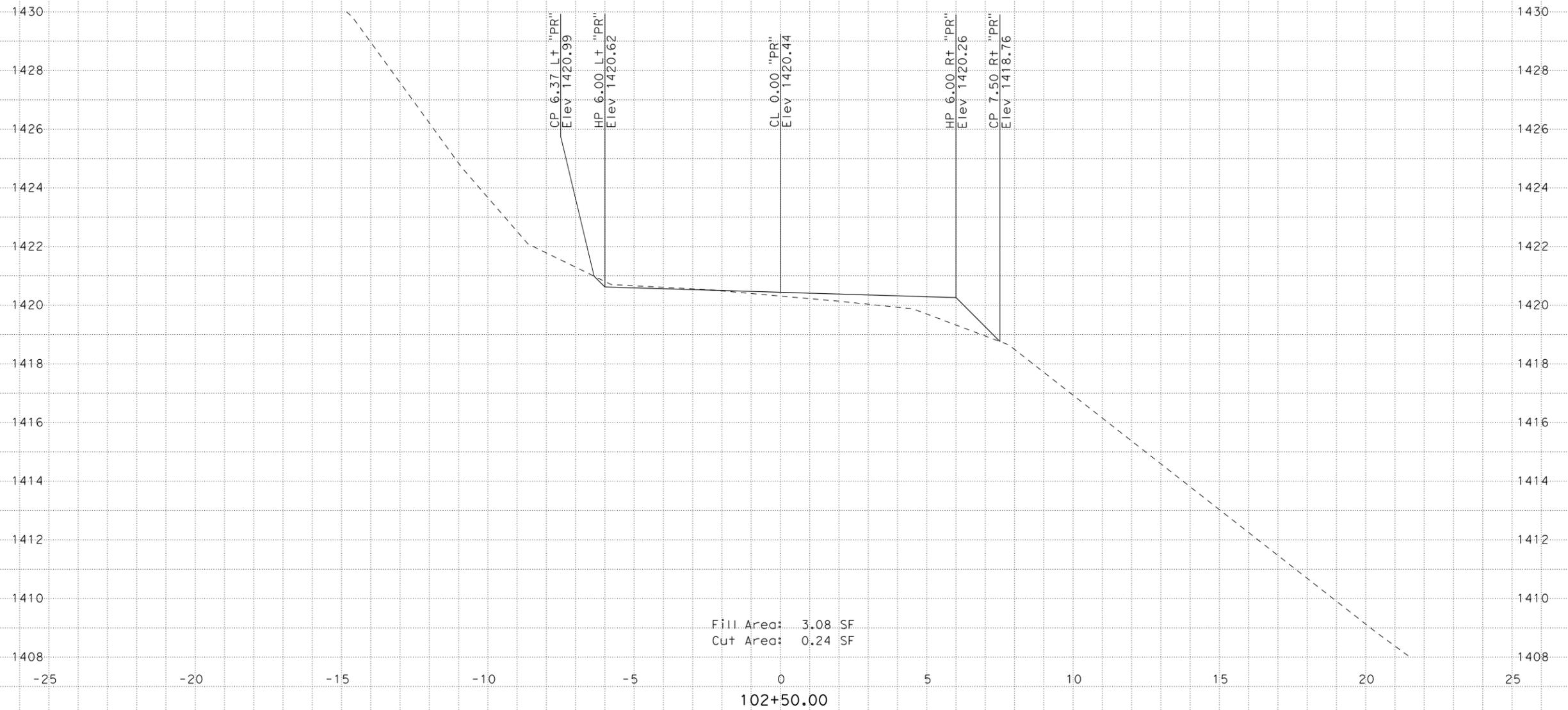
EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

SR 17 - LOCATION 22
PRIVATE DIRT ROAD
SHEET 24 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

