

INFORMATION HANDOUT

For Contract No. 04-3G1204

At 04-Son-128-PM 1.8

Identified by

Project ID 0400021276

MATERIALS INFORMATION

Foundation Report - CIDH Soldier Pile Wall dated March 14, 2013

ET-31 Assembly Manual

04-3G1204
04-Son-128-PM 1.8
Project ID 0400021276

Memorandum

*Flex your power!
Be energy efficient!*

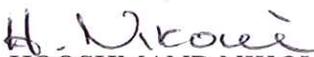
To: MR. MIKE KEEVER
Supervising Bridge Engineer
Bridge Design West
Structures Design

Date: March 14, 2013

Attention: G. Danke

File: 4-SON-128- PM 1.80
04 – 3G1201
Efis: 0400021276
Storm Damage
CIDH Soldier Pile Wall

From: 
A. KADDOURA/M. ZABOLZADEH
Associate M and R Engineers
Office of Geotechnical Design – West
Geotechnical Services
Division of Engineering Services


HOOSHMAND NIKOUI
Chief, Branch A
Office of Geotechnical Design - West
Geotechnical Services
Division of Engineering Services

Subject: Foundation Report – CIDH Soldier Pile Wall

1. INTRODUCTION

As per your request dated June 22, 2012, we are providing Office of Structure Design with our foundation recommendation for the design of the proposed CIDH soldier pile wall for permanent repair of the slipout at the above referenced project.

1.1 History

The roadway settlement and rotational movement (pavement cracking) is located on southbound Route 128, PM 1.8, approximately 1.6 miles north of Hogwarts Way, just north of the Town of Cloverdale in Sonoma County.

The settled area is approximately 130 feet long with about 4 inches settlement (dip in roadway) and rutting along with visible cracks in the eastbound lane that extend partially into the centerline of the roadway. It appears that the road within the limits of the settled area was built as cut and fill sections with steep side slopes of about 1.5H: 1V just below the road and then approaching 1H: 1V to an old dirt road approximately 80 feet below the road. From our visual inspection of the site, it appears that significant surface runoff from recent heavy winter rainstorms has saturated the area. This rain water has likely oversaturated the roadway embankment resulting in the differential settlement and possible development of a rotational failure in the embankment section. The rotational movement of the roadway was not apparent at

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the time of our inspection, however, it is suspected as an incipient movement. According to our subsurface investigation, it appears that the rotational movement is at about 13 feet below roadway surface (bottom of fill material). It should be noted that the area has recently been AC overlaid.

2. PROJECT PURPOSE AND NEED

The need for this project is to permanently repair the landslide and rebuild the roadway at this location. Several alternatives were considered for repairing the slipout such as using Gabion Wall, segmented pile wall, geosynthetic reinforced embankment and soldier pile wall. After discussing these options with Design, Headquarters Geometrician and other support units, it was determined that a 12 ft northbound lane, 4 ft shoulder and 4 ft clearance for the MBGR will be required at this location. Due to R/W acquisition, environmental clearance and project delays and contract for delivery for the 2013/2014, it appears that the most feasible alternative is constructing a CIDH soldier pile wall at this location. Based on the above, the face of the proposed wall be located at 24 ft offset from the existing Route 128 centerline.

Refer to the attached Exhibit A for details.

3. SCOPE OF WORK

The following tasks were performed for the preparation of this Foundation Report:

- Field mapping
- Field geotechnical exploration, including drilling one boring
- Review of the previously prepared memorandums by this office
- Laboratory testing on selected samples

4. SITE AND REGIONAL GEOLOGY

4.1 Regional and Site Geology

Site Geology

The site lies in northern Sonoma County, in the California Coast Ranges, a northwest-trending band of folded and faulted mountains that roughly parallel the San Andreas Fault zone. Sonoma County, like all of California, is highly seismically active. The Maacama Fault, the San Andreas Fault and the Rogers Creek Fault are major faults in Sonoma County. East of the San Andreas Fault, the Cretaceous Franciscan Formation is present throughout much of Sonoma County. The site lies on Franciscan Complex graywacke. The Franciscan Complex is commonly sheared and prone to sliding.

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The Franciscan Complex is a “Block in Matrix” rock. It is made up sheared and folded metamorphic rocks, such as graywacke, chert, and serpentine. Resistant blocks of hard rock are randomly distributed in a soft matrix. Usually, the blocks are serpentine or greenstone (metamorphosed basalt), and the matrix can be argillite (sheared mudstone) or graywacke (sandstone). The blocks are randomly distributed, which means they can range from pebble-sized to as large as a house, and they do not lie in layers or exhibit any regular structure. Moreover, within blocks, there can be variability in characteristics such as hardness and the degree of fracturing, bedding orientation, etc.

