# INFORMATION HANDOUT

**For Contract No. 05-1F8904**
**At Mon-1-28.0/28.4**

**Identified by**
**Project ID 0514000072**

## PERMITS

Coastal Development Permit

## MATERIALS INFORMATION

Revised Foundation Report for Cow Cliffs Viaduct dated October 9,2014

Manufacturer Drawings for Alternative In-Line Terminal Systems

Manufacturer/product information for Temporary Alternative Crash Cushion system

Detail for TAU-II Crash Cushion System

California Coastal Commission

# COASTAL DEVELOPMENT PERMIT

## CDP 3-14-1526 (Caltrans Cow Cliffs)

**Issue Date: November 17, 2014**



Coastal development permit (CDP) number 3-14-1526 was approved by the California Coastal Commission on November 13, 2014. CDP 3-14-1526 provides for construction of a 175-foot-long viaduct with 12-foot-wide lanes and 4-foot-wide shoulders and related improvements (including permanent rockfall netting on the inland side of the road) to stabilize Highway 1 at the site of an existing bluff failure (post miles 28.0 to 28.6) located north of Big Creek Bridge in Big Sur, Monterey County (all as more specifically described in the Commission's CDP file). CDP 3-14-1526 is subject to certain terms and conditions, including the standard and special conditions beginning on page 2 of this CDP.

By my signature below, the CDP is issued on behalf of the California Coastal Commission:

Susan Craig, Central Coastal District Manager, for Charles Lester, Executive Director

Acknowledgement

The undersigned Permittee acknowledges receipt of this coastal development permit and agrees to abide by all terms and conditions thereof. The undersigned Permittee acknowledges that Government Code Section 818.4 (which states in pertinent part that "a public entity is not liable for injury caused by the issuance of any permit") applies to the issuance of this coastal development permit.

Permittee: Authorized Caltrans Representative

Please note that this coastal development permit is not valid unless and until a copy of it with the signed acknowledgement has been returned to the California Coastal Commission's Central Coast District Office (14 Cal. Admin. Code Section 13158(a)).

## Standard Conditions

1. **Notice of Receipt and Acknowledgment.** The permit is not valid and development shall not commence until a copy of the permit, signed by the Permittee or authorized agent, acknowledging receipt of the permit and acceptance of the terms and conditions, is returned to the Commission office.

2. **Expiration.** If development has not commenced, the permit will expire two years from the date on which the Commission voted on the application. Development shall be pursued in a diligent manner and completed in a reasonable period of time. Application for extension of the permit must be made prior to the expiration date.

3. **Interpretation.** Any questions of intent or interpretation of any condition will be resolved by the Executive Director or the Commission.

4. **Assignment.** The permit may be assigned to any qualified person, provided assignee files with the Commission an affidavit accepting all terms and conditions of the permit.

5. **Terms and Conditions Run with the Land.** These terms and conditions shall be perpetual, and it is the intention of the Commission and the Permittee to bind all future owners and possessors of the subject property to the terms and conditions.

## Special Conditions

1. **Public Access/ Visual/Sand Supply Mitigation.** PRIOR TO COMMENCEMENT OF CONSTRUCTION, the Applicant shall submit two copies of a mitigation plan for Executive Director review and approval identifying the measures to be taken to implement the below mitigation requirements. Minor adjustments to these requirements may be allowed by the Executive Director if such adjustments: (1) are deemed reasonable and necessary; and (2) do not adversely impact coastal resources:

   a. **Big Creek Bridge Scenic Overlook Area and Pullout Access.** Publicly available vehicle parking areas on the seaward side of Highway 1 at the Big Creek Bridge Scenic Overlook pullout area (Pullout Area 2) shall be maintained for such use, and general public pedestrian access shall be provided and allowed at both the upcoast and downcoast ends of the Big Creek Bridge Scenic Overlook pullout area (as shown in Exhibit 3). One bench shall be installed at the downcoast end of the Big Creek Bridge Scenic Overlook area. The bench shall be rustic, and constructed of wood or rock masonry, and match the rugged character of the Big Sur area, and shall be installed in such a way as to limit visual impacts as seen from Highway 1 and maximize coastal and bridge views from the bench. Caltrans shall maintain the bench in a manner designed to facilitate public use of the bench, including replacing the bench if it becomes damaged or destroyed by natural or man-made causes. In addition, three to four large, flat-topped boulders appropriate for seating shall be installed along the outer perimeter of the upcoast portion of the Big Creek Bridge Scenic pullout area. Development that interferes with or hinders general public use of the Big Creek Bridge Scenic Overlook area and pullout shall be prohibited.

b. **Guardrail Minimization at Big Creek Bridge Scenic Overlook Area Pullout.** The project shall incorporate use of the "TAU II" crash cushion attenuator at the Big Creek Bridge Scenic Overlook pullout (Pullout Area 2 shown in Exhibit 3) in order to maximize public access and otherwise ensure continued vehicle and pedestrian access to this location. The design shall incorporate visual minimization features for the crash cushion attenuator consistent with the scenic pullout area, including appropriate treatment to darken and dull the finish of the device, and blend it with the surrounding environs to the maximum extent feasible.

c. **Recreational Improvements to Alternate Pullout Area (Pullout 3) Downcoast from Big Creek Bridge**. Three to four large, flat-topped boulders appropriate for seating shall be installed along the outer perimeter of the first ocean-side pullout area (Pullout Area 3 as shown in Exhibit 3) immediately downcoast of the Big Creek Bridge.

d. **ST-70 Railing.** All visual impact minimization measures identified in the project's Mitigated Negative Declaration (dated May 2014) and Scenic Resource Evaluation and Visual Analysis (dated April 3, 2014), including the use of ST-70 railing on the viaduct, shall be incorporated into the Project design.

e. **Undergrounding of Utilities.** The phone line identified in the project plans (Utility Plan, U-1 Exhibit 1) shall be relocated entirely underground at or near the current location of telephone pole 1 (identified on page 4 of Exhibit 3), telephone pole 2 (also identified on page 4 of Exhibit 3) shall be removed and telephone pole 1 shall be reduced in size to the maximum extent feasible.

2. **Construction Plan.** PRIOR TO COMMENCEMENT OF CONSTRUCTION, the Permittee shall submit two copies of a Construction Plan to the Executive Director for review and approval. Minor adjustments to these requirements may be allowed by the Executive Director if such adjustments: (1) are deemed reasonable and necessary; and (2) do not adversely impact coastal resources. The Construction Plan shall, at a minimum, include the following:

a. **Construction Areas.** The Construction Plan shall identify the specific location of all construction areas, all staging areas, and all construction access corridors in site plan view. All such areas within which construction activities and/or staging are to take place shall be minimized to the maximum extent feasible in order to have the least impact on public access and shoreline resources, including by using alternative areas for staging and storing construction equipment and materials as feasible.

b. **Construction Methods.** The Construction Plan shall specify the construction methods to be used, including all methods to be used to keep the construction areas separated from public (including bike and pedestrian) access through the construction area and public recreational use areas (including existing turnouts).

c. **Construction BMPs.** The Construction Plan shall specifically identify the type and location of all erosion control/water quality best management practices that will be implemented during construction to protect coastal water quality, including the following: (a) silt fences, straw wattles, or equivalent apparatus, shall be installed at the perimeter of the construction site to prevent construction-related runoff and/or sediment from discharging to the ocean; (b) equipment washing, refueling, and/or servicing shall take place at least 50 feet from the bluff edge. All construction equipment shall be inspected and maintained at an off-site location to prevent leaks and spills of hazardous materials at the project site; (c) the construction site shall maintain good construction housekeeping controls and procedures (e.g., clean up all leaks, drips, and other spills immediately; keep materials covered and out of the rain (including covering exposed piles of soil and wastes); dispose of all wastes properly, place trash receptacles on site for that purpose, and cover open trash receptacles during wet weather; remove all construction debris from the site); and (d) all erosion and sediment controls shall be in place prior to the commencement of construction as well as at the end of each work day.

d. **Construction Site Documents.** The Construction Plan shall provide that copies of the signed coastal development permit and the approved Construction Plan be maintained in a conspicuous location at the construction job site at all times, and that such copies are available for public review on request. All persons involved with the construction shall be briefed on the content and meaning of the coastal development permit and the approved Construction Plan, and the public review requirements applicable to them, prior to commencement of construction.

e. **Construction Coordinator.** The Construction Plan shall provide that a construction coordinator be designated to be contacted during construction should questions arise regarding the construction (in case of both regular inquiries and emergencies), and that their contact information (i.e., address, phone numbers, etc.) including, at a minimum, a telephone number that will be made available 24 hours a day for the duration of construction, is conspicuously posted at the job site where such contact information is readily visible from public viewing areas, along with indication that the construction coordinator should be contacted in the case of questions regarding the construction (in case of both regular inquiries and emergencies). The construction coordinator shall record the name, phone number, and nature of all complaints received regarding the construction, and shall investigate complaints and take remedial action, if necessary, within 24 hours of receipt of the complaint or inquiry.

f. **Notification.** The Permittee shall notify planning staff of the Coastal Commission's Central Coast District Office at least three working days in advance of commencement of construction, and immediately upon completion of construction.

3. **Final Water Pollution Control Plan.** PRIOR TO COMMENCEMENT OF CONSTRUCTION, the Applicant shall submit two sets of a final Water Pollution Control Plan (WPCP) to the Executive Director for review and approval. Minor adjustments to the following requirements may be allowed by the Executive Director if such adjustments: (1) are deemed reasonable and necessary; and (2) do not adversely impact coastal resources. The final WPCP shall include provisions for all of the following:

a. **Sedimentation Controlled.** Runoff from the project site shall not increase sedimentation in coastal waters post-construction. During construction, runoff from the project site shall not increase sedimentation in coastal waters beyond what is allowable under the final Water Quality Certification approved for the project by the Regional Water Quality Control Board.

b. **Pollutants Controlled.** Runoff from the project site shall not result in other pollutants entering coastal waters or wetlands during construction or post-construction.

c. **BMPs.** Best Management Practices (BMPs) shall be used to prevent the entry of polluted stormwater runoff into coastal waters and Big Creek during construction and post construction, including use of relevant BMPs as detailed in the current California Storm Water Quality Best Management Handbooks (http://www.cabmphandbooks.com).

d. **Spill Measures.** An on-site spill prevention and control response program, consisting of BMPs for the storage of clean-up materials, training, designation of responsible individuals, and reporting protocols to the appropriate public and emergency service agencies in the event of a spill, shall be implemented at the project to capture and cleanup any accidental or other releases of oil, grease, fuels, lubricants, or other hazardous materials, including to avoid them entering coastal waters or wetlands.

e. **BMP Schedule.** A schedule for installation and maintenance of appropriate construction source-control BMPs to prevent entry of stormwater runoff into the construction site and to prevent excavated materials from entering runoff leaving the construction site.

All requirements above and all requirements of the approved WPCP shall be enforceable components of this CDP. The Permittee shall undertake development in accordance with this condition and the approved WPCP.

4. **Future Monitoring and Maintenance.** This coastal development permit requires ongoing monitoring of the overall permitted viaduct structure and related improvements at this location (i.e., viaduct, railings, rockfall netting, soldier pile wall, drainage, and associated development), and authorizes future maintenance as described in this special condition. The Permittee acknowledges and agrees on behalf of Caltrans and all successors and assigns that: (a) it is Caltrans' responsibility to maintain the permitted viaduct structure and related improvements in a structurally sound manner and in its approved state; (b) it is Caltrans' responsibility to retrieve any failing portion of the permitted structure or related improvements that might otherwise substantially impair the aesthetic qualities of the beach; and (c) it is Caltrans' responsibility to annually or more often inspect the overall permitted viaduct structure and related improvements for signs of failure and/or displaced structural components. Any such maintenance-oriented development associated with the overall permitted viaduct structure and improvements shall be subject to the following:

a. **Maintenance.** "Maintenance," as it is understood in this condition, means development that would otherwise require a coastal development permit whose purpose is to repair and/or maintain the overall permitted viaduct structure and rockfall netting and make improvements to their approved configuration, including retrieval of any project components that may be displaced from

the approved design. Any proposed modifications to the approved as-built plans or required construction BMPs associated with any maintenance event shall be reported to planning staff of the Coastal Commission's Central Coast District Office with the maintenance notification (described below), and such changes shall require a coastal development permit amendment unless the Executive Director determined that an amendment is not legally required.

b. **Other Agency Approvals**. The Permittee acknowledges that these maintenance stipulations do not obviate the need to obtain permits from other agencies for any future maintenance and/or repair episodes.

c. **Maintenance Notification**. Prior to commencing any maintenance event, the Permittee shall notify planning staff of the Coastal Commission's Central Coast District Office, in writing, regarding the proposed maintenance. Except for necessary emergency interventions, such notice shall be given by first-class mail at least two weeks in advance of commencement of work. The notification shall include a detailed description of the maintenance event proposed, and shall include any plans, engineering and/or geology reports, proposed changes to the maintenance parameters, other agency authorizations, and other supporting documentation describing the maintenance event. The maintenance event shall not commence until the Permittee has been informed by planning staff of the Coastal Commission's Central Coast District Office that the maintenance event complies with this coastal development permit. If the Permittee has not received a response within 30 days of receipt of the notification by the Coastal Commission's Central Coast District Office, the maintenance event shall be authorized as if planning staff affirmatively indicated that the event complies with this coastal development permit. The notification shall clearly indicate that the maintenance event is proposed pursuant to this coastal development permit, and that the lack of a response to the notification within 30 days of its receipt constitutes approval of it as specified in the permit.

d. **Non-compliance Proviso**. If the Permittee is not in compliance with the conditions of this permit at the time that a maintenance event is proposed, then the maintenance event that might otherwise be allowed by the terms of this future maintenance condition may not be allowed by this condition, subject to determination by the Executive Director.

e. **Emergency.** Nothing in this condition shall serve to waive any Permittee rights that may exist in cases of emergency pursuant to Coastal Act Section 30611, Coastal Act Section 30624, and Subchapter 4 of Chapter 5 of Title 14, Division 5.5, of the California Code of Regulations (Permits for Approval of Emergency Work).

f. **Duration of Covered Maintenance.** Future maintenance under this coastal development permit is allowed subject to the above terms for TEN YEARS FROM THE DATE OF PERMIT ISSUANCE. Maintenance can be carried out beyond the ten-year period if the Executive Director extends the maintenance term in writing. The intent of this permit is to regularly allow for ten-year extensions of the maintenance term unless there are changed circumstances that may affect

the consistency of this maintenance authorization with the policies of Chapter 3 of the Coastal Act and thus warrant a re-review of this permit.

**5. As-Built Plans.** WITHIN THREE MONTHS OF COMPLETION OF CONSTRUCTION, the Permittee shall submit two copies of As-Built Plans for Executive Director review and approval showing all development authorized by this coastal development permit; all property lines; and all highway elements. The As-Built Plans shall be substantially consistent with the submitted project plans (dated received in the Coastal Commission's Central Coast District Office on August 18, 2014). The As-Built Plans shall include color photographs (in hard copy and jpg format) that clearly show the as-built project, and that are accompanied by a site plan that notes the location of each photographic viewpoint and the date and time of each photograph. At a minimum, the photographs shall be from upcoast, seaward, and downcoast viewpoints, seen from the edge of the highway and from a sufficient number of viewpoints as to provide complete photographic coverage of the permitted viaduct and related structures at this location (i.e., viaduct, railings, rockfall netting, soldier pile wall, drainage, and associated development). Such photographs shall be at a scale that allows comparisons to be made with the naked eye between photographs taken in different years and from the same vantage points; recordation of GPS coordinates would be desirable for this purpose. The As-Built Plans shall be submitted with certification by a licensed civil engineer with experience in coastal structures and processes, acceptable to the Executive Director, verifying that the armoring has been constructed in conformance with the submitted project plans.

**6. Environmentally Sensitive Habitat Area.** The project shall incorporate and comply with all avoidance and minimization measures for biological impacts identified in the "Programmatic Biological Opinion for Highway 1 Management Activities that Affect Smith's Blue Butterfly (1-8-07-F-68)," the "Natural Environmental Study" (dated April 2014) and the MND.

**7. Assumption of Risk, Waiver of Liability and Indemnity**. By acceptance of this permit, the Permittee acknowledges and agrees, on behalf of itself and all successors and assigns: (i) that the site is subject to hazards from episodic and long-term shoreline retreat and coastal erosion, high seas, ocean waves, storms, tsunami, tidal scour, coastal flooding, and the interaction of same; (ii) to assume the risks to the Permittee and the property that is the subject of this permit of injury and damage from such hazards in connection with this permitted development; (iii) to unconditionally waive any claim of damage or liability against the Commission, its officers, agents, and employees for injury or damage from such hazards; and (iv) to indemnify and hold harmless the Commission, its officers, agents, and employees with respect to the Commission's approval of the project against any and all liability, claims, demands, damages, costs (including costs and fees incurred in defense of such claims due to such hazards), expenses, and amounts paid in settlement arising from any injury or damage.

# M e m o r a n d u m

***Serious Drought***
***Help Save Water***

**To:** GARY BLAKESLEY
Branch Chief
Division of Engineering Services, Structure Design
Office of Bridge Design – Central, Branch 6

**Attn:** Hernan Perez
Project Engineer

**Date:** October 9, 2014

**File:** 05-MON-1-28.28
Project ID: 0514000072
EA 05-1F8901
Cow Cliffs Viaduct
Bridge No. 44-0296

**From:** **DEPARTMENT OF TRANSPORTATION**
**DIVISION OF ENGINEERING SERVICES**
**GEOTECHNICAL SERVICES**

**Subject:** **REVISED FOUNDATION REPORT FOR COW CLIFFS VIADUCT**

As a result of discussions with the Structure Project Engineer and the Specifications Engineer, a revised Foundation Report (FR) is provided for the Cow Cliffs Viaduct, a proposed new structure on Route 1 in Monterey County at post mile 28.28. This report supersedes all previous versions of the Foundation Report for Cow Cliffs Viaduct. The recommendations presented herein are based on reviews of published data, site reconnaissance, subsurface investigations, and laboratory testing. The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to recommend design and construction criteria for the foundations of the bridge. This report also establishes a geotechnical baseline to be used in assessing the existence and scope of differing site conditions.

## Existing Facilities and Proposed Improvements

Within Monterey County, Route 1 is a north-south highway that follows the coastline of the Pacific Ocean. The highway is classified as a conventional two-lane highway within the project limits. Route 1 in this area was originally constructed in the 1930's. It has been subject to regular closures during its history due to landslides and rockfall events. Within the project limits the roadway varies in width between 22 feet and 24 feet, with 11-foot lanes and 0-foot to 2-foot outside shoulders. The surrounding terrain is mountainous, and highway side slopes are steep. Cut slopes along the easterly side of the highway and fill slopes along the westerly side vary from nearly vertical to 1:1. A flexible rockfall fence, installed in 2002, parallels the highway along a portion of the easterly edge of pavement. Guardrail and temporary railing protect vehicles from the steep slopes along the west edge of the roadway. Big Creek and Big Creek Bridge are within the southern portion of this project.

It is proposed to construct a full-width sidehill viaduct to address narrowing of the southbound travel lane and a dip in the profile grade due to loss of highway embankment along the westerly side of the roadway. The viaduct will include two 12-foot lanes and two 4-foot shoulders.

The loss of embankment appears to be the result of a combination of ocean wave action washing away the toe of the slope, and percolating rain water piping soil from beneath the roadway and eroding the side slope. Due to concerns that the southbound lane could be lost to a catastrophic failure of the highway embankment, the lane has been closed to traffic, and will remain so until the viaduct is constructed. Currently, northbound and southbound traffic share the existing northbound lane by way of a temporary traffic signal installed in December 2013 under an Emergency Opening (EO) contract. Temporary concrete railing was also placed to keep traffic off of the failing portion of the southbound lane. The existing flexible rockfall fence was extended to the south under the EO contract to protect vehicles stopped at the temporary signal from falling rock.

The loss of highway embankment along this stretch of roadway appears to be episodic rather than continuous. Erosion rates have been estimated based on reviews of rainfall records and inspection of recent and historical photographs of the site. The roadway cross section in the project area initially included a continuous dirt shoulder, approximately 20 feet wide, along approximately 300 feet of its westerly side, beginning about 200 feet northwest of the Big Creek Bridge. The highway embankment appears to have been relatively stable up to 1982. Then, during the 1982/1983 "El Nino" storms approximately 6 foot of embankment was lost along the middle third of its length. From 1983 to 1997 embankment loss was minimal. Again, during 1997/1998 "El Nino" storms, another approximately 6 feet of embankment was lost. By then the hinge point of the embankment slope was 8 feet away from the edge of traveled way. Embankment loss was minimal from 1998 to 2005, but between 2005 and 2011 three episodes of high rainfall resulted in the loss of 5 additional feet of embankment. The highway embankment is presently in an over steepened condition, and arcuate cracks have developed in the roadway pavement. The apex of the erosion scarp is now approximately 2.5 feet from the edge of traveled way.

The following datums were used to reference horizontal and vertical positions of the proposed structures:

- Horizontal: North American Datum of 1983 (NAD83(92))
- Vertical: North American Vertical Datum of 1988 (NAVD88)

**Pertinent Reports and Investigations**

The following references were used to assist in the assessment of site conditions:

1. *Caltrans ARS Online (v2.3.06).*

2. *Caltrans Seismic Design Criteria, Version 1.7,* April 2013.

3. *Geologic Map of Monterey County, California*, Compiled by Lew Rosenberg.

4. *Geotechnical Summary Report, Caltrans Phase II Seismic Retrofit, Arch Bridge Over Big Creek,* Buckland & Taylor, LTD, January 1998.

## Field Investigation and Testing Program

Ten geotechnical borings were performed to support foundation design recommendations for the proposed viaduct. The maximum depth of investigation was approximately 80 feet. Seven of the borings were completed by a contract driller. The remaining three borings were performed by State forces. The contract driller used an "ODEX" air-rotary casing hammer to penetrate the existing rock fill. Bedrock was then cored using mud-rotary tooling. The State drillers used mud-rotary equipment exclusively. Soil and rock samples from all of the borings were visually classified in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (June 2010).

**Table 1: 2014 Drilling Summary**

| Boring No. | Completion Date | Drill Rig Model | Hammer Type | Hammer Efficiency (%) | Location | | Ground Surface Elevation (ft) | Boring Depth (ft) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Station ("CL" Line) | Offset | | |
| R-14-001 | 3/19/2014 | Mobile B-53 | N/A | N/A | 16+11 | 21' Lt. | 127.8 | 60.0 |
| R-14-002 | 3/21/2014 | Mobile B-53 | N/A | N/A | 15+59 | 3' Lt. | 127.0 | 46.3 |
| R-14-003 | 3/26/2014 | Mobile B-53 | N/A | N/A | 14+84 | 4' Lt. | 124.9 | 60.8 |
| R-14-004 | 3/28/2014 | Mobile B-53 | N/A | N/A | 14+36 | On "CL1" | 123.4 | 60.0 |
| R-14-005 | 4/1/2014 | Mobile B-53 | N/A | N/A | 15+58 | 1' Lt. | 126.9 | 62.5 |
| R-14-006 | 4/3/2014 | Mobile B-53 | N/A | N/A | 16+17 | 12' Rt. | 127.9 | 50.0 |
| R-14-007* | 4/8/2014 | Mobile B-53 | N/A | N/A | 14+35 | 16' Rt. | 124.0 | 39.3 |
| R-14-008 | 5/7/2014 | CS-2000 | N/A | N/A | 14+24 | 15' Rt. | 123.7 | 80.0 |
| R-14-009 | 5/8/2014 | CS-2000 | N/A | N/A | 14+74 | 15' Rt. | 124.7 | 80.0 |
| R-14-010 | 5/15/2014 | CS-2000 | N/A | N/A | 15+59 | 16' Rt. | 126.7 | 79.7 |

*Boring R-14-007 was abandoned due to lack of recovery of core. It is not reported on the LOTB.

## Laboratory Testing Program

Unconfined compressive strength (UCS**)** testing w**as** performed at the Headquarters Geotechnical Laboratory on rock cores collected during the subsurface investigation. Test results are summarized in Table 2. UCS values are not representative of the entire geologic unit; only the hardest and least fractured blocks were suitable for testing. Test results are provided to inform contractors of the

potential strength of the rock and ensure that excavation equipment and methods are suitable for the rock conditions.