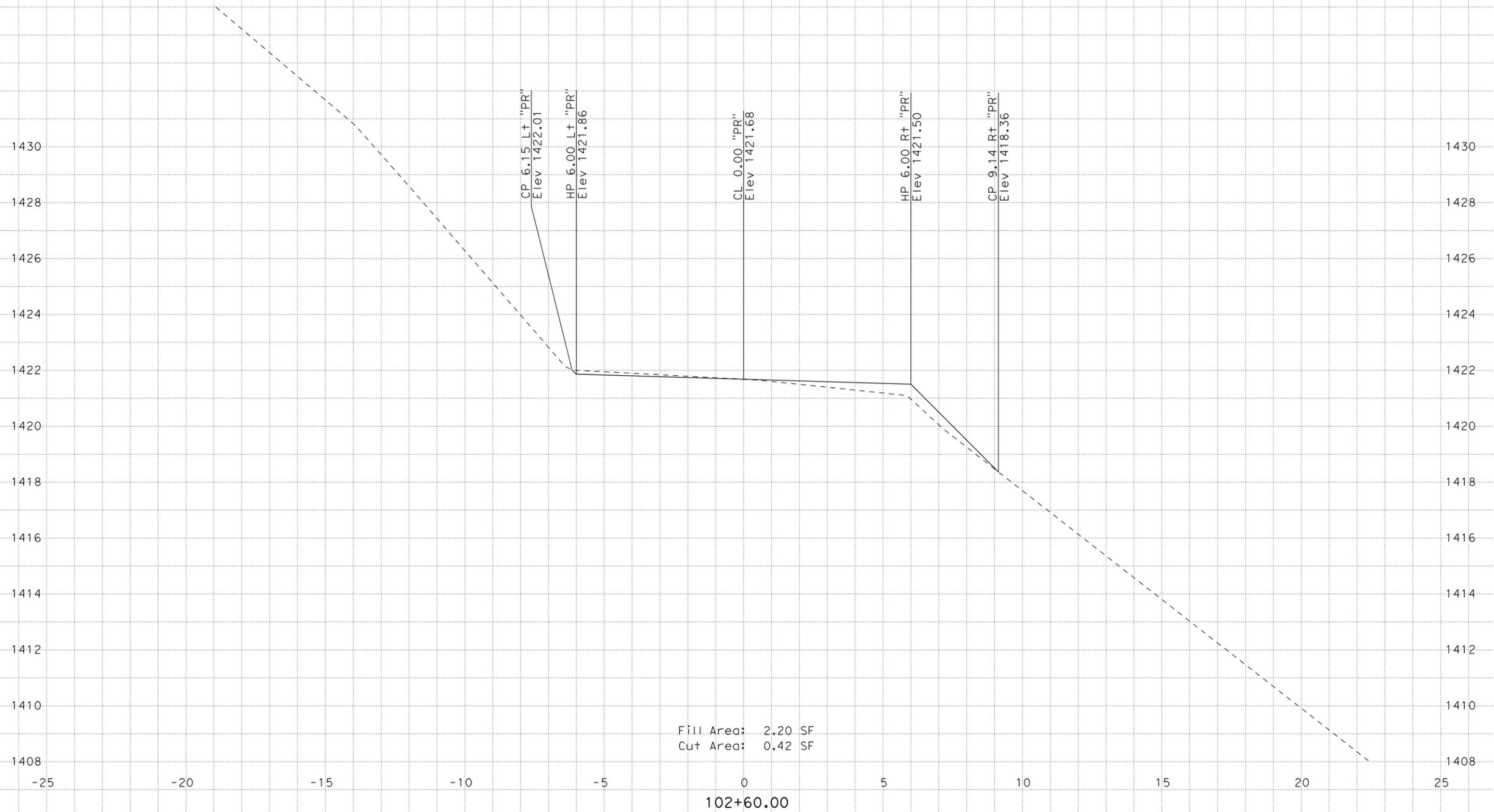
ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 25 OF 26

FOR EARTHWORK DEVELOPMENT ONLY



DATE: 12/19/2012

EA: OL701
05-Scr-RTE 17 PM8.9/PM9.9

ALL DIMENSIONS ARE ENGLISH

Scale Ratio: 1" = 20' Vert.
1" = 20' Horiz.

**SR 17 - LOCATION 22
PRIVATE DIRT ROAD**

SHEET 26 OF 26