The site lies within a large block of graywacke. (Geologic Map-Figure 1) The rock is highly deformed, with open joints and shears occurring at intervals of 6 inches or less. Bedding is thin to medium. In some places, the rock is unstable because joints and bedding intersect.

4.2 Seismicity

Geologists and seismologists recognize the San Francisco Bay Area as one of the most active seismic regions in the United States. There are 4 faults within 10 miles of the project site. The controlling fault for the project is Maacama fault zone (North section). The Maacama Fault lies 3.1 miles from the project site. Caltrans ARS tool gives a maximum PGA of 0.60 at a period of 0.01, using a Shear Wave Velocity (V_{S30}) of 560 m/s. This PGA was calculated with the USGS Probabilistic model, using the USGS Seismic Hazard Map (2008) and a 975 year return period. Fault data is presented in Table 2, and fault locations presented on the attached Fault Map-Figure 2.

Table 2: Fault Data*

Fault Name	Distance: Miles	Fault ID:	Fault Type:	Maximum Magnitude (MMax):
Maacama fault zone (North section)	3.1	66	Strike Slip	7.4
Maacama fault zone (South section)	3.5	92	Strike Slip	7.4
Chianti fault	3.5	96	Strike Slip	6.4
Wight Way	6.3	89	Strike Slip	6.5
San Andreas (North Coast) 2011 CFM	21.3	80	Strike Slip	8.0

*Caltrans ARS Online (v2.0.4)

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4.3 Geologic Hazards

The site may be affected by activity along any of the active faults discussed above. Earthquake induce hazards can be categorized as primary and secondary seismic effects.

Primary seismic effects such as ground rupture or surface deformation resulting from differential movement along a fault trace are not expected to occur. According to the Alquist-Priolo Earthquake Fault Zone Maps, there are no active faults within the project area.

Secondary seismic effects result from various soil responses to ground acceleration. These effects result from activity of any nearby active faults.

- Liquefaction of Natural Ground – Liquefaction is a process by which soil deposits below the water table temporarily lose strength and behave as a viscous liquid rather than a solid, typically during a moderate to large earthquake. In general, very loose to medium dense, clean fine- to medium-grained sand and very soft to firm; low plasticity silts that are relatively free of clay are most susceptible to liquefaction. Earthquake-induced ground shaking can cause these loose or soft materials to densify, resulting in increased pore water pressures and an upward movement of groundwater that may result in a liquefied condition. Depending on the weight of the structure, the depth to the liquefied stratum and the nature of the overlying soils, structures situated above such temporarily liquefied soils may sink or tilt, causing significant structural damage.

According to the Liquefaction Susceptibility Map, the project is located in an area of very low liquefaction susceptibility level (see Figure 4, Liquefaction Susceptibility Map). Additionally, based on the subsurface soil description in Section 5 of this report, liquefaction potential is considered to be insignificant.

- Cracking – Lurch cracks may develop in the silty and clayey soil overlying the site. The potential for lurch cracking will be higher in the rainy periods when the soil is saturated. The hazard from cracking is considered minimal.
- Differential Compaction – During moderate and large earthquakes, soft or loose, natural or fill soils can become densified and consolidated, often unevenly across a site. Since loose or soft material was not encountered in our investigation, the potential for differential compaction is minimal.

Ground Shaking - As noted in the Seismicity Section above, moderate to large earthquakes are probable along several active faults in the greater Bay Area. Therefore, strong ground shaking should be expected at some time during the design life of the proposed development.

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The improvements should be designed in accordance with current earthquake resistant standards.

5. SUBSURFACE SOIL CONDITIONS

One Power boring (A-12-001) was drilled utilizing 6 inches hollow stem auger drilling method with Standard Penetration Test (SPT) sampling in July 2012, on the northbound lane within the slide area to the depths of 61.5 feet. The boring describe the foundation soils/rocks as approximately 13 feet of very stiff to hard sandy lean clay (of which there are about 13 ft of fill). The remainder of the borings describes the foundation soils/rocks as moderately weathered, very intensely fractured hard metamorphic rock (Meta chert) with soft sandy clay infilling. The unconfined compressive strength of the clayey soil (using a pocket penetrometer) was estimated to range between 3.5 and 4.5 tsf. The SPT blow counts range from 6 to more than 50 (refusal) blows per foot.