**Table 2: Rock Unconfined Compressive Strength**

| Boring | Depth (ft) | Elevation (ft) | UCS (psi) |
|---|---|---|---|
| R-14-001 | 34.4-35.1 | 93.4-92.7 | 1479 |
| R-14-001 | 45.4-45.9 | 82.4-81.9 | 5087 |
| R-14-001 | 57.5-58.0 | 70.3-69.8 | 8362 |
| R-14-003 | 52.0-52.6 | 72.9-72.3 | 6644 |
| R-14-004 | 46.0-47.0 | 77.4-76.4 | 9789 |
| R-14-006 | 20.0-21.5 | 107.9-106.4 | 8735 |
| R-14-006 | 48.6-49.5 | 79.3-78.4 | 4655 |
| R-14-010 | 39.1-40.0 | 87.6-86.7 | 2581 |

## Site Conditions

*Topography, Geology, and Subsurface Conditions*

The project area is located along the Pacific coast. The area is characterized by rugged, steep terrain with steeply incised drainages and narrow crested ridges.

The major drainage feature in the vicinity of the project is Big Creek Canyon which lies just south of the proposed viaduct. Big Creek flows year round and drains directly to the Pacific Ocean.

The project site lies within the Coast Ranges Geomorphic Province which extends south to the Santa Ynez River and north to the northern border of California. The Coast Ranges Geomorphic Province is characterized by northwest-southeast trending mountains and valleys, controlled by the San Andreas Fault Zone, a dextral-strike slip fault extending over 600 miles through the Coast Ranges. The San Andreas Fault Zone represents the boundary between the North America and Pacific tectonic plates. Plate motion along the San Andreas Fault Zone is transferred across a system of en echelon faults ranging in motion from strike-slip to reverse or thrust faulting. In the Central Coast region, the largely strike-slip movement has juxtaposed exotic "slivers" of rock of contrasting lithologic origin along smaller fractures within the Sur Fault Zone during the Late Cretaceous (70 million years ago) and Oligocene (30 million years ago) periods. In the project vicinity, the basement rock is divided between the Salinian Block to the east and the Nacimiento Block to the west. Intrusive and high temperature metamorphic rocks of the Coast Ridge Belt (part of the Salinian Block) form the basement rocks east of the Sur Fault. The Nacimiento Block, on the western side of the Fault, is mostly underlain by Franciscan Complex metavolcanic and metasedimentary rocks. The basement rocks of these exotic terrains are overlain unconformably by Quaternary landslide and marine terrace deposits.

The project site is locally underlain by up to 20-feet of fill composed of native Franciscan Complex cobbles and boulders in a matrix of well-graded gravel with silt and sand. The matrix material is assumed to be loose based on the abundance of large diameter rock, caving of geotechnical borings, and rapid loss of fluid circulation during drilling. The fill material overlies retrogressively eroding, intensely sheared Franciscan Complex Rocks ($KJ_{fv}$) which mostly includes metabasite (greenstone) and metagraywacke/metasiltstone, juxtaposed by moderately (40 to 60-degree) to steeply (80 degree to near-vertical) plunging shears. Metagraywacke/metasiltstone is not exposed on the surface, and is found only in minor quantity at depth within the limits of the geotechnical investigation. Strong foliation, sub-parallel to observed shear surfaces, appears most dominant in the metabasite, but occurs within the sheared-in blocks of metagraywacke as well. The highest intensity of shearing was observed in the vicinity of the proposed southerly abutment (near boring R-14-008), where shearing along foliation has reduced fresh to moderately weathered rock to coarse sand. Geotechnical borings to the north, on both sides of the roadway, exposed intensely fractured rock (negligible RQD), although blockier than rock observed in boring R-14-008.

Colluvial debris ($Q_{ls}$) occurs largely at the angle of repose on the slopes above and below the highway in the project area. Differential erosion of the more susceptible zones of very intense shearing has exposed large, vertical to overhanging fractured blocks upslope, which have generated large rock fall (up to several feet in diameter) over the years. Raveling of intensely sheared rock has produced a thin covering (<3-ft) of $Q_{ls}$ near the edge of the northbound shoulder, and thicker (<6-ft) near the bottom of slope below the highway. Ephemeral drainage has traveled along the fill-bedrock contact and has incised the $Q_{ls}$ unit near the toe.

*Climate*

The climate in the project area is mild, with average summer temperatures in the 60's (Fahrenheit) and average winter temperatures in the 50's. The area typically receives heavy rains in the winter months amounting to 30 to 40 inches annually.

*Groundwater*

Groundwater was not measured during the 2014 subsurface investigation. Groundwater measurements during the subsurface investigation for the seismic retrofit of the nearby Big Creek Bridge suggest that the perennial groundwater table lies at approximately the elevation of Big Creek, one to two feet above sea level. Seasonal perched groundwater may periodically accumulate in the fractures of the weathered bedrock. Seasonal springs have been observed exiting the slope beneath the highway at the contact between the fill and bedrock.

**Scour Evaluation**

Scour is not an issue of concern in the project area because the proposed viaduct will not span moving water.

**Corrosion Evaluation**

Representative rock samples taken during the foundation investigation were tested for corrosion potential. The Department considers a site corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

- Chloride concentration is greater than or equal to 500 ppm
- Sulfate concentration is greater than or equal to 2000 ppm
- The pH is 5.5 or less

Since resistivity serves as an indicator parameter for the possible presence of soluble salts, tests for sulfate and chloride are usually not performed unless the resistivity of the soil is 1,000 ohm-cm or less.

**Table 3: Corrosion Test Summary**

| Boring | Depth | SIC Number | Minimum Resistivity (Ohm-Cm) | pH | Chloride Content (ppm) | Sulfate Content (ppm) |
|---|---|---|---|---|---|---|
| R-14-008 | 33'-34.5' | C440101 | 2569 | 8.33 | N/A | N/A |
| | 61.5'-62.5' | C440102 | 3961 | 8.6 | N/A | N/A |
| R-14-009 | 76.9'-78' | C440103 | 2772 | 8.32 | N/A | N/A |
| **Corrosive if:** | | | **≤ 1000** | **≤ 5.5** | **≥ 500** | **≥ 2000** |

Based on corrosion test results, the site is considered non-corrosive to foundation elements. However, because the project area is within 1000 feet of the Pacific Ocean, the site is considered corrosive to above-ground structural elements.

**Seismic Recommendations**

The project is located within a seismically active region of California. There are several earthquake faults in close proximity to the project area. Table 4 lists the active and potentially active faults in the project vicinity as described in Caltran's *2012 Fault Database*. Corresponding Moment Magnitudes and distances to the bridge site are also given. A fault map is included in the attachments to this report.

**Table 4: Active and Potentially Active Faults**

| *Fault* | *Moment Magnitude of Maximum Credible Earthquake*[1] | *Fault ID*[2] | *Type of Fault*[3] | *Distance to Fault from Project Area (kilometers)*[4] |
|---|---|---|---|---|
| San Gregorio Fault Zone (Sur Region Section - Sur Fault) | 7.4 | 178 | SS | 3.0 |
| San Gregorio Fault Zone (Sur Region Section – Palo Colorado Fault) | 7.4 | 190 | SS | 6.7 |
| Rinconada 2011 CFM | 7.4 | 209 | SS | 34.2 |
| San Andreas (Creeping Section) 2011 CFM | 7.9 | 182 | SS | 65.7 |

A design response spectrum for the project area was estimated using *Caltrans ARS Online (v2.3.06)*, a web-based tool that calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in Appendix B of *Caltrans Seismic Design Criteria*. The procedure used by ARS Online was developed to calculate the minimum seismic design requirements for bridges on State highways. The method calculates design response spectra over a range of periods. The design response spectrum is based on the envelope of a deterministic and a probabilistic spectrum. The deterministic spectrum is calculated as the arithmetic average of median response spectra computed using the Chiou & Youngs and Campbell & Bozorgnia ground motion prediction equations (CY-CB GMPE). These equations are applied to all faults in or near California considered to be active in the last 700,000 years (late Quaternary age) and capable of producing a moment magnitude earthquake of 6.0 or greater.

The probabilistic spectrum is obtained from the *2008 USGS Seismic Hazard Map* for the 5% in 50 years probability of exceedance (or 975 year return period). The spectral values are adjusted with a soil amplification factor based on an average of the Boore-Atkinson (2008), Campbell Bozorgnia (2008), and Chiou-Youngs (2008) ground motion prediction models. For sites underlain by soils having an average shear wave velocity for the upper 30 meters of soil ($V_{S30}$) of less than 300 meters per second, the *2009 USGS Probabilistic Seismic Hazard Analysis Interactive Deaggregation Tool* is used to develop the probabilistic spectrum.

[1] According to *Caltrans 2012 Fault Database*
[2] *Caltrans 2012 Fault Database* Identifier
[3] SS=strike-slip fault; R=reverse fault; N=normal fault
[4] Perpendicular distance to fault or fictitious extension of fault

The design ground motion for the Cow Cliffs Viaduct is governed by the deterministic method. A design response spectrum is provided in the attachments to this report. The design response spectrum was developed using soil amplification factors for a $V_{S30}$ of 760 meters per second. This shear wave velocity is an estimate, based on the rock type at the project site.

No known active or potentially active faults project towards or cross the highway alignment within the project limits. Therefore, the potential for surface fault rupture to occur is insignificant, and no mitigation efforts are necessary.

Soil liquefaction occurs when loose, water-saturated soils lose shear strength in response to the sudden shaking from an earthquake and begin behaving like a liquid, reducing their ability to support embankments and structures. Loose sands and gravels with 35 percent fines or less that lie below the groundwater table are susceptible to liquefaction. Generally, the younger and looser the sediment, and the shallower the water table, the more susceptible the soil is to liquefaction. Sediments most susceptible to liquefaction include historical and late Holocene age river channel and flood plain deposits, and poorly compacted fills. Bedrock and dense soils, including well-compacted fills have a low susceptibility to liquefaction. Liquefaction is most prevalent in areas where groundwater lies within 30 feet of the ground surface; liquefaction rarely occurs in areas with groundwater deeper than 50 feet.

Based on the prevalence of rock at shallow depths, the potential for liquefaction in the project area is considered to be low.

**Foundation Recommendations**

Construction of a viaduct and soldier pile retaining wall is recommended to restore the roadway to its full width. The viaduct is proposed to be founded on two-column bents with 48” diameter CIDH (Cast-In-Drilled-Hole) permanently cased concrete piles with 36” diameter uncased rock sockets below the permanent casing. The permanent casing will serve as column forms, and will provide a finished appearance to the concrete piles if the existing roadway embankment continues to erode. Abutments are to be supported on pile caps with (7) 24” diameter uncased CIDH concrete piles.

Axial loads on the piles were determined by Structure Design and presented to Geotechnical Design in Foundation Design Data Tables. Piles are assumed to obtain their axial resistance solely through side resistance in the uncased rock socket portion of the shaft. Geotechnical resistance of the permanent casing is not included in the axial or lateral design due to the potential loss of the roadway fill from future erosion. Unit skin friction values were estimated from a literature search of CIDH pile load test data, and values reported in *Geotechnical Summary Report, Caltrans Phase II Seismic Retrofit, Arch Bridge Over Big Creek* by Buckland & Taylor, LTD for “Class E” rock. The Buckland & Taylor report describes “Class E” rock as sheared mélange. The material was encountered during the subsurface investigation for the northerly abutment of Big Creek Bridge, and is assumed to be similar to the very intensely sheared Franciscan Complex metabasite encountered

in the southerly borings of the 2014 subsurface investigation. The resistance factors used in calculating the axial geotechnical capacity of the rock sockets for the Cow Cliffs Viaduct are as recommended in FHWA Publication GEC 010, *Drilled Shafts: Construction Procedures and LRFD Design Methods*.

Because the CIDH piles are designed to obtain their axial geotechnical resistance solely from skin friction, pile settlement is expected to be less than 0.4-inch. According to 2012 AASHTO LRFD Bridge Design Specifications, the axial compression load on a shaft socketed into rock is typically carried solely in side resistance until a total shaft settlement on the order of 0.4-inch occurs. Axial deformations greater that 0.4-inch begin to mobilize base resistance, and side resistance may be reduced to residual values, depending on the shearing behavior of the rock as either ductile or brittle. Theoretically the load on the CIDH piles for the subject viaduct will never exceed the ultimate side resistance of the shaft, so movement should be less than 0.4-inch.

Recommended pile tip elevations are provided in following tables:

**Table 5: Foundations Design Recommendations**

| Support Location | Pile Type | Cut-off Elevation (ft) | Service-I Limit State Load per Support (kips) | | Total Permissible Support Settlement (inches) | Required Nominal Resistance (kips) | | | | | | | | Design Tip Elevation[1,2] (ft) | Specified Tip Elevation[3] (ft) | Steel Casing Specified Tip Elevation[3] (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Strength/Construction Limit | | | | Extreme Event | | | | | | |
| | | | | | | Compression (φ=0.55) | | Tension (φ=0.40) | | Compression ( φ=1.0) | | Tension (φ=1.0) | | | | |
| | | | Total | Permanent | | Per Support | Max/ Pile | Per Support | Max/ Pile | Per Support | Max/ Pile | Per Support | Max/ Pile | | | |
| Abut. 1 | 24" CIDH | 114.25 | 700 | 450 | 1 | 950 | 200 | 0 | 0 | N/A | N/A | N/A | N/A | 94( a-I)<br>94 (c) | 94 | N/A |
| Bent 2 Lt | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 121.49 | 650 | 400 | 1 | 1050 | 1050 | 0 | 0 | 900 | 900 | 0 | 0 | 61 ( a-I)<br>80 ( a-II),<br>61 (c) | 61 | 104.00 |
| Bent 2 Rt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 119.96 | 650 | 400 | 1 | 1050 | 1050 | 0 | 0 | 900 | 900 | 0 | 0 | 62 ( a-I)<br>81 ( a-II),<br>62 (c) | 62 | 105.00 |
| Bent 3 Lt | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 123.93 | 650 | 400 | 1 | 1050 | 1050 | 0 | 0 | 900 | 900 | 0 | 0 | 64 ( a-I)<br>83 ( a-II),<br>64 (c) | 64 | 106.44 |
| Bent 3 Rt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 122.40 | 650 | 400 | 1 | 1050 | 1050 | 0 | 0 | 900 | 900 | 0 | 0 | 65 ( a-I)<br>84 ( a-II),<br>65 (c) | 65 | 107.44 |
| Abut. 4 | 24" CIDH | 120.25 | 700 | 450 | 1 | 950 | 200 | 0 | 0 | N/A | N/A | N/A | N/A | 92 ( a-I)<br>92 (c) | 92 | N/A |

*Notes:*

*1) Design tip elevations for Abutments are controlled by: (a-I) Compression (Strength Limit) and (c) Settlement.*

*2) Design tip elevations for Bents are controlled by: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), and (c) Settlement.*

*3) The specified tip elevation must not be raised or lowered.*

**Table 6: Pile Data Table**

| Support Location | Pile Type | Nominal Resistance (kips) | | Design Tip Elevation[1,2] (ft) | Specified Tip Elevation[3] (ft) | Permanent Steel Casing Specified Tip Elevation[3] (ft) | Required Nominal Driving Resistance (kips) |
|---|---|---|---|---|---|---|---|
| | | Compression | Tension | | | | |
| Abut. 1 | 24" CIDH | 370 | 0 | 94(a-I), 94(c) | 94 | N/A | N/A |
| Bent 2 Lt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 1910 | 0 | 61 ( a-I)<br>80 ( a-II),<br>61 (c) | 61 | 104.00 | N/A |
| Bent 2 Rt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 1910 | 0 | 62 ( a-I)<br>81 ( a-II),<br>62 (c) | 62 | 105.00 | N/A |
| Bent 3 Lt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 1910 | 0 | 64 ( a-I)<br>83 ( a-II),<br>64 (c) | 64 | 106.44 | N/A |
| Bent 3 Rt. | 48" CIDH w/ Permanent Steel Casing and 36" Rock Socket | 1910 | 0 | 65 ( a-I)<br>84 ( a-II),<br>65 (c) | 65 | 107.44 | N/A |
| Abut. 4 | 24" CIDH | 370 | 0 | 92 (a-I), 92(c) | 92 | N/A | N/A |

*Notes:*

*1) Design tip elevations for Abutments are controlled by: (a-I) Compression (Strength Limit) and (c) Settlement.*

*2) Design tip elevations for Bents are controlled by: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), and (c) Settlement.*

*3) The specified tip elevation must not be raised or lowered.*

The in situ rock should be treated as silt (cemented c-phi soil) for the purposes of conducting an L-pile analysis of the lateral capacity of the shafts. Strength parameters recommended for the analyses are as follows:

- $\Phi' = 36^{\circ}$
- Cohesion = 300 psf
- Effective Unit Weight = 120 pcf

Program default values for strain factor ($\varepsilon_{50}$) and the constant *k* should be utilized in the analysis.

Construction of a timber-lagged cantilevered soldier pile wall along the inside edge of the viaduct deck is recommended to act as temporary shoring for the excavation required to form and construct the viaduct bent caps and place girders, and to provide permanent retention of the soil between the existing cut slope and the edge of the viaduct deck. The maximum retained height of the wall will be approximately 10 feet at the bent cap excavations, and will decrease to approximately 7.5 feet between bent cap excavations. The wall will be free draining via gaps between lagging members. Filter fabric will be placed behind the timber lagging to prevent migration of soil through the gaps. The following material properties for the retained and resisting masses are recommended for design:

- $\Phi' = 34^{\circ}$ Cohesion = 0 psf Total Unit Weight = 120 pcf
- Active Pressure Coefficient $K_A = 0.28$
- Passive Pressure Coefficient $K_P=3.54$

The timber lagging should extend a minimum of 2 feet below finished grade. Soldier piles will consist of steel H-sections embedded in 30" diameter CIDH piles. Design pile tip elevations will be calculated by Structure Design and will be provided in the construction documents, in the pile data table. Cut slopes required for construction of the retaining wall and for bent caps excavations must be constructed at inclinations of 1.5:1 (horizontal : vertical) or flatter.

**Construction Considerations**

Difficult soil and rock drilling conditions were encountered in the geotechnical borings for the subsurface investigation and can be expected during the foundation excavations for the viaduct and retaining wall. Very hard cobbles and boulders in a loose matrix of gravel and sand were encountered in the fill overlying the bedrock. The gravel/sand matrix will not provide substantial resistance to movement of the cobbles and boulders while they are being drilled. Additionally, caving occurred during geotechnical drilling, and should be expected during foundation drilling.

Bedrock encountered beneath the fill consisted of very intensely to moderately fractured rock varying from very hard to very soft, and from fresh to moderately weathered. Near-vertical fracture orientation and weak, intensely sheared layers may cause caving into uncased portions of the drilled holes. The steeply inclined fractures in the bedrock made it difficult to maintain the plumbness of

the geotechnical borings; the drill bit path tended to follow the fracture orientation. Similar problems may be encountered during foundation drilling.

Rock can be anticipated for portions of the abutment footing excavations, and equipment must be available on site to remove the rock from those footing excavations.

Depending on the time of year of construction and the amount of rainfall received in the project area, perched groundwater may be encountered during foundation drilling operations. If groundwater flow into CIDH concrete pile excavations exceeds 12 inches per hour and/or more than 3 inches of water accumulates in the base of the excavation prior to concrete placement, the Contractor must propose and utilize a construction method that prevents development of an inward hydraulic gradient into the foundation excavation. One method of preventing inward hydraulic gradient is to maintain an offsetting higher hydrostatic pressure in the excavation with a drilling fluid. Inward hydraulic gradient results in inward seepage forces that can disturb the rock mass, reducing the available side resistance of the completed foundation.

Intermittent loss of drilling fluid circulation into the formation was experienced during the subsurface exploration due to the intensely fractured nature of the rock. Loss of drilling fluid into the formation may occur if drilling fluids are used to control groundwater or caving.

Permanent steel casings at Bents 2 and 3 are for constructability purposes and are not included in the structural or geotechnical design resistance. Permanent steel casing must be installed by placement in a drilled hole. Use of corrugated metal pipe (CMP) as casing is not permitted.

Even though the CIDH concrete piles are designed to obtain their geotechnical capacity in side résistance, the bottoms of drilled holes must be cleaned in accordance with Section 49-3.02C(2), “Drilled Holes,” of the Standard Specifications. The Contractor and the Engineer must verify that the bottoms of all drilled holes are cleaned before the Engineer approves placement of concrete.

When drilling for the 24” diameter CIDH concrete piling, a minimum of 24 hours or until the initial set of concrete occurs, whichever is longer, must elapse before drilling an adjacent 24” diameter CIDH concrete pile located within 3 pile diameters of the recently placed CIDH concrete pile.

The Contractor must notify the Engineer of intent to begin work 14 calendar days before the start of drilling/coring for the foundations. The Engineer or Engineer’s representative must be present during all CIDH concrete piling operations and casing installations. The Engineer will notify Geotechnical Design personnel of the planned schedule of operations.

Difficult excavation conditions can be expected during installation of the timber lagging of the soldier pile retaining wall. Removal of the boulders comprising much of the highway embankment may result in large voids behind the lagging. Additionally, caving may occur while excavating the

intensely sheared bedrock. Very hard rock may also be encountered while excavating for the lagging.

**Project Information**

Standard Special Provision 2-1.06B "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to the Addressee of this report via electronic mail.

*Data and information attached with the project plans are:*

A. Log of Test Borings (Cow Cliffs Viaduct, Bridge No. 44-0296).

*Data and information included in the Information Handout provided to the Bidders and Contractors are:*

A. Revised Foundation Report for Cow Cliffs Viaduct dated October 9, 2014.

*Data and information available for inspection at the District Office:*

A. Rock core from subsurface investigation.

**Closure**

The recommendations contained in this report are based on specific project information regarding structure type, location, and design loads that have been provided by Office of Bridge Design – Central, Branch 6. If any conceptual changes are made during final project design, the Office of Geotechnical Design – North, Branch D should review those changes to determine if the foundation recommendations contained in this report are still applicable. Any questions regarding the recommendations contained herein should be directed to the attention of Dan Appelbaum, (805) 549-3745, or Mike Finegan, (805) 549-3194, at the Office of Geotechnical Design – North, Branch D.


Supervised by,

DANIEL L. APPELBAUM, PE
Transportation Engineer
Geotechnical Design – North
Branch D

MICHAEL S. FINEGAN, PE, Chief
Geotechnical Design - North
Branch D

c: Roy Bibbens / GDN Records (E-copy)
Ken Dostalek – Project Manager (E-copy)
Lance Gorman – Maintenance Design Engineer (E-copy)
Steve Wyatt – Design Engineer (E-copy)
Structure Construction R.E. Pending File (email RE_pending_file@dot.ca.gov)
Craig Whitten – DES Office Engineer, Office of PS&E (E-copy)
Eric Karlson – District Materials Engineer (E-copy)
GeoDOG - Digital Archive of Geotechnical Data (E-copy)
Job File / Branch D Records

# LIST OF ATTACHMENTS

**ATTACHMENT 1** **GENERAL PLAN**

**ATTACHMENT 2** **GEOLOGIC MAP**

**ATTACHMENT 3** **EARTHQUAKE FAULTS**

**ATTACHMENT 4** **DESIGN RESPONSE SPECTRUM**

**ATTACHMENT 5** **MATERIAL PROPERTIES SUMMARY**

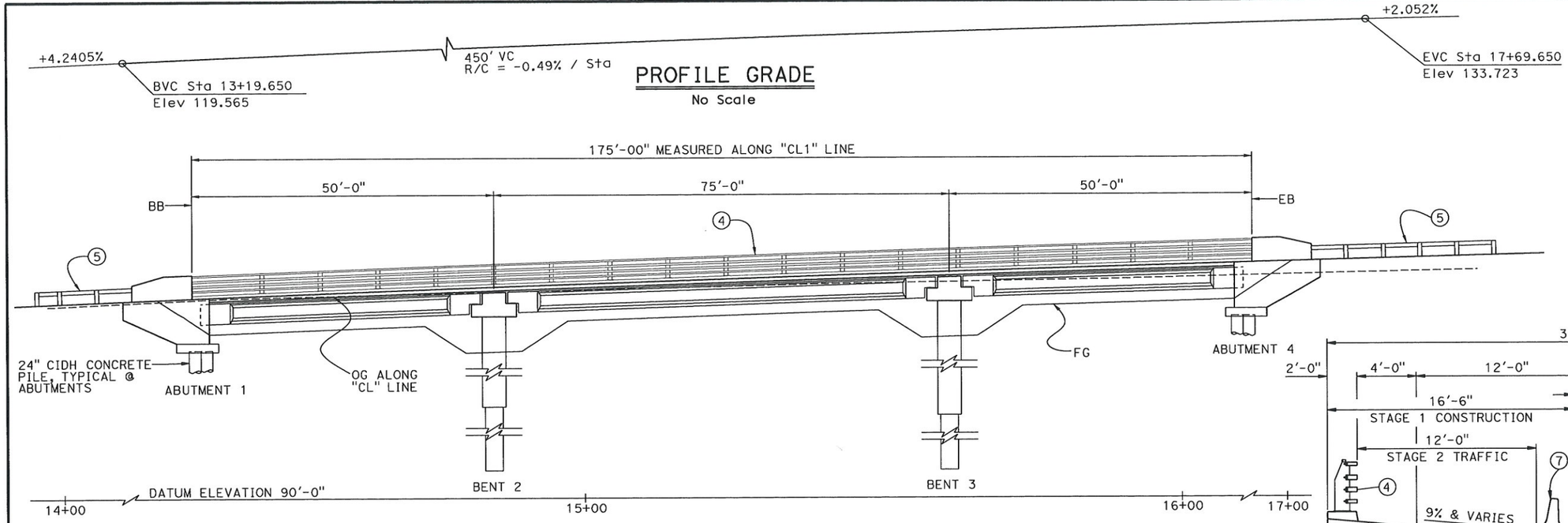
| DIST | COUNTY | ROUTE | POST MILES TOTAL PROJECT | SHEET No. | TOTAL SHEETS |
|---|---|---|---|---|---|
| 5 | MON | 1 | | | |

X
REGISTERED CIVIL ENGINEER DATE

REGISTERED PROFESSIONAL ENGINEER
HERNAN PEREZ
No. C 60993
Exp. 12-31-14
CIVIL
STATE OF CALIFORNIA

PLANS APPROVAL DATE

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

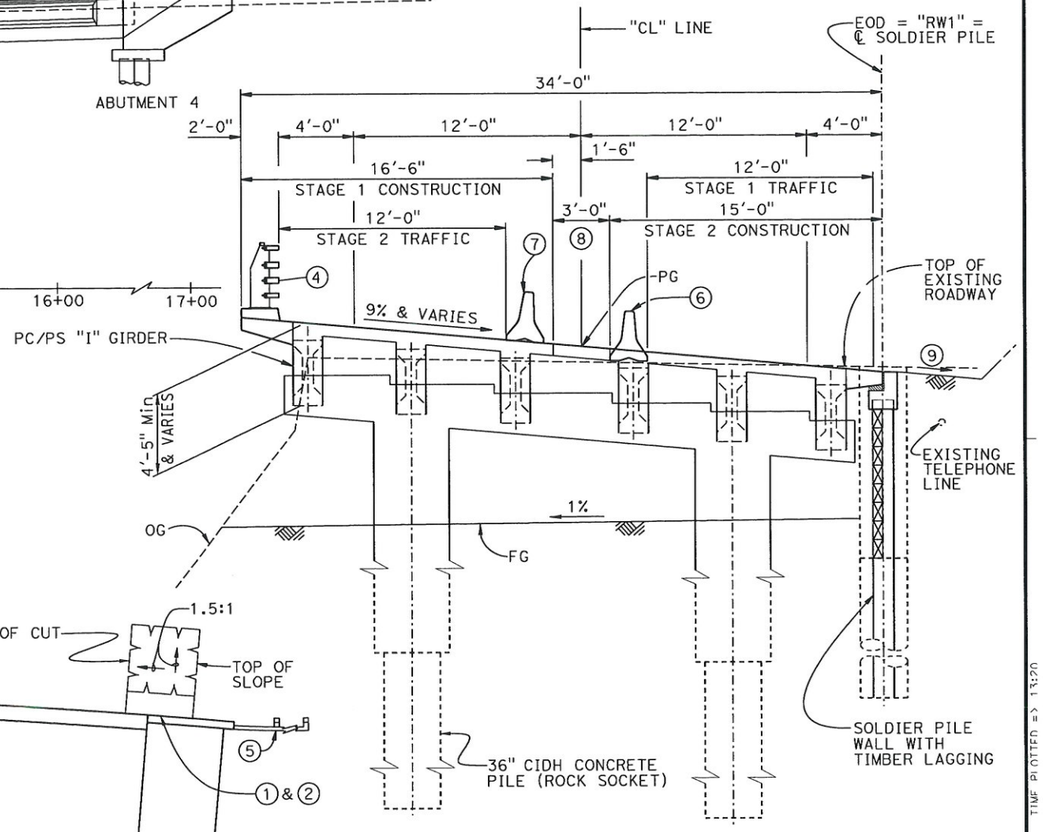



## PROFILE GRADE
No Scale

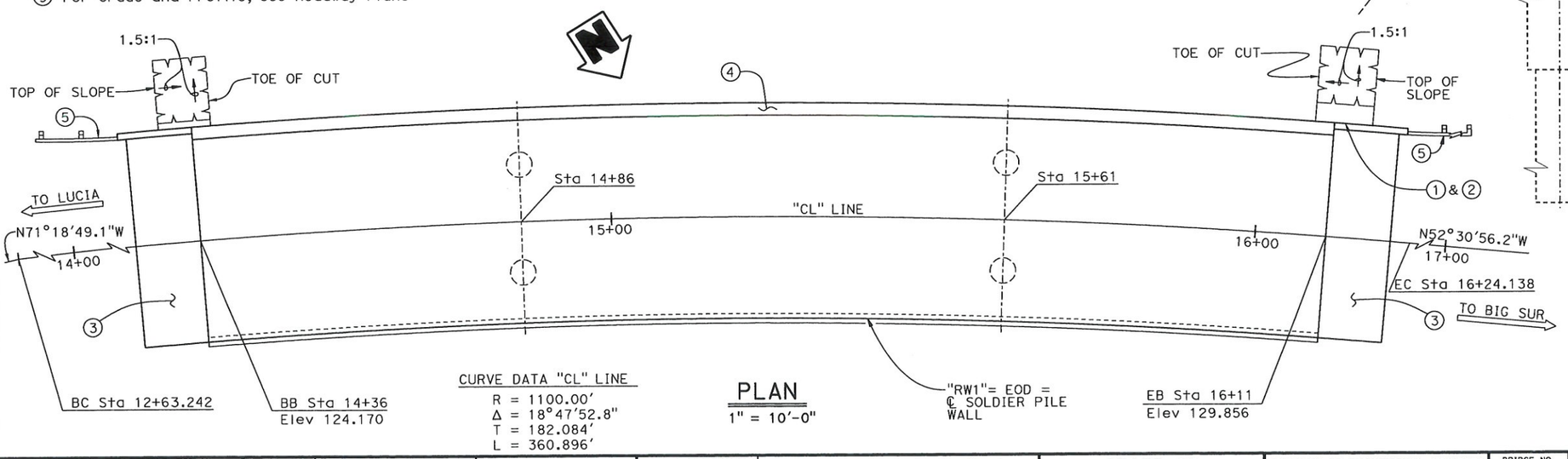
## MIRRORED ELEVATION
1" = 10'-0"

NOTES:

1. Paint "COW CLIFFS VIADUCT"
2. Paint "Br No. 44-0296"
3. Structure Approach Type EQ(10)
4. California ST-70 Bridge Rail (Mod)
5. Midwest Guardrail System, see Roadway Plans
6. Temporary Railing (Type K) during Stage 1 Traffic, see Roadway Plans
7. Temporary Railing (Type K) during Stage 2 Traffic, see Roadway Plans
8. Closure Pour
9. For Grade and Profile, see Roadway Plans




## TYPICAL SECTION
1/4"=1'-0"




## PLAN
1" = 10'-0"

LEGEND:
- New Construction
- Direction of Traffic

# ATTACHMENT 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| X DESIGN ENGINEER | DESIGN | BY H. PEREZ | CHECKED M. CULLEN | LOAD & RESISTANCE FACTOR DESIGN | LIVE LOADING: HL93 W/"LOW-BOY" and PERMIT DESIGN VEHICLE | | |
| | DETAILS | BY K. CHONKRIA | CHECKED H. PEREZ | LAYOUT | BY K. CHONKRIA | CHECKED H. PEREZ | |
| | QUANTITIES | BY X | CHECKED X | SPECIFICATIONS | BY X | PLANS AND SPECS COMPARED X | |

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN
DESIGN BRANCH 6

| BRIDGE NO. | 44-0296 |
|---|---|
| POST MILE | 28.28 |

# COW CLIFFS VIADUCT
## GENERAL PLAN

UNIT: 3591
PROJECT NUMBER & PHASE: 0514000072-K CONTRACT NO.: 05-1F8904

DISREGARD PRINTS BEARING EARLIER REVISION DATES

| REVISION DATES | | | | SHEET | OF |
|---|---|---|---|---|---|
| 6-26-14 | 6-30-14 | 7-22-14 | 7-22-14 | 1 | X |

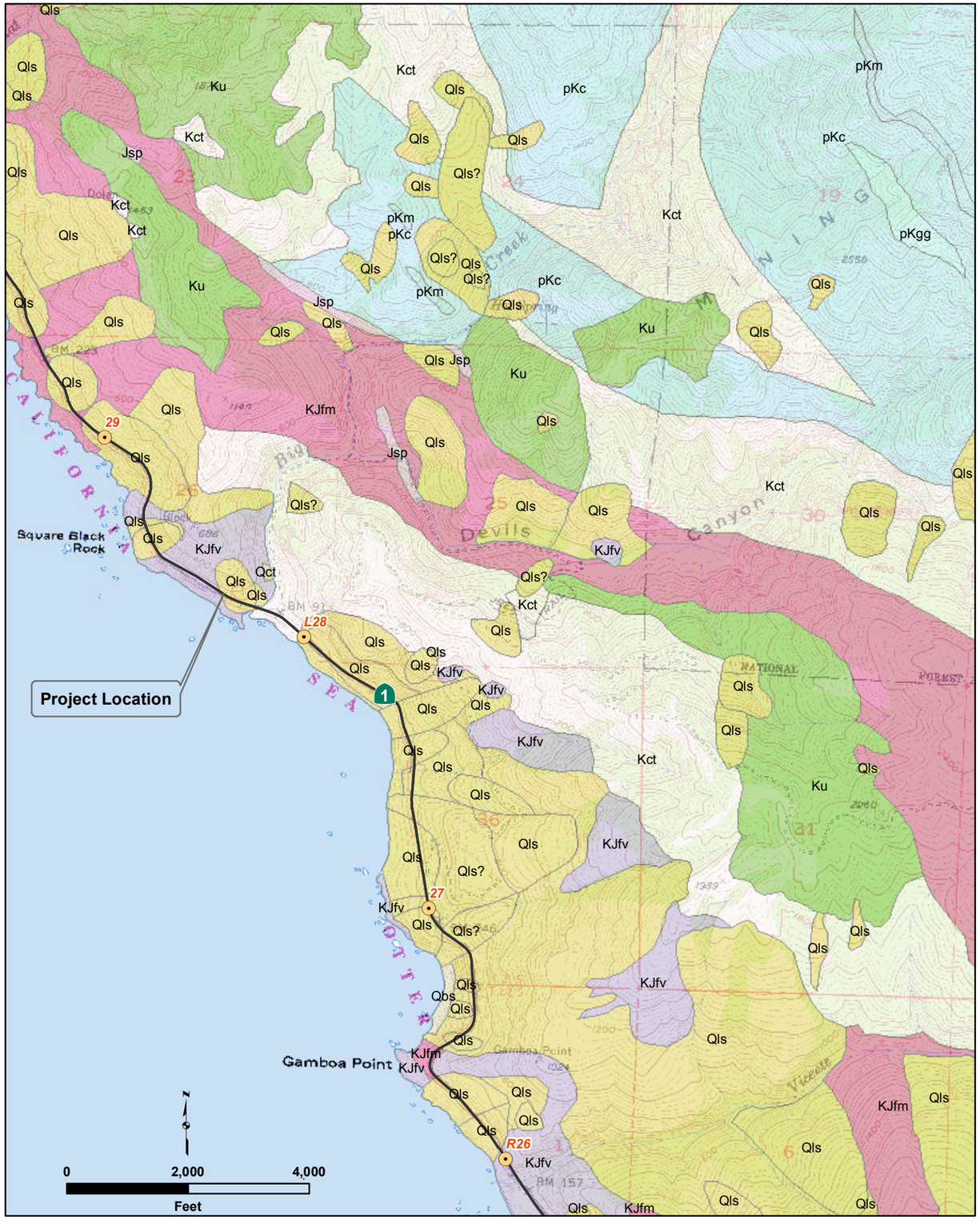
STRUCTURES DESIGN GENERAL PLAN SHEET (ENGLISH) (REV.09-01-13)

FILE => 44-0296-a gc01.dgn

DATE PLOTTED => 22-JUL-2014 TIME PLOTTED => 13:20

# Geologic Map

**Cow Cliffs Viaduct**
**05-MON-1-28.28**
**EA 05-1F8901, Project ID 0514000072**



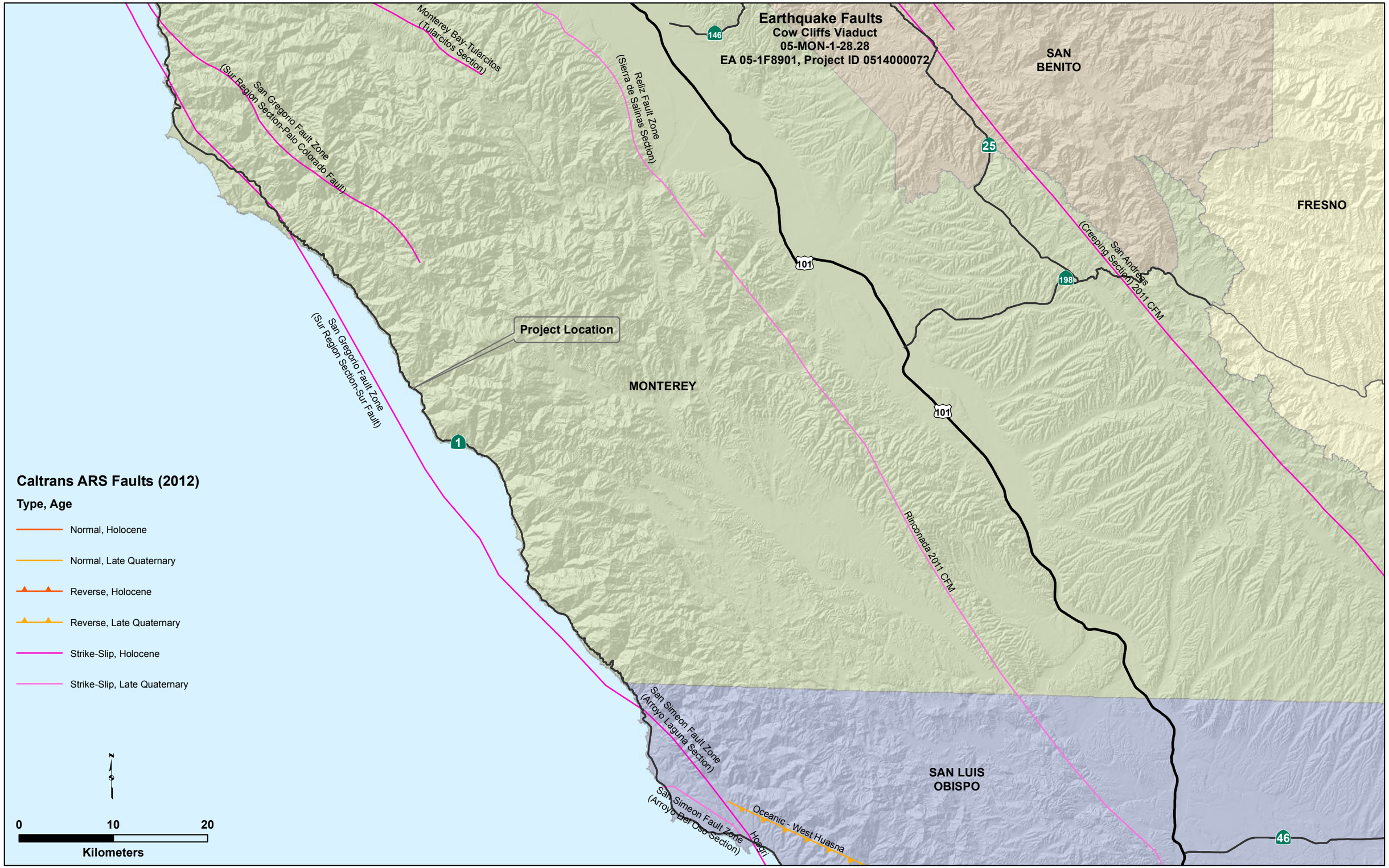

## Monterey Geology

**Geologic Units**

| | | |
|---|---|---|
| | Qbs | Quaternary Beach Sand |
| | Qls | Quaternary Hillslope Debris |
| | Qls? | Quaternary Hillslope Debris |
| | Qct | Quaternary Coastal Terraces, undifferentiated |
| | Ku | Late Cretaceous Unmaned Sedimentary Rocks |
| | Kct | Cretaceous Charnocktic Tonolite |
| | KJfv | Jurassic-Cretaceous Franciscan Complex, Greenstone |
| | KJfm | Jurassic-Cretaceous Franciscan Complex,Melange |
| | Jsp | Jurassic Serpentinite |
| | pKc | Pre-Cretaceous Coast Ridge Belt Consisting of Marble |
| | pKgg | Pre-Cretaceous Graphitic Gneiss |
| | pKm | Pre-Cretaceous Marble |

Geologic Mapping Compiled by Lewis I. Rosenberg

**ATTACHMENT 2**

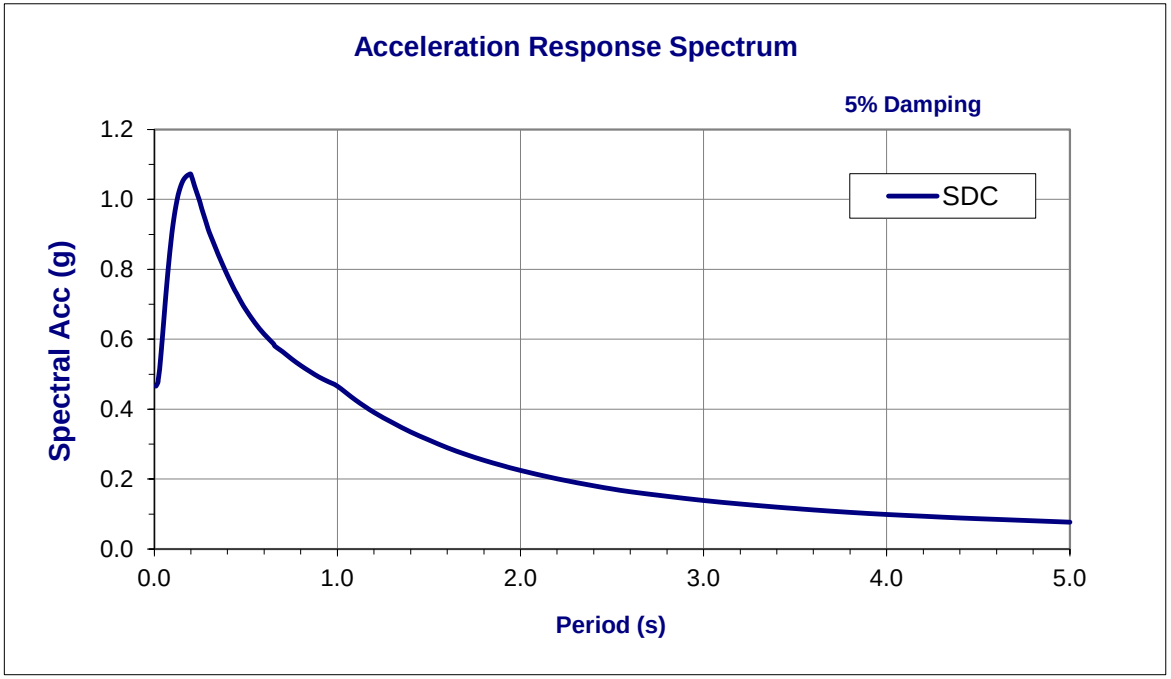



ATTACHMENT 3

## Cow Cliffs Viaduct

**Bridge No.** 44-0296 **SDC Controlling Procedure :** **Deterministic**

| Period (s) | SDC |
|---|---|
| 0.010 | 0.466 |
| 0.020 | 0.476 |
| 0.030 | 0.515 |
| 0.050 | 0.638 |
| 0.075 | 0.793 |
| 0.100 | 0.917 |
| 0.120 | 0.985 |
| 0.150 | 1.045 |
| 0.200 | 1.072 |
| 0.250 | 0.992 |
| 0.300 | 0.907 |
| 0.400 | 0.783 |
| 0.500 | 0.685 |
| 0.750 | 0.544 |
| 1.000 | 0.466 |
| 1.500 | 0.312 |
| 2.000 | 0.225 |
| 3.000 | 0.139 |
| 4.000 | 0.099 |
| 5.000 | 0.077 |




**Deterministic Procedure Data**

| | | | | | |
|---|---|---|---|---|---|
| **Fault** | San Gregorio Fault Zone (Sur Fault) | | $R_{rup}$ | 3.04 | km |
| **Fault ID** | 178 | | $R_{jb}$ | 3.04 | km |
| **Style** | Slip-Strike | | $R_x$ | 3.04 | km |
| **Mmax** | 7.4 | | $V_{S30}$ | 760 | m/s |
| **Dip** | 90 | deg | $Z_{1.0}$ | N/A | m |
| $Z_{TOR}$ | 0 | km | $Z_{2.5}$ | N/A | km |

**Notes**

ARS curve was modified for Near Fault Directivity Effect (SDC Section 6.1.2.1)

**Design Response Spectrum**
**ATTACHMENT 4**

# MATERIALS PROPERTIES SUMMARY
## COW CLIFFS VIADUCT (BRIDGE NO. 44-0296)
## 05-MON-1-28.28

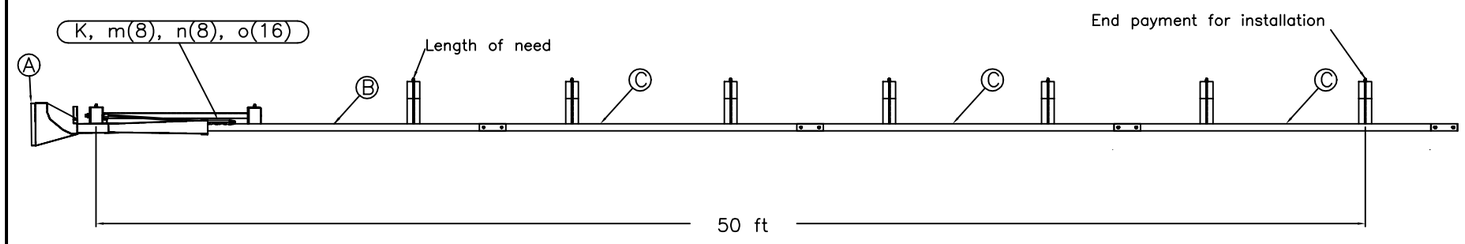
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DESCRIPTION | Boring No. | R-14-001 | | | R-14-003 | R-14-004 | R-14-006 | |
| | Station | 16+11 | | | 14+84 | 14+36 | 16+17 | |
| | Line | "CL" Line | | | "CL" Line | "CL" Line | "CL" Line | |
| | Offset | 21' Lt. | | | 4' Lt. | On The Line | 12' Rt. | |
| | Date Sampled | 3/19/2014 | 3/19/2014 | 3/19/2014 | 3/26/2014 | 3/27/2014 | 4/2/2014 | 4/3/2014 |
| | Sample ID | 440104 | 440105 | 440106 | 440107 | 440108 | 440109 | 440110 |
| | Depth Below OG | 34.4'-35.1' | 45.4'-45.9' | 57.5'-58.0' | 52.0'-52.6' | 46.0'-47.0' | 20.0'-21.5' | 48.6'-49.5' |
| | USCS Classification | | | | | | | |
| PARTICLE SIZE ANALYSIS | 50 mm (2") | | | | | | | |
| | 37.5 mm (1½") | | | | | | | |
| | 25 mm (1") | | | | | | | |
| | 19 mm (3/4") | | | | | | | |
| | 12.5 mm (1/2") | | | | | | | |
| | 9.5 mm (3/8") | | | | | | | |
| | 4.75 mm (No. 4) | | | | | | | |
| | 2.36 mm (No. 8) | | | | | | | |
| | 1.18 mm (No. 16) | | | | | | | |
| | 600 um (No. 30) | | | | | | | |
| | 300 um (No. 50) | | | | | | | |
| | 150 um (No. 100) | | | | | | | |
| | 75 um (No. 200) | | | | | | | |
| | 5 um | | | | | | | |
| | 1 um | | | | | | | |
| PI | Liquid Limit | | | | | | | |
| | Plasticity Index | | | | | | | |
| Expansion Index | | | | | | | | |
| CORROSION | Resistivity (ohm-cm) | | | | | | | |
| | pH | | | | | | | |
| | Chlorides (ppm) | | | | | | | |
| | Sulfates (ppm) | | | | | | | |
| DENSITY AND MOISTURE CONTENT | In Situ: Dry Density (pcf) | 181 | 167 | 166 | 164 | 183 | 176 | 163 |
| | In Situ: Moisture (%) | | | | | | | |
| | Optimum: Dry Density (pcf) | | | | | | | |
| | Optimum: Moisture (%) | | | | | | | |
| | Specific Gravity | | | | | | | |
| CUe TRIAXIAL IN SITU Total Stress | Friction Angle (°) | | | | | | | |
| | Cohesion (psf) | | | | | | | |
| IN SITU Effective Stress | Friction Angle (°) | | | | | | | |
| | Cohesion (psf) | | | | | | | |
| REMOLDED 90% Total Stress | Friction Angle (°) | | | | | | | |
| | Cohesion (psf) | | | | | | | |
| REMOLDED 90% Effective Stress | Friction Angle (°) | | | | | | | |
| | Cohesion (psf) | | | | | | | |
| Unconfined Compressive Strength (psi) | | 1479 | 5087 | 8362 | 6644 | 9789 | 8735 | 4655 |
| Consol. | Consolidation Index (Cc) | | | | | | | |
| | Recompression Index (Cr) | | | | | | | |
| | Initial Void Ratio | | | | | | | |

**ATTACHMENT 5**

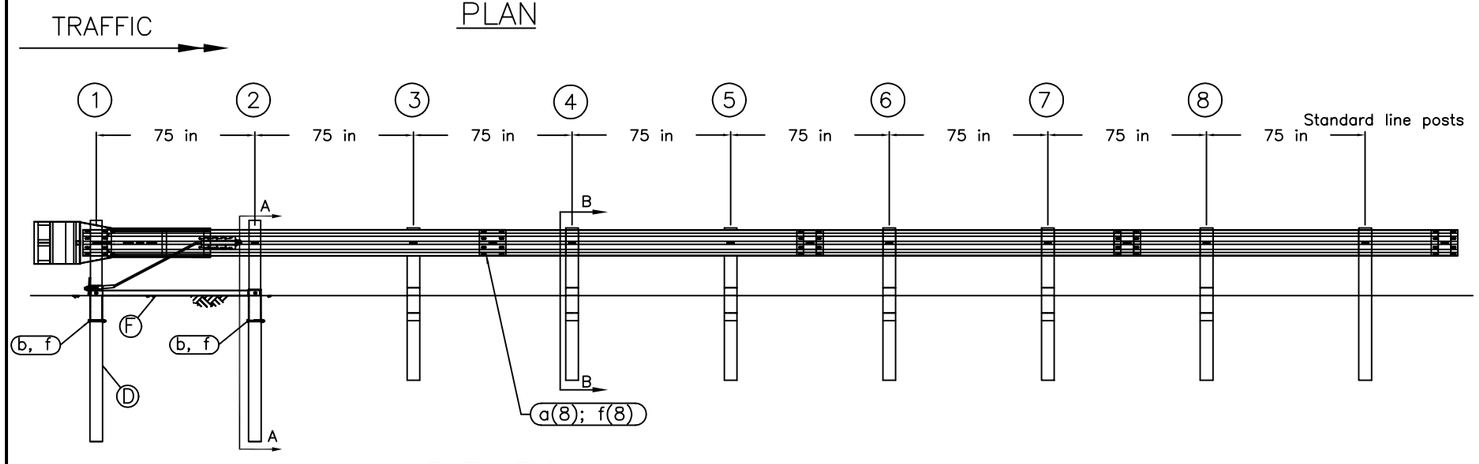
# MATERIALS PROPERTIES SUMMARY
## COW CLIFFS VIADUCT (BRIDGE NO. 44-0296)
## 05-MON-1-28.28

| | | | | | |
|---|---|---|---|---|---|
| DESCRIPTION | Boring No. | R-14-008 | | R-14-009 | R-14-010 |
| | Station | 14+24 | | 14+74 | 15+59 |
| | Line | "CL" Line | | "CL" Line | "CL" Line |
| | Offset | 15' Rt. | | 15' Rt. | 16' Rt. |
| | Date Sampled | 5/6/2014 | 5/6/2014 | 5/7/2014 | 5/13/2014 |
| | Sample ID | 440101 | 440102 | 440103 | 440111 |
| | Depth Below OG | 33'-34.5' | 61.5'-62.5' | 76.9'-78' | 39.1'-40' |
| | USCS Classification | | | | |
| PARTICLE SIZE ANALYSIS | 50 mm (2") | | | | |
| | 37.5 mm (1½") | | | | |
| | 25 mm (1") | | | | |
| | 19 mm (3/4") | | | | |
| | 12.5 mm (1/2") | | | | |
| | 9.5 mm (3/8") | | | | |
| | 4.75 mm (No. 4) | | | | |
| | 2.36 mm (No. 8) | | | | |
| | 1.18 mm (No. 16) | | | | |
| | 600 um (No. 30) | | | | |
| | 300 um (No. 50) | | | | |
| | 150 um (No. 100) | | | | |
| | 75 um (No. 200) | | | | |
| | 5 um | | | | |
| | 1 um | | | | |
| PI | Liquid Limit | | | | |
| | Plasticity Index | | | | |
| Expansion Index | | | | | |
| CORROSION | Resistivity (ohm-cm) | 2569 | 3961 | 2772 | |
| | pH | 8.33 | 8.6 | 8.32 | |
| | Chlorides (ppm) | N/A | N/A | N/A | |
| | Sulfates (ppm) | N/A | N/A | N/A | |
| DENSITY AND MOISTURE CONTENT — In Situ | Dry Density (pcf) | | | | 178 |
| | Moisture (%) | | | | |
| DENSITY AND MOISTURE CONTENT — Optimum | Dry Density (pcf) | | | | |
| | Moisture (%) | | | | |
| | Specific Gravity | | | | |
| CUe TRIAXIAL — IN SITU — Total Stress | Friction Angle (°) | | | | |
| | Cohesion (psf) | | | | |
| CUe TRIAXIAL — IN SITU — Effective Stress | Friction Angle (°) | | | | |
| | Cohesion (psf) | | | | |
| CUe TRIAXIAL — REMOLDED 90% — Total Stress | Friction Angle (°) | | | | |
| | Cohesion (psf) | | | | |
| CUe TRIAXIAL — REMOLDED 90% — Effective Stress | Friction Angle (°) | | | | |
| | Cohesion (psf) | | | | |
| Unconfined Compressive Strength (psi) | | | | | 2581 |
| Consol. | Consolidation Index (Cc) | | | | |
| | Recompression Index (Cr) | | | | |
| | Initial Void Ratio | | | | |

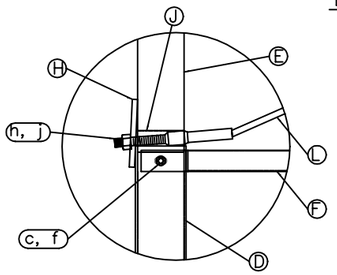
**ATTACHMENT 5**



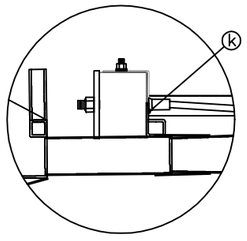

PLAN



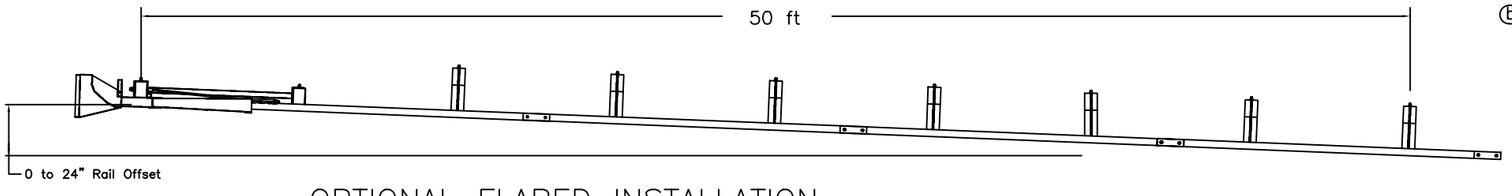

ELEVATION




POST #1 CONNECTION DETAIL




IMPACT HEAD CONNECTION DETAIL



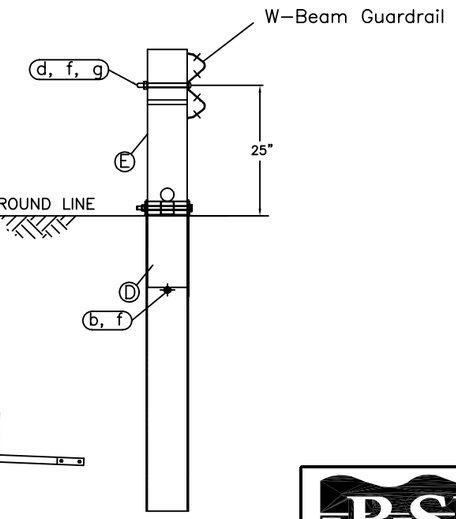

OPTIONAL FLARED INSTALLATION

25:1 maximum flare rate

GENERAL NOTES:

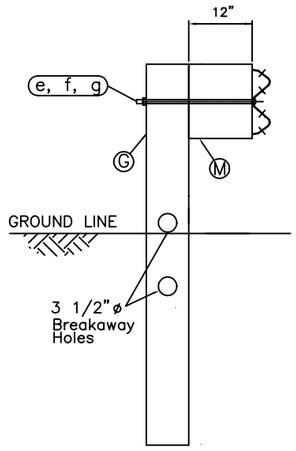
1. Breakaway posts are required with the SKT.
2. All bolts, nuts, cable assemblies, cable anchors and bearing plates shall be galvanized.
3. The SKT can be flared at a rate of up to 25:1 to prevent the impact head from encroaching on the shoulder.
4. The foundation tubes shall not protrude more than 4" above the ground (measured along a 5' cord). Site grading may be necessary to meet this requirement.
5. When rock is encountered, a 12" Ø post hole, 20" into the rock surface may be used if approved by the engineer. Granular material will be placed in the bottom of the hole, approximately 2.5" deep to provide drainage. The first two posts can be field cut to length, placed in the hole and backfilled with adequately compacted material excavated from the hole.
6. The breakaway cable assembly must be taut. A locking device (vice grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.
7. A site evalution should be considered if there is less than 25' between the outlet side of the terminal and any adjacent driving lane.
8. The soil tubes may be driven with an approved driving head. They shall not be driven with the post in the tube.
9. The wood blockouts should be "toe-nailed" to the rectangular wood posts to prevent them from turning when the wood shrinks.

| ITEM | QTY | BILL OF MATERIALS | ITEM NO. |
|---|---|---|---|
| A | 1 | IMPACT HEAD | S3000 |
| B | 1 | W-BEAM GUARDRAIL END SECTION, 12 Ga. | S1303 MGS |
| C | 3 | W-BEAM GUARDRAIL, 12 Ga. | G1203 MGS |
| D | 2 | FOUNDATION TUBE | E731 |
| E | 2 | BCT WOOD POST | P650 MGS |
| F | 1 | GROUND STRUT | E780 |
| G | 6 | CRT WOOD POST | P671 MGS |
| H | 1 | BEARING PLATE | E750 |
| J | 1 | PIPE SLEEVE | E740 |
| K | 1 | CABLE ANCHOR BOX | S760 |
| L | 1 | BCT CABLE ANCHOR ASSEMBLY | E770 |
| M | 6 | MGS TIMBER BLOCKOUT OR EQUIV. | P618 |
| | | HARDWARE (ALL DIMENSIONS IN INCHES) | |
| a | 24 | 5/8ø x 1 1/4 SPLICE BOLT | B580122 |
| b | 2 | 5/8ø x 7 1/2 HEX BOLT | B580754 |
| c | 2 | 5/8ø x 10 HEX BOLT | B581004 |
| d | 1 | 5/8ø x 10 H.G.R. BOLT | B581002 |
| e | 6 | 5/8ø x 22 H.G.R. BOLT | B582202 |
| f | 35 | 5/8ø H.G.R. NUT | N050 |
| g | 7 | H.G.R. WASHER | W050 |
| h | 2 | 1 ANCHOR CABLE HEX NUT | N100 |
| j | 2 | 1 ANCHOR CABLE WASHER | W100 |
| k | 2 | 3/8 x 3 LAG SCREW | E350 |
| m | 8 | CABLE ANCHOR BOX SHOULDER BOLT | SB58A |
| n | 8 | 1/2 A325 STRUCTURAL NUT | N055A |
| o | 16 | 1 1/16 OD x 9/16 ID A325 STR. WASHER | W050A |




SECTION A-A

Post #2




SECTION B-B

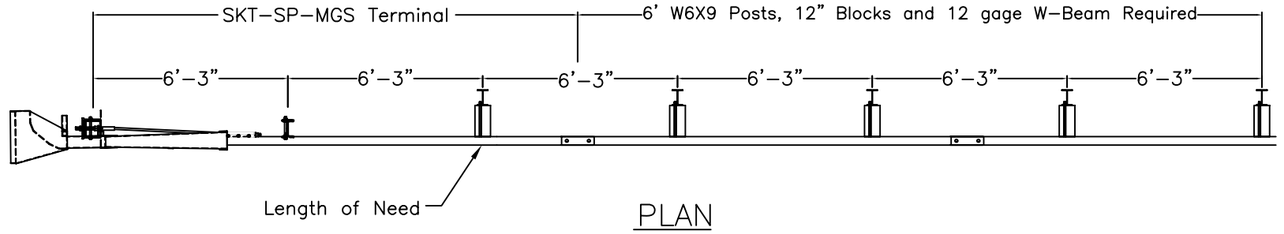
Posts 3 thru 8

RSI
Road Systems, Inc.
Big Spring, TX
Phone: 432-263-2435
or Phone: 330-346-0721

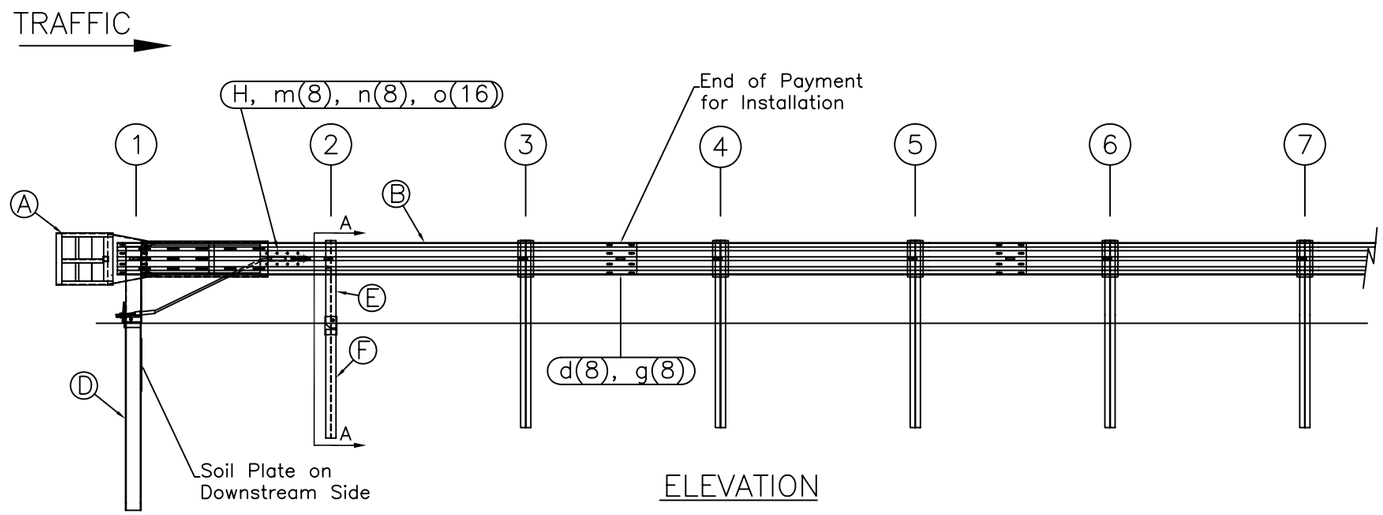
Sequential Kinking Terminal
SKT - Assembly

Midwest Guardrail System
Wood Post System

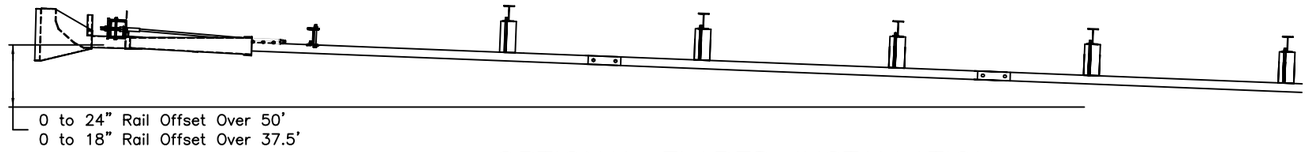
Sheet: A1
Date: 12/01/04
By: JRR
Drawing Name: SKT-MGS-W-US
Scale: NONE
Rev: 0




PLAN



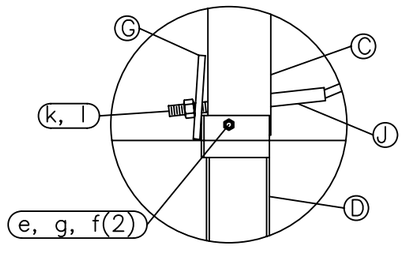

ELEVATION



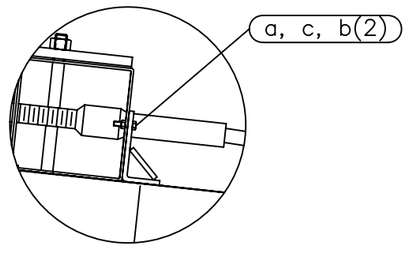

OPTIONAL FLARED INSTALLATION
25:1 maximum flare rate

| ITEM | QTY | BILL OF MATERIALS | ITEM NO. |
|---|---|---|---|
| A | 1 | IMPACT HEAD | S3000 |
| B | 1 | W–BEAM GUARDRAIL END SECTION, 12 Ga. | MGS–SF1303 |
| C | 1 | FIRST POST TOP (6X6X$\frac{1}{8}$" Tube) | TPHP1A |
| D | 1 | FIRST POST BOTTOM (6' W6X15) | TPHP1B |
| E | 1 | SECOND POST ASSEMBLY TOP | UHP2A |
| F | 1 | SECOND POST ASSEMBLY BOTTOM | HP3B |
| G | 1 | BEARING PLATE | E750 |
| H | 1 | CABLE ANCHOR BOX | S760 |
| J | 1 | BCT CABLE ANCHOR ASSEMBLY | E770 |
| | | | |
| | | HARDWARE (ALL DIMENSIONS IN INCHES) | |
| a | 2 | 5/16 x 1 HEX BOLT GRD 5 | B5160104A |
| b | 4 | 5/16 WASHER | W0516 |
| c | 2 | 5/16 HEX NUT | N0516 |
| d | 9 | 5/8 Dia. x 1 1/4 SPLICE BOLT (POST #2) | B580122 |
| e | 1 | 5/8 Dia. x 9 HEX BOLT GRD 5 | B580904A |
| f | 3 | 5/8 WASHER | W050 |
| g | 10 | 5/8 Dia. H.G.R NUT | N050 |
| h | 1 | 3/4 Dia. x 8 1/2 HEX BOLT GRD A449 | B340854A |
| j | 1 | 3/4 Dia. HEX NUT | N030 |
| k | 2 | 1 ANCHOR CABLE HEX NUT | N100 |
| l | 2 | 1 ANCHOR CABLE WASHER | W100 |
| m | 8 | CABLE ANCHOR BOX SHOULDER BOLT | SB58A |
| n | 8 | 1/2 A325 STRUCTURAL NUT | N055A |
| o | 16 | 1 1/16 OD x 9/16 ID A325 STR. WASHER | W050A |

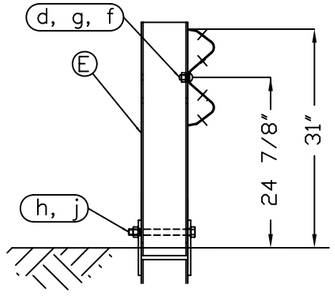
GENERAL NOTES:
1. All bolts, nuts, cable assemblies, cable anchors and bearing plates shall be galvanized.
2. The lower sections of the Posts 1&2 shall not protrude more than 4 in above the ground (measured along a 5' cord). Site grading may be necessary to meet this requirement.
3. The lower sections of the hinged posts should not be driven with the upper post attached. If the post is placed in a drilled hole, the backfill material must be satisfactorily compacted to prevent settlement.
4. When competent rock is encountered, a 12" Ø post hole, 20 in. deep cored into the rock surface may be used if approved by the engineer for post 1. Granular material will be placed in the bottom of the hole, approximately 2.5" deep to provide drainage. The first post can be field cut to length, placed in the hole and backfilled with suitable backfill. The soil plate may be trimmed if required.
5. A site evaluation should be considered if there is less than 25' between the outlet side of the terminal and any adjacent driving lane.
6. The breakaway cable assembly must be taut. A locking device (vice grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.




Post #1 Connection Detail




Impact Head Connection Detail

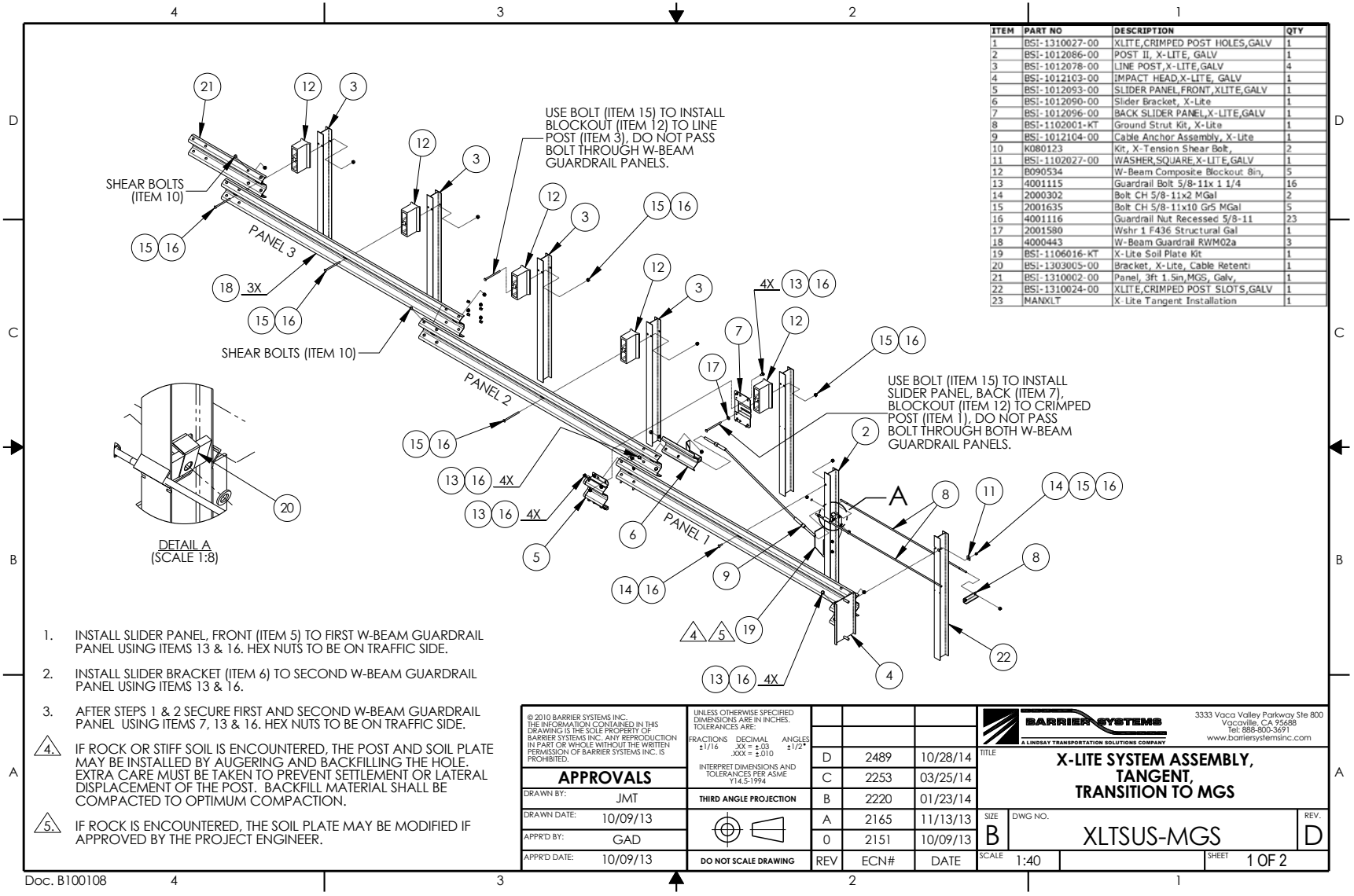



SECTION A–A
Post #2

**Road Systems, Inc.**
Big Spring, TX
Phone: 432-263-2435
or Phone: 330-346-0721

SKT-SP-MGS Terminal
Midwest Guardrail System
31" Top of Rail

Sheet: 1
Date: 02/24/10
By: JRR
Drawing Name: SKT-SP-S-MGS
Scale: None
Rev: 0




| ITEM | PART NO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | BSI-1310027-00 | XLITE,CRIMPED POST HOLES,GALV | 1 |
| 2 | BSI-1012086-00 | POST II, X-LITE, GALV | 1 |
| 3 | BSI-1012078-00 | LINE POST,X-LITE,GALV | 4 |
| 4 | BSI-1012103-00 | IMPACT HEAD,X-LITE, GALV | 1 |
| 5 | BSI-1012093-00 | SLIDER PANEL,FRONT,XLITE,GALV | 1 |
| 6 | BSI-1012090-00 | Slider Bracket, X-Lite | 1 |
| 7 | BSI-1012096-00 | BACK SLIDER PANEL,X-LITE,GALV | 1 |
| 8 | BSI-1102001-KT | Ground Strut Kit, X-Lite | 1 |
| 9 | BSI-1012104-00 | Cable Anchor Assembly, X-Lite | 1 |
| 10 | K080123 | Kit, X-Tension Shear Bolt, | 2 |
| 11 | BSI-1102027-00 | WASHER,SQUARE,X-LITE,GALV | 1 |
| 12 | B090534 | W-Beam Composite Blockout 8in, | 5 |
| 13 | 4001115 | Guardrail Bolt 5/8-11x 1 1/4 | 16 |
| 14 | 2000302 | Bolt CH 5/8-11x2 MGal | 2 |
| 15 | 2001635 | Bolt CH 5/8-11x10 Gr5 MGal | 5 |
| 16 | 4001116 | Guardrail Nut Recessed 5/8-11 | 23 |
| 17 | 2001580 | Wshr 1 F436 Structural Gal | 1 |
| 18 | 4000443 | W-Beam Guardrail RWM02a | 3 |
| 19 | BSI-1106016-KT | X-Lite Soil Plate Kit | 1 |
| 20 | BSI-1303005-00 | Bracket, X-Lite, Cable Retenti | 1 |
| 21 | BSI-1310002-00 | Panel, 3ft 1.5in,MGS, Galv, | 1 |
| 22 | BSI-1310024-00 | XLITE,CRIMPED POST SLOTS,GALV | 1 |
| 23 | MANXLT | X-Lite Tangent Installation | 1 |

1. INSTALL SLIDER PANEL, FRONT (ITEM 5) TO FIRST W-BEAM GUARDRAIL PANEL USING ITEMS 13 & 16. HEX NUTS TO BE ON TRAFFIC SIDE.
2. INSTALL SLIDER BRACKET (ITEM 6) TO SECOND W-BEAM GUARDRAIL PANEL USING ITEMS 13 & 16.
3. AFTER STEPS 1 & 2 SECURE FIRST AND SECOND W-BEAM GUARDRAIL PANEL USING ITEMS 7, 13 & 16. HEX NUTS TO BE ON TRAFFIC SIDE.
4. IF ROCK OR STIFF SOIL IS ENCOUNTERED, THE POST AND SOIL PLATE MAY BE INSTALLED BY AUGERING AND BACKFILLING THE HOLE. EXTRA CARE MUST BE TAKEN TO PREVENT SETTLEMENT OR LATERAL DISPLACEMENT OF THE POST. BACKFILL MATERIAL SHALL BE COMPACTED TO OPTIMUM COMPACTION.
5. IF ROCK IS ENCOUNTERED, THE SOIL PLATE MAY BE MODIFIED IF APPROVED BY THE PROJECT ENGINEER.



**APPROVALS**

| | |
|---|---|
| DRAWN BY: | JMT |
| DRAWN DATE: | 10/09/13 |
| APPR'D BY: | GAD |
| APPR'D DATE: | 10/09/13 |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
FRACTIONS ±1/16 DECIMAL .XX = ±.03 .XXX = ±.010 ANGLES ±1/2°
INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-1994
THIRD ANGLE PROJECTION
DO NOT SCALE DRAWING

| REV | ECN# | DATE |
|---|---|---|
| D | 2489 | 10/28/14 |
| C | 2253 | 03/25/14 |
| B | 2220 | 01/23/14 |
| A | 2165 | 11/13/13 |
| 0 | 2151 | 10/09/13 |

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY
3333 Vaca Valley Parkway Ste 800
Vacaville, CA 95688
Tel: 888-800-3691
www.barriersystemsinc.com

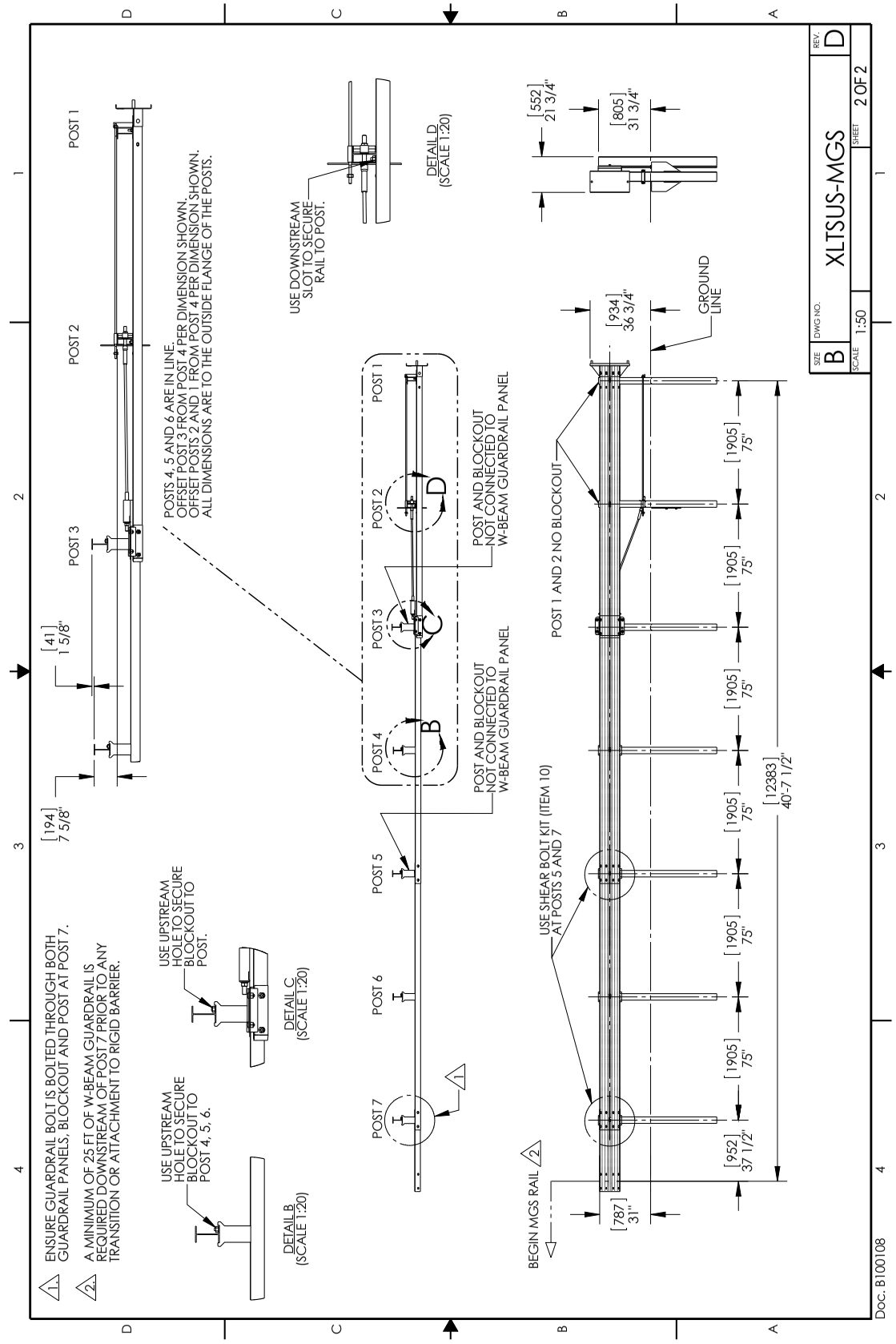
TITLE: **X-LITE SYSTEM ASSEMBLY, TANGENT, TRANSITION TO MGS**

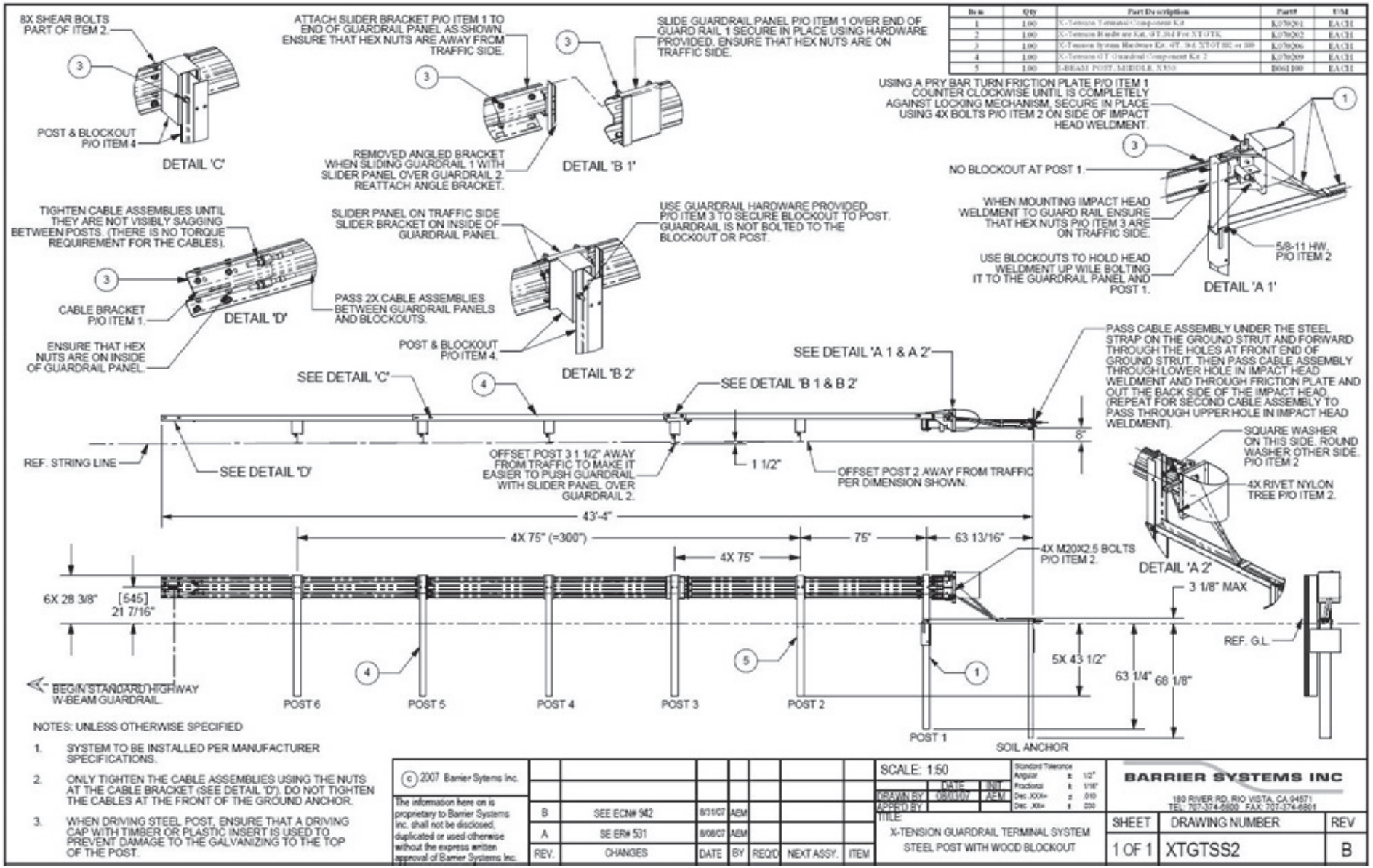
SIZE: B | DWG NO.: XLTSUS-MGS | REV.: D

SCALE: 1:40 | SHEET: 1 OF 2

Doc. B100108

## Appendix A - System Configuration, 37’ 6” MGS






| Item | Qty | Part Description | Part# | U/M |
|---|---|---|---|---|
| 1 | 1.00 | X-Tension Terminal Component Kit | KIT0301 | EACH |
| 2 | 1.00 | X-Tension Hardware Kit, 6T,3M For XTGTK | KIT0302 | EACH |
| 3 | 1.00 | X-Tension System Hardware Kit, 6T, 3M, XTGTSS2 or 3SS | KIT0306 | EACH |
| 4 | 1.00 | X-Tension 6T Guardrail Component Kit 2 | KIT0309 | EACH |
| 5 | 1.00 | I-BEAM POST, MIDDLE, X30 | B061100 | EACH |

NOTES: UNLESS OTHERWISE SPECIFIED

1. SYSTEM TO BE INSTALLED PER MANUFACTURER SPECIFICATIONS.
2. ONLY TIGHTEN THE CABLE ASSEMBLIES USING THE NUTS AT THE CABLE BRACKET (SEE DETAIL 'D'). DO NOT TIGHTEN THE CABLES AT THE FRONT OF THE GROUND ANCHOR.
3. WHEN DRIVING STEEL POST, ENSURE THAT A DRIVING CAP WITH TIMBER OR PLASTIC INSERT IS USED TO PREVENT DAMAGE TO THE GALVANIZING TO THE TOP OF THE POST.



| REV. | CHANGES | DATE | BY | REQ'D | NEXT ASSY. | ITEM |
|---|---|---|---|---|---|---|
| B | SEE ECN# 942 | 6/31/07 | AEM | | | |
| A | SE ER# 531 | 6/08/07 | AEM | | | |

SCALE: 1:50

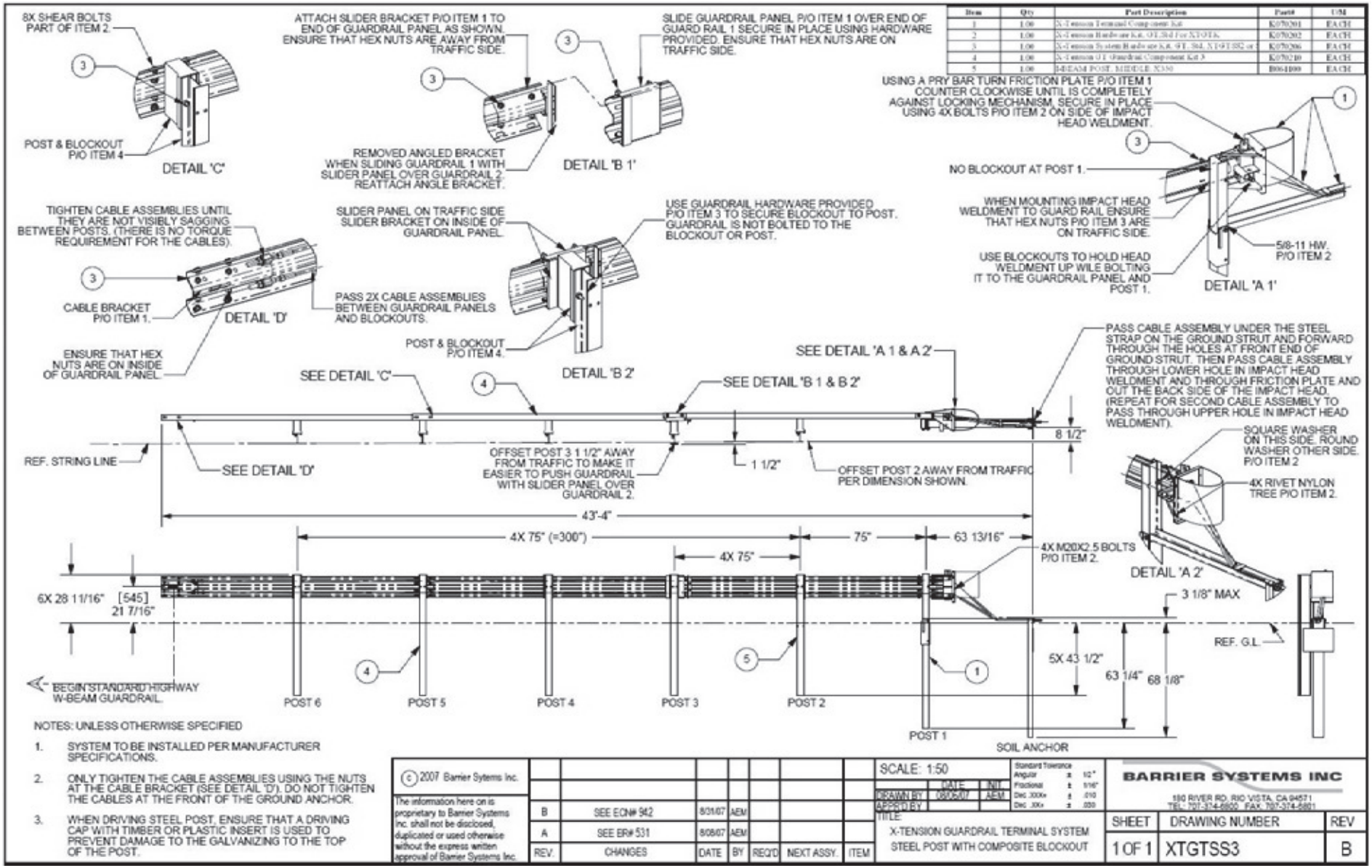
| | DATE | INIT |
|---|---|---|
| DRAWN BY | 06/01/07 | AEM |
| APPD BY | | |

Standard Tolerance: Angular ± 1/2°; Fractional ± 1/16"; Dec .XX± .010; Dec .XXX± .005

TITLE: X-TENSION GUARDRAIL TERMINAL SYSTEM STEEL POST WITH WOOD BLOCKOUT

BARRIER SYSTEMS INC
189 RIVER RD, RIO VISTA, CA 94571
TEL: 707-374-6800 FAX: 707-374-6801

| SHEET | DRAWING NUMBER | REV |
|---|---|---|
| 1 OF 1 | XTGTSS2 | B |




| Item | Qty | Part Description | Part# | UM |
|---|---|---|---|---|
| 1 | 1.00 | X-Tension Terminal Component Kit | K070201 | EACH |
| 2 | 1.00 | X-Tension Hardware Kit, QTY.5x4 For XTGTS | K070202 | EACH |
| 3 | 1.00 | X-Tension System Hardware Kit, QTY. 5x4, XTGTSS2 or | K070206 | EACH |
| 4 | 1.00 | X-Tension QTY Guardrail Component Kit 3 | K070210 | EACH |
| 5 | 1.00 | BEAM POST, MIDDLE, X350 | B064000 | EACH |

NOTES: UNLESS OTHERWISE SPECIFIED

1. SYSTEM TO BE INSTALLED PER MANUFACTURER SPECIFICATIONS.
2. ONLY TIGHTEN THE CABLE ASSEMBLIES USING THE NUTS AT THE CABLE BRACKET (SEE DETAIL 'D'). DO NOT TIGHTEN THE CABLES AT THE FRONT OF THE GROUND ANCHOR.
3. WHEN DRIVING STEEL POST, ENSURE THAT A DRIVING CAP WITH TIMBER OR PLASTIC INSERT IS USED TO PREVENT DAMAGE TO THE GALVANIZING TO THE TOP OF THE POST.



| REV. | CHANGES | DATE | BY | REQ'D | NEXT ASSY. | ITEM |
|---|---|---|---|---|---|---|
| B | SEE ECN# 942 | 8/31/07 | AEM | | | |
| A | SEE ER# 531 | 8/08/07 | AEM | | | |

SCALE: 1:50

| | DATE | INIT. |
|---|---|---|
| DRAWN BY | 08/06/07 | AEM |
| APP'D BY | | |

Standard Tolerance: Angular ± 1/2°; Fractional ± 1/16"; Dec .XXX± .010; Dec .XX± .030

TITLE: X-TENSION GUARDRAIL TERMINAL SYSTEM STEEL POST WITH COMPOSITE BLOCKOUT

BARRIER SYSTEMS INC
180 RIVER RD, RIO VISTA, CA 94571
TEL: 707-374-6800 FAX: 707-374-6801

| SHEET | DRAWING NUMBER | REV |
|---|---|---|
| 1 OF 1 | XTGTSS3 | B |

BARRIER SYSTEMS INC

TECHNICAL
BRIEF

180 River Road • Rio Vista, CA 94571 • Tel 707-374-6800 • Fax 707-374-6801
Email: info@barriersystemsinc.com • Website: barriersystemsinc.com

# Product Specification

# ABSORB 350™ TL-3
# Non-Redirective, Gating, Crash Cushion
# Applied to Permanent and Portable Concrete Barrier

## I. General

The ABSORB 350™ TL-3 System is a Non-Redirective, Gating, Crash Cushion in accordance with the definitions in the National Cooperative Highway Research Program Report 350 (NCHRP 350). The system shall be tested and perform in an acceptable manner in accordance with the guidelines of NCHRP 350 at Test Level 3 (100 km/h).

## II. Performance

The ABSORB 350 is designed to absorb the impact energy of an errant vehicle in accordance with NCHRP 350 guidelines for Non-Redirective, Gating, Crash Cushions. The system is designed to be attached to Permanent Concrete Barrier and Portable Concrete Barrier with section lengths of at least 3.1 meters (10 feet). When attached in accordance with the manufacturers instructions, the ABSORB 350 system is capable of safely stopping a 2000 kg (4400 pound) pickup truck impacting the system at 100 km/h (62.3 mph) and 0 degrees and an 820 kg (1800 pound) compact vehicle impacting the system at 100 km/h (62.3 mph), 0 degrees and with an offset of the vehicle and system centerlines of one-fourth the vehicle width.

A. When properly installed according to the manufacturer's recommendations the ABSORB 350 system shall be fully tested to and meet the recommended structural adequacy, occupant risk, and vehicle trajectory criteria set forth in NCHRP 350 for Test Level 3 Non-Redirective, Gating Crash Cushions (NCHRP 350 TL-3):

1. Impact at 0 degrees at w/4 offset (centerline of vehicle offset 1/4 width of vehicle from centerline of system) at 100 km/h with an 820C vehicle. This is Test 3-40 of NCHRP 35.

2. Impact at 0 degrees into center nose of device (0 offset from centerline of vehicle) at 100 km/h with a 2000P vehicle. This is Test 3-41 of NCHRP 350.

3. Impact at 15 degrees into center nose of device (0 offset from centerline of vehicle) at 100 km/h with an 820C vehicle unless the Federal Highway Administration, due to acceptable performance in test 3-40, waives this test. This is Test 3-42 of NCHRP 350.

4. Impact at 15 degrees into center nose of device (0 offset from centerline of vehicle) at 100 km/h with a 2000P vehicle. This is Test 3-43 of NCHRP 350.

5. Impact at 20 degrees along the side of the unit (with the centerline of the vehicle aligned with the centerline of the attachment of the barrier and the ABSORB 350™) at 100 km/h with a 2000P vehicle. This is Test 3-44 of NCHRP 350 as modified by the Federal Highway Administration.

B. The impact velocity of a hypothetical front seat passenger against the vehicle interior as calculated from the longitudinal vehicle acceleration and 600 mm [23 5/8 in] forward displacement, and the lateral vehicle acceleration and 300 mm [1 ft] lateral displacement shall be less than 12 m/s (39.3 ft/s] and the highest 10 ms average vehicle acceleration in the longitudinal and lateral directions subsequent to the instant of hypothetical occupant impact shall be less than 20 g's in NCHRP 350 tests 3-40, 41, 42 and 43.

For TL-3 impacts detached debris shall not show potential for penetrating the vehicle occupant compartment or presenting a hazard to other traffic, pedestrians, or workers in a work zone. The vehicle shall remain upright during and after the collision although moderate roll, pitch and yaw may occur.

## III. Description of System

A. The ABSORB 350 system shall be made up of the following components and the system shall be fabricated from materials conforming to the following specifications:

1. ABSORB 350 Energy Absorbing Element – Each element of the system shall be composed of a plastic container, steel side bars, end plate/ hinge assemblies, an evaporation prevention cap with tether and appropriate fasteners. The overall dimensions of the assembled element are 610 mm (24 inches) wide, 812 mm (32 inches) tall and 1000 mm (39 1/2 inches) long, as shown in the attached drawing (B000524). Each element of the system shall weigh approximately 50 kg (110 pounds) when empty and 325 kg (717 pounds) when filled. The first element of the assembled system should always be empty of fluid with the evaporation prevention cap installed. All other elements of the system should be filled with fluid in accordance with the installation instructions and the evaporation prevention cap shall be securely installed. All elements shall be attached in accordance with the installation instructions and drawings supplied by the manufacturer.

a. The plastic elements shall be molded from Linear Low Density Polyethylene.

b. All steel sidebars, end plate/hinge assemblies shall be fabricated from mild steel in conformance with ASTM A-36 specifications.

c. The evaporation prevention cap shall be molded from low density polyethylene

2. ABSORB 350 Nose Piece – Each ABSORB 350 system shall contain one Nose Piece at the front of the system. The Nose Piece is approximately 620 mm (24 3/8inches) wide, 825mm (32 1/2inches) tall and 610mm (24 inches) long, as shown in the attached drawing (B000526). The Nose Piece shall weigh approximately 60 kg (132 pounds) and shall be attached to the first Energy Absorbing Element in accordance with the installation instructions and drawings supplied by the manufacturer.

    a. The Nose Piece shall be fabricated from mild steel in conformance with ASTM A-36.

    b. The Nose Piece shall also have an aluminum skin on the front portion to provide an aesthetic cover and a place for attaching traffic control signage, if needed. This skin shall be fabricated from 5052 H32 in conformance with ASTM B209 and shall be attached to the steel portion of the Nose Piece with adhesives and pop rivets.

3. ABSORB 350 Transition Hardware for PCB – The transition configuration is as shown in the attached drawing B000608.

    a. PCB Transition Hardware is fabricated from mild steel in conformance with ASTM A-36 as shown in the attached drawing (B000531). The steel components shall weigh approximately 80 kg (176 pounds).

B. Attachment of the ABSORB 350™ system to PCB systems shall require nine (9) Energy Absorbing Elements. Assembly should be in compliance with the manufactures drawings and written instructions.

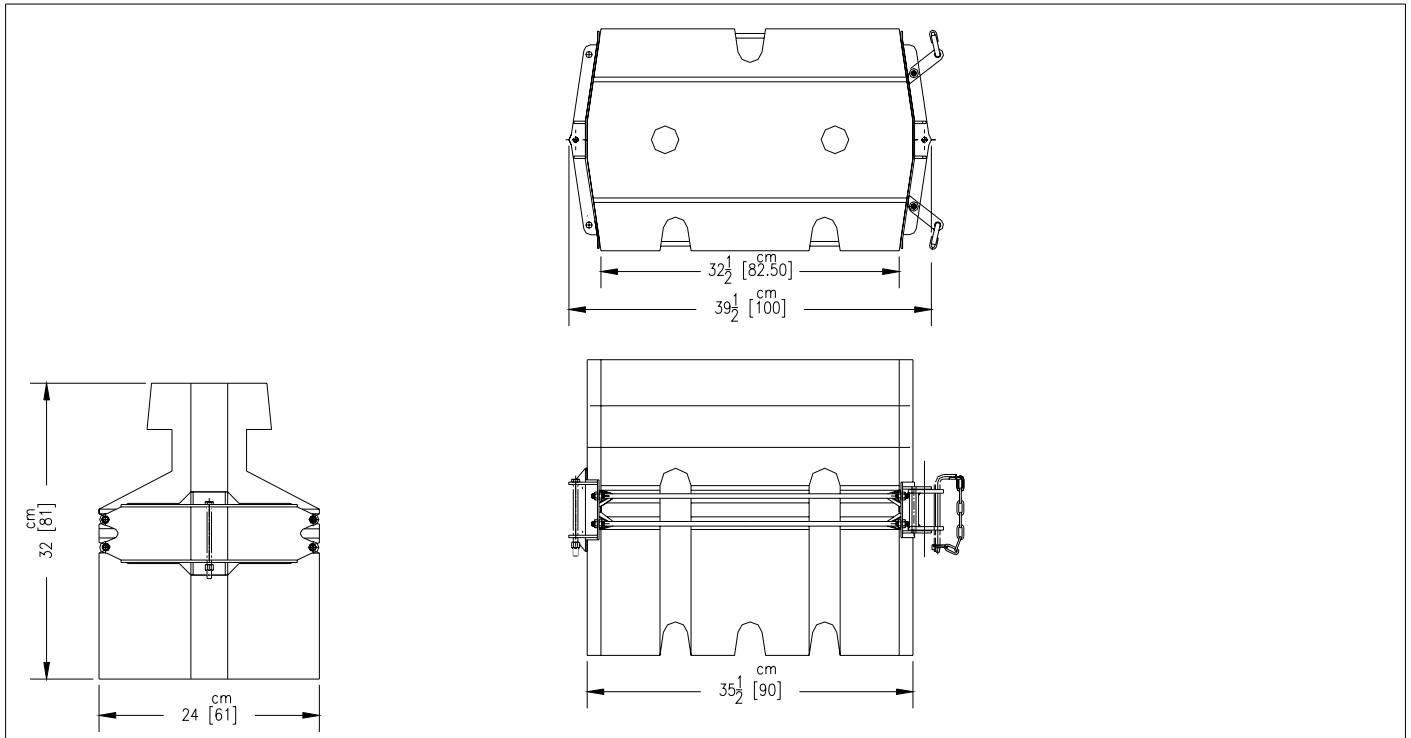
C. The ABSORB 350™ system shall be able to be refurbished after a NCHRP 350 type impact in less than 1 hour with two people, an adequate fluid supply and refurbishment materials.

D. The ABSORB 350™ system shall not require attachment to a foundation. Attachment to the PCB system will require attachment in accordance with the manufacturer's drawings and instructions.

E. The ABSORB 350™ system shall be assembled and filled with fluid in accordance with the manufacturers instructions. If there is a possibility that the fluid in the system could freeze due to low temperatures, proper antifreeze agents should be used in accordance with local standards and environmental regulations.

## IV. Application of Safety Appurtenances

Highway safety appurtenances should be applied to hazardous sites in accordance with the guidelines and recommendations in the American Association of State Highway Transportation Officials (AASHTO), "Roadside Design Guide," 1989, and other Federal Highway Administration and State Department of Transportation requirements. Placement and use of the ABSORB 350 system should comply with these specifications and guidelines.




NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.



| REV. | CHANGES | DATE | BY | REQ'D | NEXT ASSY. | ITEM |
|---|---|---|---|---|---|---|

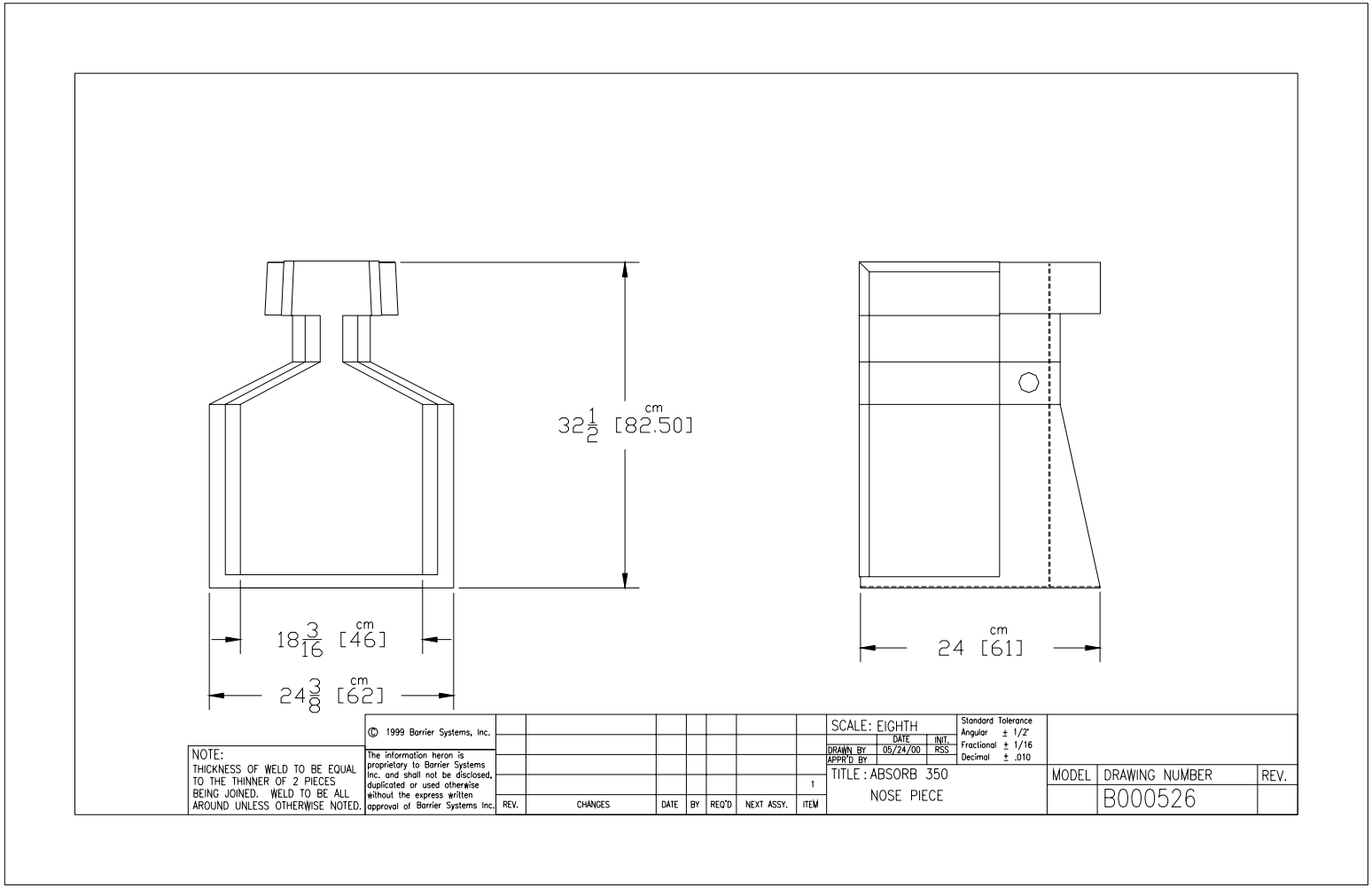
SCALE: 1=10

| | DATE | INIT. |
|---|---|---|
| DRAWN BY | 3/2/00 | R.R.C. |
| APPR'D BY | | |

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16
Decimal ± .010

TITLE : ABSORB 350 ELEMENT

| MODEL | DRAWING NUMBER | REV. |
|---|---|---|
| | B000524 | |






NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.

| REV. | CHANGES | DATE | BY | REQ'D | NEXT ASSY. | ITEM |
|---|---|---|---|---|---|---|
| | | | | | | 1 |

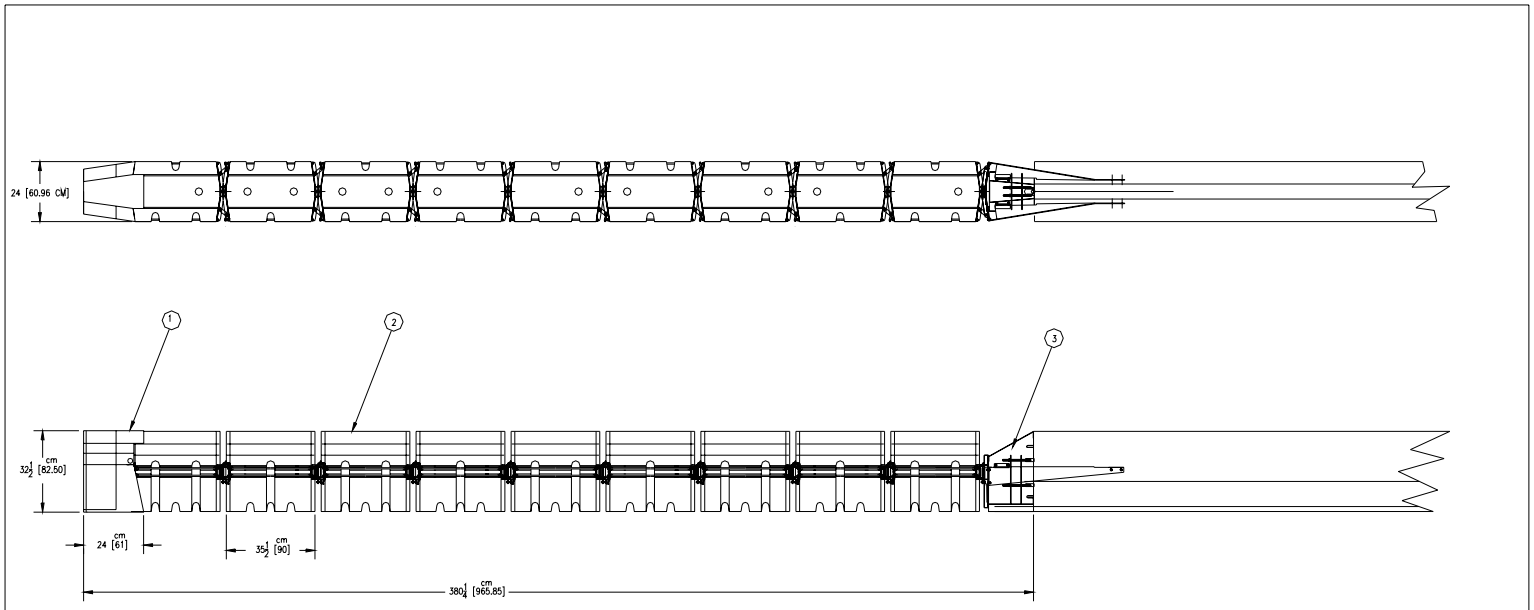
SCALE: EIGHTH

| | DATE | INIT. |
|---|---|---|
| DRAWN BY | 05/24/00 | RSS |
| APPR'D BY | | |

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16
Decimal ± .010

TITLE : ABSORB 350
NOSE PIECE

| MODEL | DRAWING NUMBER | REV. |
|---|---|---|
| | B000526 | |




SEE B000608.BOM FOR MATERIAL LIST

NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.



| REV. | CHANGES | DATE | BY | REQ'D | NEXT ASSY. | ITEM |
|---|---|---|---|---|---|---|
| | | | | | | |

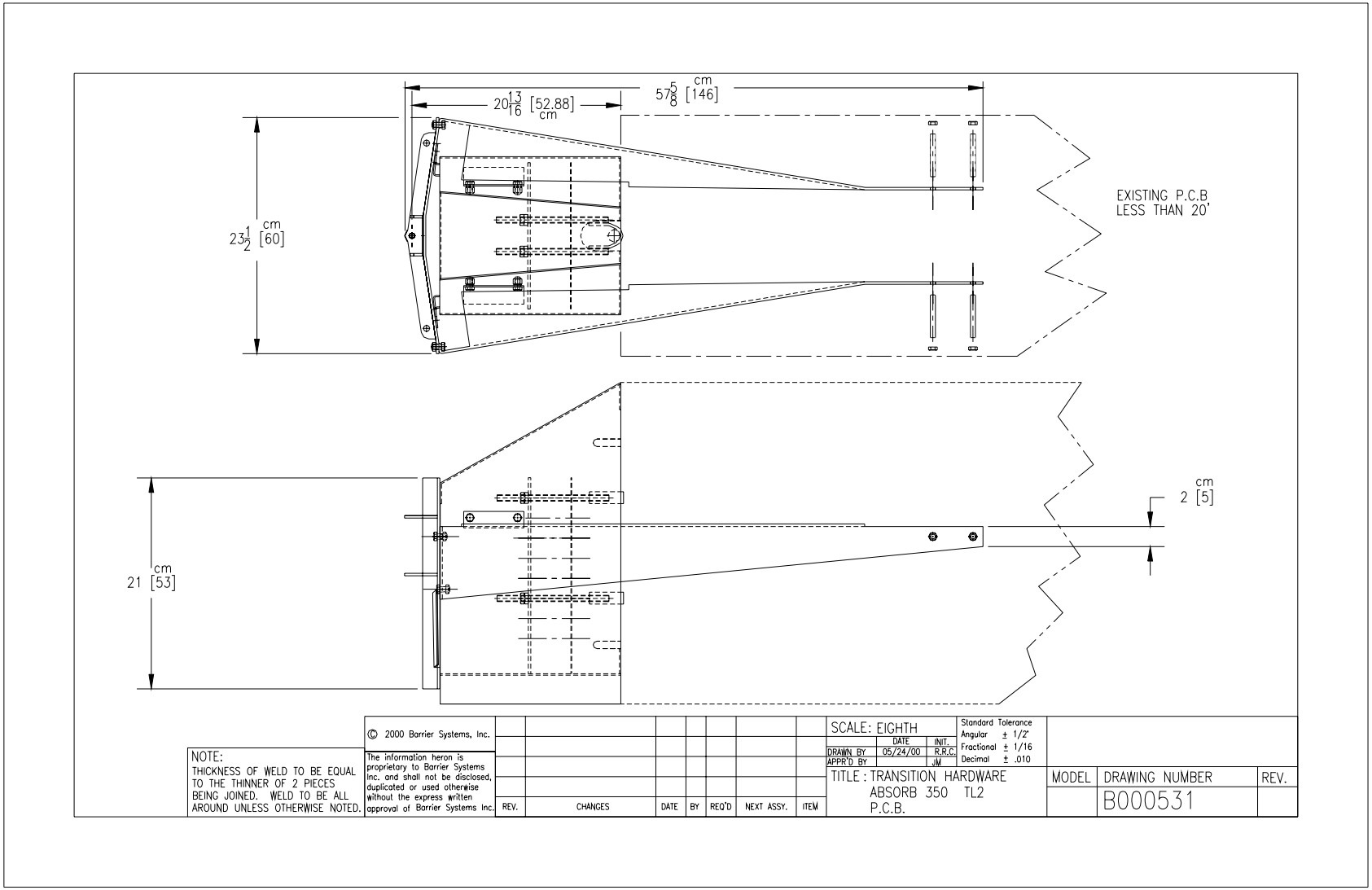
SCALE: 1=40

| | DATE | INIT. |
|---|---|---|
| DRAWN BY | 5/24/00 | DGB |
| APPR'D BY | | |

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16
Decimal ± .010

TITLE : ASSEMBLY SYSTEM, ABSORB TL3 P.C.B.

| MODEL | DRAWING NUMBER | REV. |
|---|---|---|
| | B000608 | |


20 13/16 [52.88] cm
57 5/8 [146] cm
23 1/2 [60] cm
EXISTING P.C.B
LESS THAN 20'
21 [53] cm
2 [5] cm
NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.
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The information heron is proprietary to Barrier Systems Inc. and shall not be disclosed, duplicated or used otherwise without the express written approval of Barrier Systems Inc.
REV. CHANGES DATE BY REQ'D NEXT ASSY. ITEM
SCALE: EIGHTH
DRAWN BY 05/24/00 R.R.C.
APPR'D BY JM
Standard Tolerance
Angular ± 1/2'
Fractional ± 1/16
Decimal ± .010
TITLE : TRANSITION HARDWARE
ABSORB 350 TL2
P.C.B.
MODEL DRAWING NUMBER REV.
B000531

**ACZ-350 SYSTEM**
**GENERAL SPECIFICATIONS**

## I. GENERAL

A. The ACZ-350 is especially suited for use with Portable Concrete Median Barrier (PCMB). When assembled as specified by the manufacturer, the components of the ACZ-350 shall provide an integral non-redirecting crashworthy end treatment.

B. All elements, components, and subassemblies of the ACZ-350 shall be designed, manufactured, and/or supplied by Energy Absorption Systems, Inc., of Chicago, Illinois.

## II. DESCRIPTION OF THE SYSTEM

A. The ACZ-350 TL-3 system shall consist of a nose, four water filled barrier sections**,** and a transition.

1. The nose segment shall be constructed of 14 ga steel, free of water and connect to the lead barrier sections.

2. Barrier sections shall be composed of the following:

a) Each barrier section shall be constructed of a lightweight, recyclable, linear low density polyethylene plastic shell, with UV stabilizers and antioxidants, designed to accept water ballast.

b) The approximate physical dimensions and capacities of the barrier section shall be: length (pin to pin) 2019 mm [79.5 in.]; width: 546 mm [21 1/2 in.]; height: 826 mm [32 1/2 in.].

c) Barrier sections shall be constructed in yellow, white or workzone safety orange colors for high visibility.

d) Each barrier section shall be equipped with a bent 1/8" steel piece recess in the top of the section, for suitable tensioning and compressive characteristics.

e) Each barrier section shall be constructed to interact with an impacting vehicle.

f) The ends of each barrier section shall be constructed with vertically aligned knuckles which interlock with those of abutting sections and accept a 51 mm [2 in.] dia. hollow steel connecting pin. The connecting pin shall be constructed to securely connect adjoining sections and their respective bent 1/8" steel pieces. A galvanized bolt, lock washer, and 102mm [4 in.] washer will retain the pin for suitable impact performance.

g) Each barrier section shall be constructed with elevated forklift openings to allow for mechanical lifting when empty or full.

h) Each barrier section shall be constructed with two 127 mm [5 in.] diameter quick fill openings with covers, and a 38 mm [1 1/2 in.] diameter rapid release gate valve to allow quick draining of the water ballast. A reflectorized fill level indicator shall be constructed in the top of each section to allow quick verification that the section is adequately full of water ballast.

i) The back two barrier sections shall include an internal galvanized steel framework and four strap assemblies recessed into the ribbed sidewalls to provide additional rigidity during impacts. Empty weight: 64 kg [140 lb.]; water ballast: 549 liters [145 gallons]. Weight when filled shall be approximately 612kg (1350 lbs). Weight does not include strap assemblies or connections.

j) The front two barrier sections shall <u>not</u> include an internal galvanized steel framework or four strap assemblies recessed into the ribbed sidewalls to ensure proper performance during impacts. Empty weight: 45 kg [99 lb.]; water ballast: 549 liters [145 gallons]. Weight when filled shall be approximately 595kg (1312 lbs).

3. ACZ-350 Transition Section

a) The transition section shall be constructed of galvanized steel.

b) The approximate physical dimensions of the transition section shall be: length (pin to pin) 510 mm [20 in.]; width: 621 mm [24.5 in.]; height: 813 mm [32 in.];

c) The section shall attached to the PCMB with two ¾" B7 all thread rods, four flat washers, four lock washers, and four nuts, in addition to a connection pin and two threaded "U" shaped fasteners.

## III. PERFORMANCE CRITERIA

A. The ACZ-350 System is a narrow, non-redirective, gating crash cushion and shall have been tested and evaluated per the criteria set forth in the National Cooperative Highway Research Program Report 350 (NCHRP-350) in accordance with TL-3 criteria. An FHWA acceptance letter shall be available authorizing its use on the National Highway System.

## IV. DESIGN AND SELECTION CRITERIA

A. Design, selection, and placement of the ACZ-350 System should conform with applicable guidelines in:

1. U.S. Department of Transportation, Federal Highway Administration, "Manual on Uniform Traffic Control Devices", Washington, D.C. U.S. Government Printing Office, 2003 and all subsequent revisions.
2. American Association of State Highway and Transportation Officials, "Roadside Design Guide", Washington, D.C. AASHTO, January 2002 and all subsequent revisions.

B. Installation of the ACZ-350 System shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Inc., and the ACZ-350 manual.

# ACZ-350™

PORTABLE
TL-2 & TL-3
END
TREATMENT

## OVERVIEW

The ACZ-350 System combines ease of use and NCHRP 350, gating, non-redirective TL-2 and TL-3 crash cushion performance for work zone protection. This partially reuseable crash cushion can be easily transported, and installed with No Roadway Anchors.

## SUPERIOR IMPACT PERFORMANCE

The unique design of the ACZ-350 systems protects errant drivers from impacting concrete barrier ends, and also contains the errant vehicle from vaulting into the workzone.

## FEATURES AND BENEFITS

- No Vaulting
- Safely contains errant vehicle
- Accommodates impacts up to 2,000 kg, (4,500 lbs) traveling at speeds up to 100 km/h (62 mph)
- Simple and Fast Installation
- Protects Permanent or Temporary, Steel or Concrete Barrier
- Ideal for Work Zones
- No Foundation or Anchoring

**EASY CLEAN-UP**
**NARROW PROFILE**
**MINIMUM INTRUSION**
**LOW COST/ AFFORDABLE**
**QUICK/EASY TO MOVE**

## NON-REDIRECTIVE, GATING CRASH CUSHION SYSTEM

All Crash Cushions defined as Non-redirective and Gating require a clear zone. Clear Zones are areas behind the crash cushion that NO workers, machinery, obstructions or other debris could interfere with an errant vehicle. This area should also remain relatively flat. If there are any questions or concerns, please contact your local Energy Absorption Systems, Inc. representative.



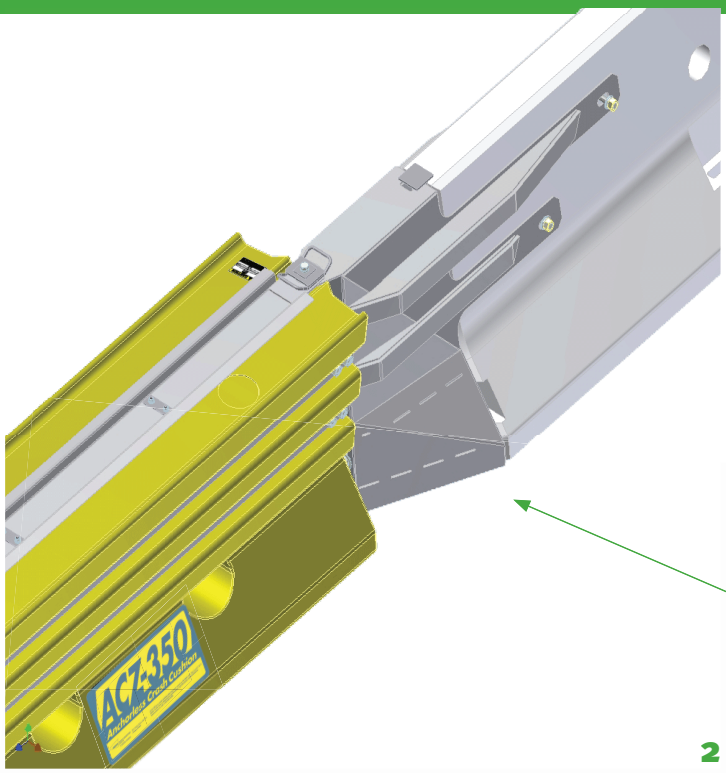



ENERGY ABSORPTION SYSTEMS, INC.

SAVING LIVES BY DESIGN®

www.energyabsorption.com

# ACZ-350™

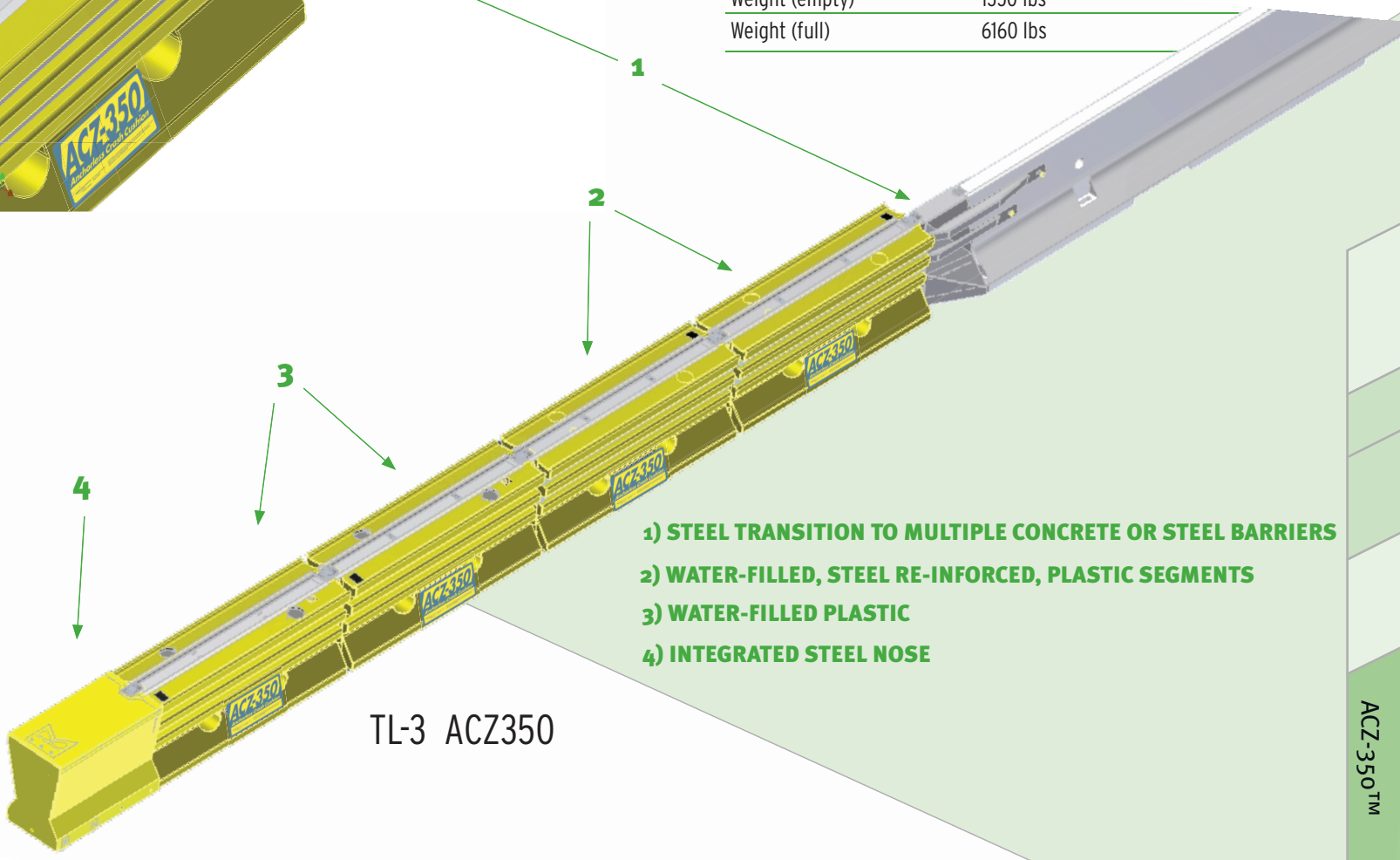



## EASY DEPLOYMENT AND REMOVAL

The ACZ-350 System can be easily unloaded and positioned without cranes or heavy equipment. Deployment involves three simple steps:

1. Unload
2. Position and pin barrier sections.
3. Fill Segments with water

| SPECIFICATIONS | TL-3 |
|---|---|
| Length | 31'-7" (9.6 m) |
| Width | 1'-10" (.6m) |
| Height | 2' 9" (.8m) |
| Weight (empty) | 1350 lbs |
| Weight (full) | 6160 lbs |




TL-3 ACZ350

**1) STEEL TRANSITION TO MULTIPLE CONCRETE OR STEEL BARRIERS**

**2) WATER-FILLED, STEEL RE-INFORCED, PLASTIC SEGMENTS**

**3) WATER-FILLED PLASTIC**

**4) INTEGRATED STEEL NOSE**

ACZ-350™

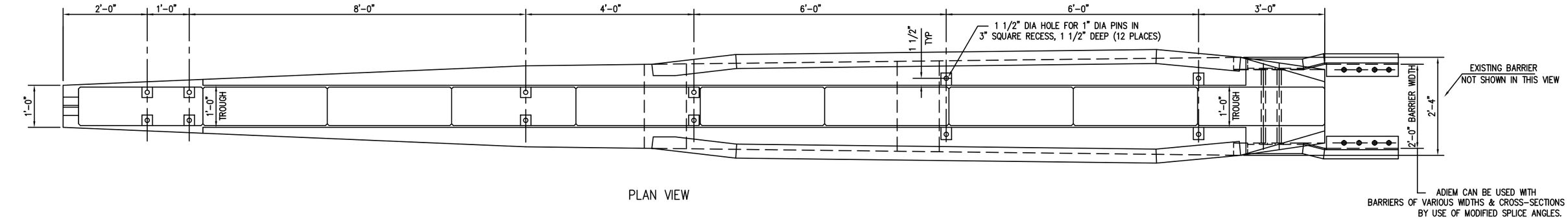
DISTRIBUTED BY:

Quixote Transportation Safety

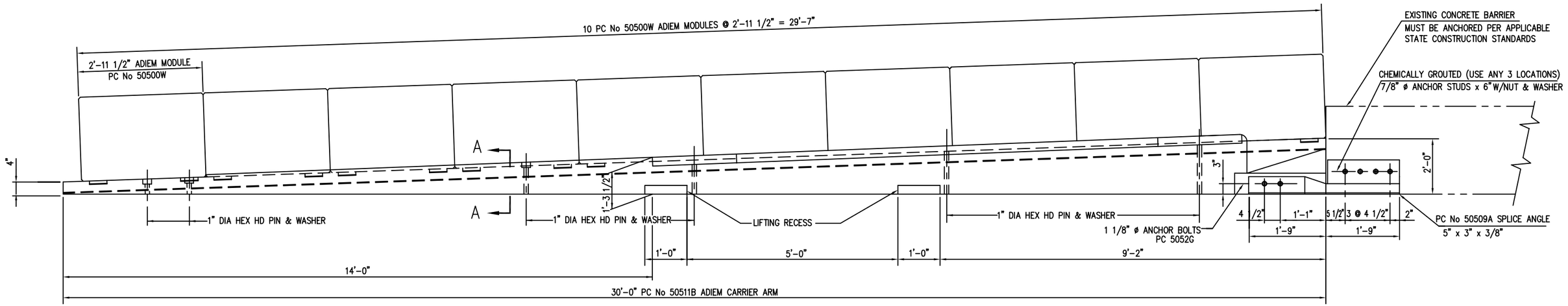
35 East Wacker Drive • Chicago, IL 60601
Tel: (312) 467-6750 • Fax: (312) 467-9625
www.energyabsorption.com

ENERGY ABSORPTION SYSTEMS, INC.

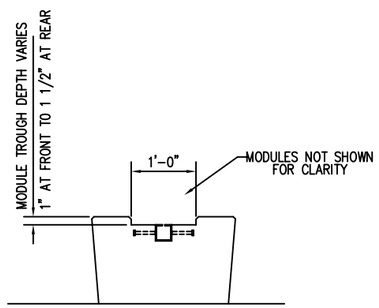
www.quixtrans.com



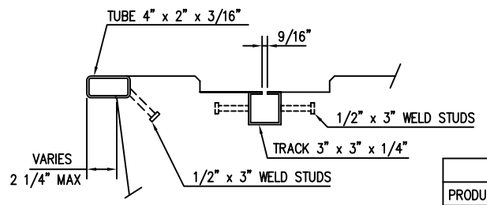

PLAN VIEW



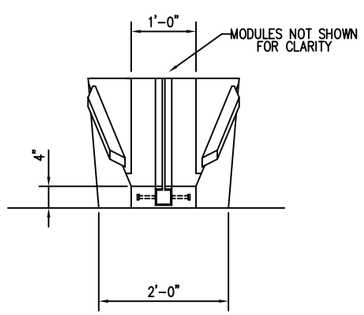

ELEVATION VIEW



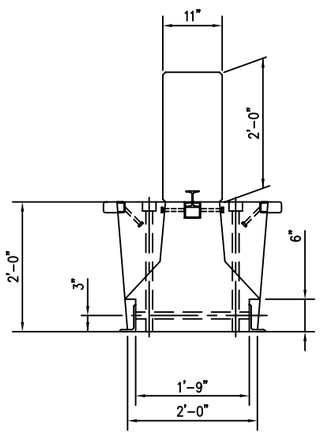

SECTION A-A




TRACK & BUMPER DETAIL




FRONT ELEVATION VIEW




REAR ELEVATION VIEW

BILL OF MATERIAL

| PRODUCT CODE | QTY | DESCRIPTION | REMARKS |
|---|---|---|---|
| 50500W | 10 | MODULES x 2'-11 1/2" | |
| 50511B | 1 | BASE x 30'-0" | |
| 50508A | 1 | SPLICE ANGLE x 3'-6" RT | |
| 50509A | 1 | SPLICE ANGLE x 3'-6" LT | |
| 6549W | 1 | GARNA-THANE COATING (1 GAL) | |
| 5052G | 2 | 1 1/8" ø x 25" HEX HD BOLT | |
| 4963G | 4 | 1 1/8" WASHER | |
| 3976G | 2 | 1 1/8" HEX NUT | |
| 4616G | 6 | 7/8"ø STUD x 6" (FULL THD) | |
| 3725G | 6 | 7/8" WASHER | |
| 3735G | 6 | 7/8" HEX NUT | |
| ☆ 5206B | 1 | ADHESIVE HY150 CARTRIDGE | |
| 3900G | 12 | 1" WASHER | |

| PRODUCT CODE | QTY | DESCRIPTION | REMARKS | ANCHOR PIN SCHEDULE PER SURFACE (SEE NOTES 1-5) PCC | ACP | BASE |
|---|---|---|---|---|---|---|
| 5665G | SEE SCH | 1" ø HEX HD PIN x 48" | SEE NOTES 1-5 | | | 4 |
| 5642G | | 1" ø HEX HD PIN x 42" | | | 4 | |
| 5650G | | 1" ø HEX HD PIN x 36" | | 4 | | 4 |
| 5641G | | 1" ø HEX HD PIN x 30" | | | 4 | 4 |
| 5646G | | 1" ø HEX HD PIN x 24" | | 4 | 4 | |
| 5643G | | 1" ø HEX HD PIN x 18" | | 4 | | |

☆ EACH CARTRIDGE INCLUDES 1 EACH : MIXER HY 150 CARTDIDGE(NOZZLE)
: FILLER HIT HY 150 (FILLER TUBE)

NOTES:
1) ANCHOR PINS ARE 1" DIA HEX HD, POINTED, GALV RODS (A307)
2) PORTLAND CEMENT CONCRETE (PCC)
3) ASPHALTIC CONCRETE (ACP)
4) BASE AND/OR COMPACTED SOIL (BASE)
5) ADIEM INSTALLATION NOT RECOMMENDED ON LOOSE SOIL.

ADIEM INSTALLATION INSTRUCTIONS

1. The ADIEM base is to be placed on a smooth surface (the same horizontal plane as the concrete barrier) and parallel to the mainline or ramp traveled lane(s).
2. Install anchor rods for ADIEM base by driving in soil or soft asphalt or driving in pre-drilled holes for hard asphalt or concrete (no epoxy required). The base should not be moved after the holes are drilled. The holes should be drilled using, at a mininum, a 35# hammer and minimum 36 inch long drill bit. (A 50# hammer is recommended.)
3. Attach connection brackets to base with two (2) 1 1/8" X 25" hex head bolts provided. Then field drill holes in the existing barrier and attach connection brackets to it with chemically grouted hardware provided.
4. Oil the ADIEM base track. Slide the modules onto the base. Be careful not to damage edges of the modules while sliding onto the base.
5. If the modules are scuffed or nicked, apply GARNA-THANE coating to the affected area.
6. Recommended tools and equipment:
   - 35/50# air hammer/drill
   - 1 3/8" ø x 36" rock drill
   - 1 1/4" ø x 12" rock drill
   - Sledge hammer
   - Oil
   - Wrenches

| OPTIONAL ANCHOR ITEMS | |
|---|---|
| PRODUCT CODE | DESCRIPTION |
| 5205B | ADHESIVE DISPENSER |
| 5207B | MIXER HIT HY150 (NOZZLE) |
| 5208B | FILLER HIT HY150 (FILLER TUBE) |
| 5209B | BIT TE-C+ 11/16-18 (11/16" ø BIT) |

ALTERNATE ADIEM INSTALLATION INSTRUCTIONS

1. At a holding site, the modules are slid into the ADIEM base after oiling the base track. Be careful not to damage the edges of the modules while sliding them onto the base.
2. If the modules are scuffed or nicked, apply GARNA-THANE coating to the affected area.
3. The unit is then delivered to the job site. The unit is to be placed on a smooth surface (the same horizontal slope as the concrete barrier) and parallel to the mailine or ramp traveled lane (s).
4. The front module should be removed so the remaining modules can be shifted for easy access for drilling the anchor rod holes.
5. Install anchor rods for ADIEM base by driving in soil or soft asphalt or driving in predrilled holes for hard asphalt or concrete (no epoxy required). The base should not be moved after the holes are drilled. The holes should be drilled using, at a minimum, a 35# hammer and a minimum 36 inch long drilling bit. (A 50# hammer is recommended.)
6. Attach connection brackets to base with two (2) 1 1/8" X 25" hex head bolts provided. Then field drill holes in the existing barrier and attach connection brackets to it with chemically grouted hardware provided.

| REV. | CHK'D | BY | DATE | REMARKS |
|---|---|---|---|---|
| 6 | B.T. | L.H. | 12/10/03 | REPLACED GROUT WITH HILTI, UPDATED DWG |
| 5 | | L.H. | 03/12/03 | DELETED NOTE #7, REVISED NOTE #3 |
| 4 | D.D. | L.H. | 12/17/99 | REVISED COATING, CHANGED TITLE BLOCK |
| 3 | | BT | 3-14-97 | DELETED PC 5484, ADDED PC 5052, CHG QTY PC 3976 |
| 2 | | BT | 2-14-97 | GENERAL UPDATES |

# ADIEM 30'

## ERECTION DETAILS

TRINITY INDUSTRIES, INC.
HIGHWAY SAFETY PRODUCTS
2525 STEMMONS FREEWAY, DALLAS, TX 75207

| | |
|---|---|
| DRAWN | B.TAKACH |
| CHECKED | D.D. |
| APPROVED | |
| DATE | 3/19/96 |
| ENG. FILE # | SS349-01E |
| SHT.No. | E1 OF 1 |
| DRAWING NO. | SS 349 |
| REV. | 6 |

# QuadGuard® CZ System

## PORTABLE NON-GATING REDIRECTIVE CRASH CUSHION FOR WORK ZONES

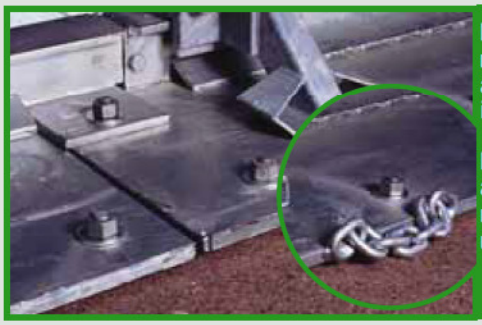
## OVERVIEW

The innovative QuadGuard CZ System has been improved with the addition of modular plate bases to reduce anchorage and speed installation. The QuadGuard CZ System meets all of today's strict crash cushion performance criteria. The QuadGuard CZ System provides the same lifesaving efficiency and features of the permanent QuadGuard System, in a compact, portable system that is easier than ever to install.

During head-on impacts, the QuadGuard Systems telescope rearward and crush the cartridges to absorb the energy of impact. When impacted from the side at angles up to 20°, the QuadGuard Systems safely redirect the errant vehicle back toward its original travel path without allowing gating.

## FEATURES AND BENEFITS

- NCHRP 350 TL-3 performance requires only 30 anchors
- Compact, modular design can accommodate speeds from 70 km/h (45 mph) to 115 km/h (71 mph)
- 80% reusability after most design impacts
- Lifting points allow easy repositioning as a complete unit
- Easy to access anchor holes allow for fast installation
- Available in 610, 762 & 910 mm (24, 30 & 36 in.) widths to protect a wide array of hazards

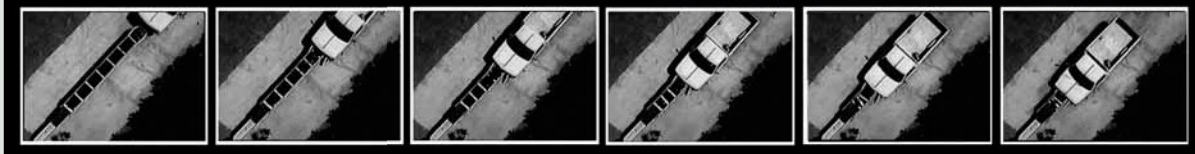


Modular plate base reduces anchorage and speeds installation

Built-in lifting points allow the system to be moved as a complete unit

ENERGY ABSORPTION SYSTEMS, INC.

SAVING LIVES BY DESIGN



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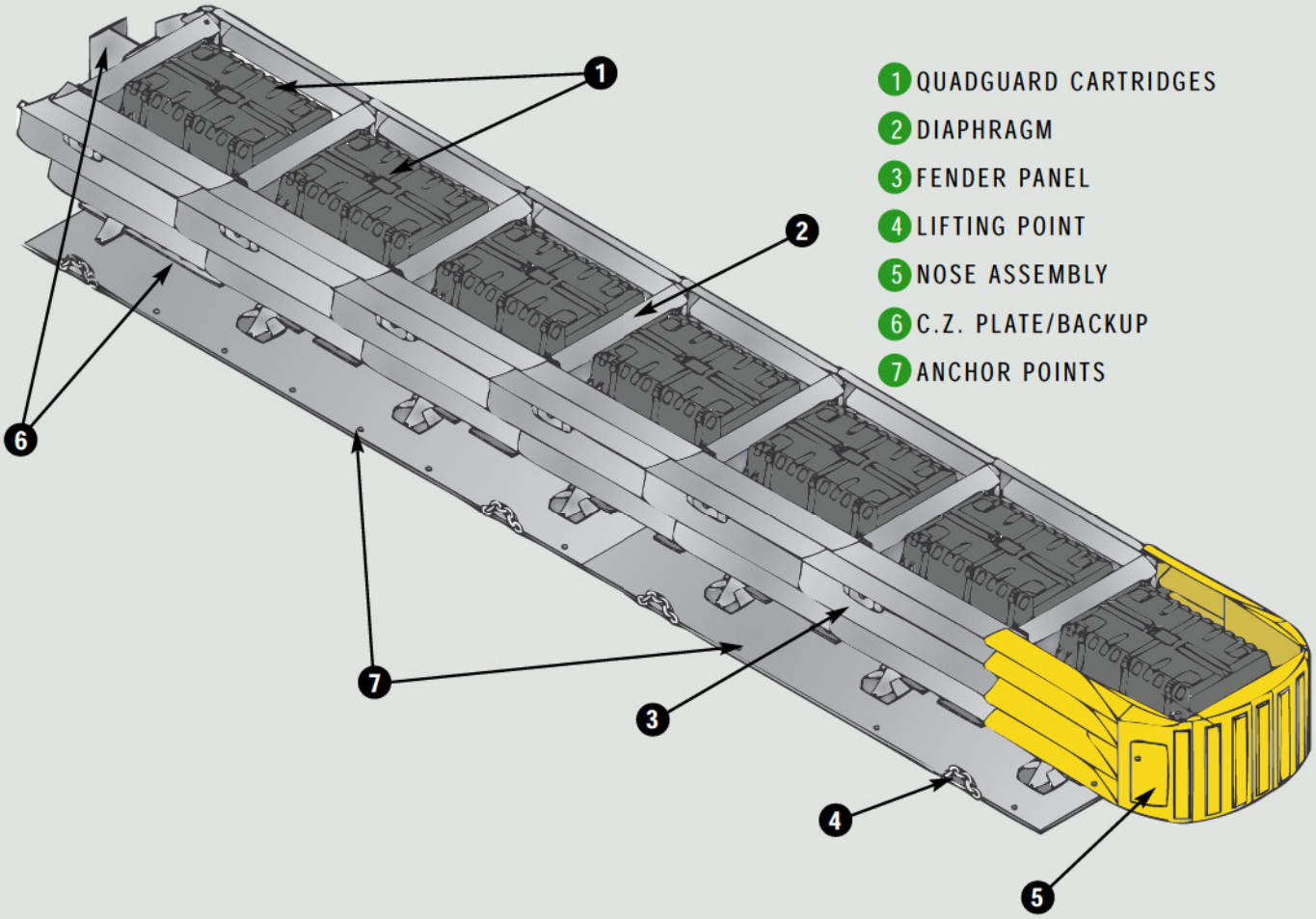
## QUICK & EASY INSTALLATION & REMOVAL

- Only 30 anchor bolts needed for TL-3 six bay unit
- Easy access to anchor holes
- Entire system can be moved as a single unit using lifting points

## SPECIFICATIONS

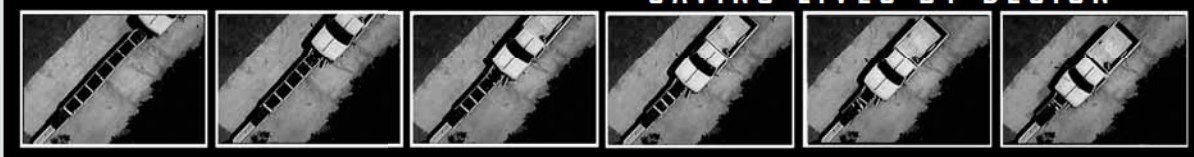
| | | |
|---|---|---|
| Minimum Width at Backup | 610.0 mm | (2') |
| Maximum Width at Backup | 915 mm | (3') |
| Weight (typical 6-bay unit) | 1594.0 kg | (3512 lb.) |
| Length (typical 6-bay unit) | 6.4 m | (21') |




1. QUADGUARD CARTRIDGES
2. DIAPHRAGM
3. FENDER PANEL
4. LIFTING POINT
5. NOSE ASSEMBLY
6. C.Z. PLATE/BACKUP
7. ANCHOR POINTS

Quixote Transportation Safety

SAVING LIVES BY DESIGN



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General specifications for the QuadGuard System are subject to change without notice to reflect improvements and upgrades. Additional information is available in the Product Manual for this system. Contact Energy Absorption Systems for details.

# QuadGuardÒ System

GENERAL SPECIFICATIONS

## I. GENERAL

All QuadGuard Systems shall be designed and manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois.

## II. DESCRIPTION OF SYSTEM

A. General

The QuadGuard System shall consist of energy absorbing cartridges surrounded by a framework of steel Quad-beam™ guardrail which can telescope rearward during head-on impacts. The QuadGuard System shall have a center monorail which will resist lateral movement during side angle impacts and a backup which will resist movement during head-on impacts. The nose shall consist of a formed plastic nose wrap and an energy absorbing cartridge. Transitions are available and may be required depending on site conditions.

B. Component Description

1. A bay describes a section of the QuadGuard System consisting of an energy absorbing cartridge, a diaphragm, two fender panels and fasteners.

   a. There are two types of cartridges, referred to as Type I and Type II. The front portion of the system shall be fitted with Type I cartridges. The rear of the system shall be fitted with Type II cartridges. The outside of each cartridge shall be fabricated from a weather resistant plastic. The actual quantity of each shall be determined by the system design speed. Refer to the product design manual for more information.

   b. The diaphragms shall be made from 10 gauge, steel Quad-beam sections. Two support legs shall be welded to the Quad-beam. Ski-shaped plates shall be welded to the bottom of the support legs. The diaphragms shall be designed to lock onto and be guided by a ground-mounted, center monorail support structure.

   c. The fender panels shall be fabricated from 10 gauge steel Quad-beam sections. The rear of each fender panel (the panel end furthest from the nose of the assembled system) shall be tapered to help maximize performance during wrong-way, redirective impacts. Each fender panel shall be drilled and slotted in accordance with the manufacturer's

specifications so that when assembled in the field, the front end (the end closest to the nose of the assembled system) shall be bolted to a diaphragm or hinge plate (depending on width of system) by means of 5/8" bolts. The rear of each Quad-beam™ fender panel shall overlap the next rearward fender panel and be connected to the diaphragm or hinge plate of the next bay by means of a bolt and "mushroom" washer. The bolt fits through the long horizontal slot in the forward fender panel. This permits the movement, front to back, of one set of fender panels relative to the panels in the underlying, next rearward bay. For QuadGuard® Systems with a backup width greater than 915mm (36"), the mushroom bolt assembly is held in place by a compression spring, which allows limited separation of the fender panels during an impact.

2. The monorail support structure shall be made of steel and be anchored per manufacturers instructions, to a specified concrete pad. The monorail shall prevent lateral movement, vertical movement and overturning of the diaphragms during design impacts.

3. The nose section shall contain a nose cover and an energy absorbing cartridge and is not counted as a bay. The nose cover shall be made from a plastic material formulated to resist weathering. The nose shall attach to the front diaphragm. Standard colors shall be gray or yellow.

4. The backup shall be made of steel and be attached to concrete or an integral tension strut framework, and shall be available in nominal widths of 610mm (24"), 762mm (30"), 915mm (36"), 1753mm (69"), and 2286mm (90").

5. Several transition panels are available as required by site conditions including: Quad-beam to Safety Barrier, Quad-beam to Thrie-beam, Quad-beam to W-beam, and Quad-beam End Shoe. Contact Energy Absorption Systems, Inc. for specific applications.

C. Material Specifications

1. Metal work shall be fabricated from either M1020 Merchant Quality or ASTM A-36 steel. After fabrication, metal work shall be galvanized in accordance with ASTM A-123. All welding shall be done by or under the direction of a certified welder.
2. The system shall be assembled with galvanized fasteners. All bolts, nuts, and washers shall be Commercial Quality "American National Standard" unless otherwise specified.

## III. PERFORMANCE CRITERIA

A. For head-on impacts into the nose, a QuadGuard® System shall be specified which is capable of meeting the occupant risk criteria as recommended in NCHRP 350. For vehicles weighing between 820 and 2000 kg [1,810 and 4,410 lbs], the theoretical impact velocity of a hypothetical front seat passenger against the vehicle's interior (calculated from vehicle acceleration and 600mm [24"] forward displacement) shall be less than 12m/s [39.4 ft/sec], and the vehicle's highest 10 millisecond average acceleration subsequent to the instant of the hypothetical passenger impact shall be less than 20 G's.

B. The QuadGuard System shall be capable of redirecting 2000 kg [4,410 lbs] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 20° for both right-way and wrong-way impacts (angles measured from system's longitudinal centerline). The QuadGuard System shall be capable of redirecting 820 kg [1,810 lbs] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 15°. (See Test Criteria below.)

C. The QuadGuard System shall be designed and constructed so there is no solid debris from the system which can create a hazard on the roadway after either head-on or side angle design impacts.

## IV. TEST CRITERIA

The QuadGuard System shall have been fully tested per the recommended criteria set forth in National Cooperative Highway Research Program (NCHRP) Report 350, 1993, Test Level 3 for redirective, non-gating terminals and crash cushions.

## V. DESIGN AND SELECTION CRITERIA

A. Design, selection and placement of crash cushions shall conform to The American Association of State Highway and Transportation Officials (AASHTO) Publication, "Roadside Design Guide" 1996.

B. Installation of the QuadGuard System attenuators shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Incorporated.

# TrafFix Devices Inc.

# SLED™

**Sentry Longitudinal Energy Dissipater**

PRODUCT BULLETIN

*SLED™ TL-3 in use on a Missouri Highway*

*SLED™ TL-2 in Illinois*

*SLED™ TL-3 in Downtown Cincinnati, Ohio*

- FHWA Accepted for Shielding the Blunt End of Concrete, Steel and Water Filled Barriers
- Quick and Easy Set-Up, No Foundation Anchoring, Minimized Installation Exposure Time
- Cost Effective End Treatment for Concrete, Steel or Water Filled Barriers
- Universal Transition Quickly and Easily Attaches to a Variety of Barrier Shapes and Sizes
- *SLED's* Stout Design Virtually Eliminates Vaulting
- Narrow Footprint is Ideal for Work Zones or Roads with Minimal Shoulder Spacing
- Shortest Length TL-3 Water Filled Crash Cushion, Fewer Incidental Impacts
- Containment Impact *SLED* Minimizes Debris Field
- Visual "Drive By" Fill Indicators Quickly Verify Water Module's are Properly Filled
- FHWA Accepted for Use in Uni- and Bi- Directional Applications
- Internal Steel Cables Help Envelop Vehicle After an Impact, Creating a Truly "Limited Gating" System

*Scan for Instant QR Video*

www.traffixdevices.com

# SLED™

***Sentry Longitudinal Energy Dissipater***

Inline TL-3 Truck Test Pre Impact

Inline TL-3 Truck Test Post Impact

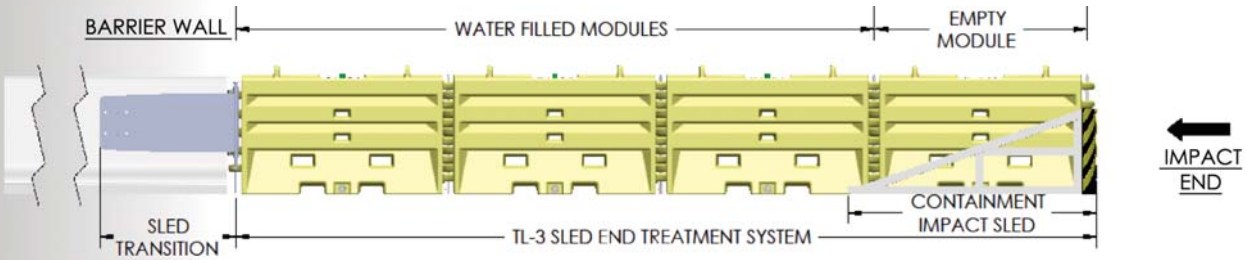
## SLED™ Sentry Longitudinal Energy Dissipater

The Sentry Longitudinal Energy Dissipater (SLED) is a narrow, non-redirective gating crash cushion. SLED is designed to shield the end of all permanent and temporary portable barrier shapes including concrete, steel and plastic. SLED's unique design incorporates four internal steel cables which help envelop the impacting vehicle, reducing the possibility of secondary accidents. The SLED End Treatment does not require foundation anchor bolts to be attached to the road or bridge deck. The complete crash cushion can be installed quickly, with as little as one pick up truck and two workers on compacted dirt, gravel, decomposed granite, asphalt or concrete.

Each SLED module is manufactured from a high visibility yellow polyethylene that is UV stabilized to minimize degradation. It is designed to deform and rupture on impact, absorbing the energy of the errant vehicle. SLED has the most versatile transition for shielding all permanent and temporary portable barriers. The combination of hinging and contouring, allows the transition panels of the SLED End Treatment to be attached to narrow, wide or other profile shapes with either converging, or diverging angles, up to 10 degrees.

*SLED*™ TL-3 4500 lb. Pick-Up Truck Impact Attached to Concrete Median Barrier Wall

| TL-3 SPECIFICATIONS | |
|---|---|
| Length: | 25' 3" |
| Width: | 22'-1/2" |
| Height: | 42" |
| Weight (Empty): | 995 lb. |
| Weight (Full): | 6505 lb. |




Steel Barrier Attachment

SLED™ TL-3 Transports in a Pick-Up Truck

Concrete Barrier Attachment

SLED™ Internal Cables

Distributed by:

**TrafFix Devices Inc.**

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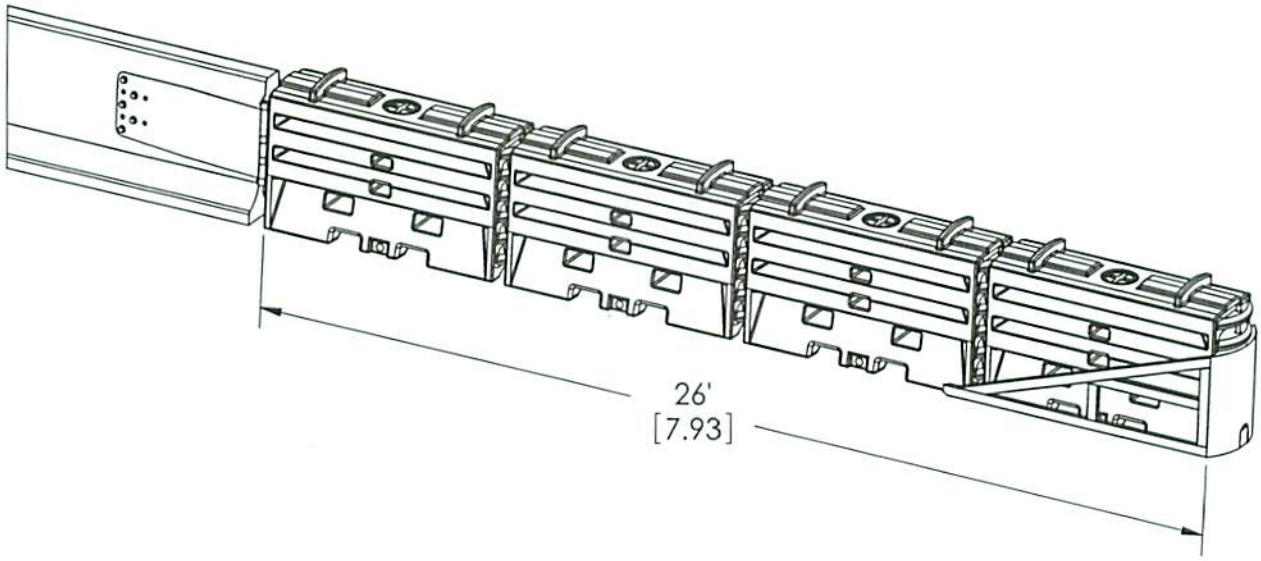


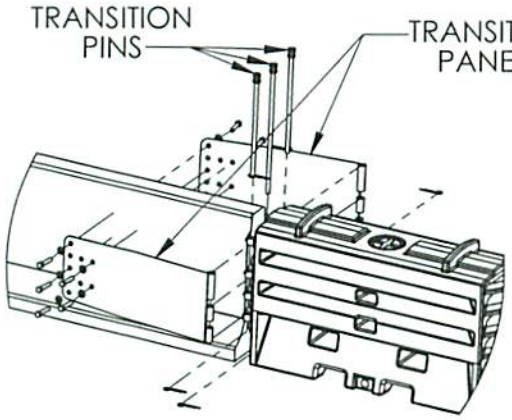


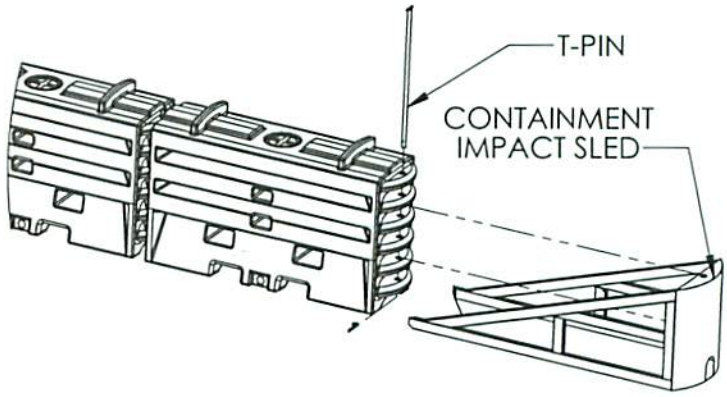


# SLED END TREATMENT

TrafFix Devices Inc.

SER##

| SHEET NO. | DATE: |
|---|---|
| 1 OF 2 | 08/27/2010 |

## INTENDED USE

The Sentry Longitudinal Energy Dissipater (SLED) End Treatment is a narrow water-filled non-redirective, gating crash cushion designed to shield the end of all permanent and portable barrier shapes including concrete, steel, and plastic. The SLED End Treatment does not require foundation anchor bolts to be attached to the road surface. The complete crash cushion can be installed on firm soil, asphalt, and concrete.

The SLED End Treatment meets NCHRP-350 TL-3, TL-2, and TL-1 crashworthy test requirements as a non-redirective crash cushion. Four yellow modules make up the complete crash cushion assembly. Front module 1 is left empty and weighs 160 lbs. [75.6 kg]. Modules 2, 3, and 4 are filled and weigh approximately 2000 lbs [907.2 kg]. The Containment Impact Sled is attached to the front of Module 1 and the Transition is attached to the rear of Module 4.

SLED End Treatment
Length: 26 ft (7.93 m) Four (4) Modules
Height: 42-11/16 in (1.09 m)
Width: 22-1/2 in (0.57 m)

The SLED End Treatment has been fully tested to the recommended procedures of NCHRP-350.

## ACCEPTANCE

FHWA Acceptance Letters:

## CONTACT INFORMATION

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www.traffixdevices.com

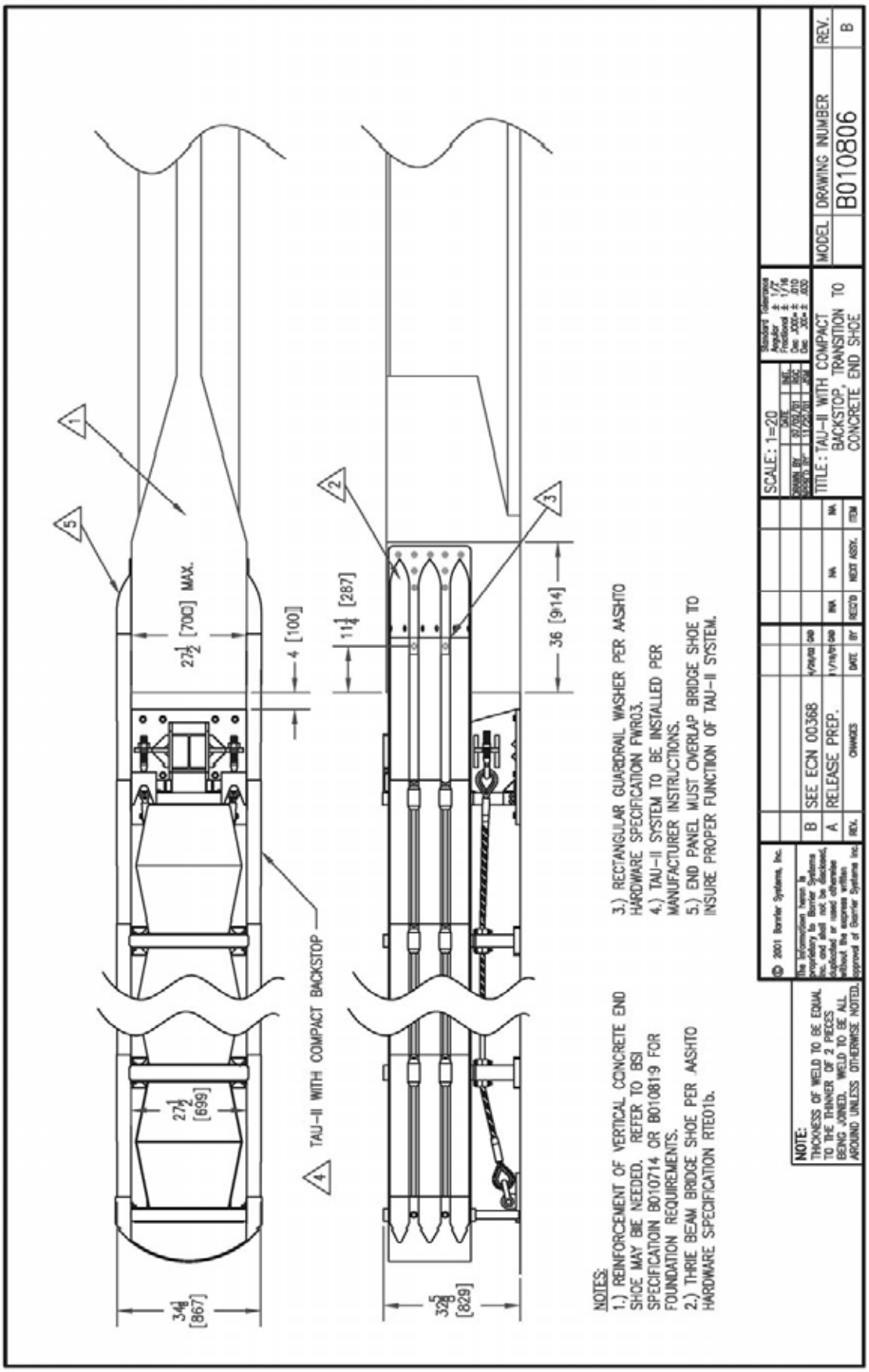
Phone: +1(949)-361-5663
Fax: +1(949)-361-9205
Email: info@traffixdevices.com

SLED END TREATMENT

SER##

| SHEET NO. | DATE: |
|---|---|
| 2 OF 2 | 08/27/2010 |

TrafFix Devices Inc.


TAU-II WITH COMPACT BACKSTOP
27½ [700] MAX.
4 [100]
11¼ [287]
36 [914]
34⅛ [867]
27½ [699]
32⅝ [829]
NOTES:
1.) REINFORCEMENT OF VERTICAL CONCRETE END SHOE MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
3.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
4.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
5.) END PANEL MUST OVERLAP BRIDGE SHOE TO INSURE PROPER FUNCTION OF TAU-II SYSTEM.
NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.
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B SEE ECN 00368 KRAVEL DAB
A RELEASE PREP. 11/15/01 DAB
REV. CHANGES DATE BY
SCALE: 1=20
DRAWN BY KRAVEL 07/09/01
ENGR'D BY DAB 11/29/01
Standard Tolerances
Angular ± 1/2°
Fractional ± 1/16
Dec .XXX= ± .010
Dec .XX= ± .030
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO CONCRETE END SHOE
MODEL
DRAWING NUMBER B010806
REV. B
RECD'D
NEXT ASSY.
ITEM