Groundwater was not encountered in boring A-12-001 at the time during drilling (July 2012). Refer to the attached Log of Test Boring Sheets (LOTB) for details. The LOTB sheets should be included with the contract plans.

6.0 GEOTECHNICAL TESTING

6.1 Laboratory and In-Situ Testing

Laboratory testing was performed on selected samples of the subsurface materials obtained during our subsurface investigation for corrosion and moisture content. In-Situ tests include performing SPT and pocket penetrometer testing on clay soil samples.

7. FOUNDATION RECOMMENDATIONS

CIDH Soldier Pile Wall

We recommend repairing the slide part of the storm damage by placing an approximately 150 feet long (Station 23+00± to Station 24+50±) CIDH soldier pile wall along the outside edge of shoulder and mitigating the settlement portion with soil densification using cement compaction grouting. See attached Exhibits A, B and approved cement compaction grouting NSSP.

Based on the LOTB, we recommend the proposed CIDH soldier pile wall be designed for the following design parameters:

- The proposed wall should act as 13 feet (max.) cantilever.

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- The proposed piles should be minimum 24 inches in diameter (H beam), 35 ft (min, total length) long, and should be located about 24 feet right of the existing centerline of Route 128 (should be confirmed with Design team) at maximum 7 ft O.C.

Earth Pressures

The proposed wall should be designed for the following:

For *active pressure* against the wall, use the following:

Between 0' and 13' depth (dredge line):

- Internal friction angle $\phi = 30^\circ$, $C = 1000$ psf & soil moist unit weight (γ) = 120 lb/ft³.
- For earth pressure distribution, use a triangular pressure distribution.
- A rectangular pressure diagram from top of the wall to a depth of 10 ft for traffic surcharge equivalent to about 2 ft of fill.
- The wall shall be capable of resisting an additional seismic uniform earth pressure estimated to be equal to 20H psf.

For *passive pressure* against the soldier piles, use the following input:

Between 13' and 30' depth:

- Internal friction angle $\phi = 32^\circ$, $C = 2000$ psf & soil moist unit weight (γ) = 125 lb/ft³.

Below 30' depth:

- Internal friction angle $\phi = 36^\circ$, $C = 1000$ psf & soil moist unit weight (γ) = 125 lb/ft³.

Vertical CIDH Pile Capacities and Penetration Depth

Maximum pile spacing should be limited to 7 ft.

The ultimate vertical compression and tension capacities of piles may be calculated using the following design parameters:

Use a unit pile shaft friction of 1.00 ksf per unit surface area of the pile length below the dredge line of the wall.

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Use 60 percent of the compression shaft resistance values mentioned above to calculate the ultimate tension (uplift) resistance of the pile.

For ultimate pile tips compression, use bearing capacity of 80 ksf per unit tip. This is based on minimum 35 feet pile depth below the ground surface.

The above recommendations are based on parameters established by our field exploration and engineering judgment.

Cement Compaction Grouting

As mentioned above, in order to address the settlement portion of this project, we recommend using cement compaction grouting to densify the foundation soil of the settled areas between Stations 23+20 and 23+40. The minimum depth of the grout injection is 4 ft and as directed by the Engineer.

Compaction grouting refers to the soil improvement technique of injecting under pressure grout of low slump/high internal friction to densify and compact the surrounding soil or fill and lift structure. The grout is most accurately classified as a Low Mobility (LMG) since the concept is that, upon injection, it retains a spherical, coherent grout mass, which, as it expands radially, causes densification.

The estimated quantity of cement grout required is about 180 ft³ (total of 60 grout holes) at a total geotechnical cost of about \$ 23,500 (\$13,500 for grout @\$75/ft³ and \$10,000 mobilization).

It should be noted that the location of the grout injection holes are subject to change during construction and may vary according to field conditions.

Injecting grout will create an uneven pavement surfacing. After completion of the grouting, we recommend AC overlay of the grouted area.

Refer to the attached Exhibits A and B and approved non standard special provisions (NSSP) for compaction grouting for more details.

8. CORROSION

The Department considers the site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

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Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 2000 ppm, or the pH is 5.5 or less.

The following table provides our corrosion test summary:

<i>Boring</i>	<i>SIC Number (TL-101)</i>	<i>Sample Depth</i>	<i>Resistivity (Ohm-Cm)</i>	<i>pH</i>	<i>Chloride Content (ppm)</i>	<i>Sulfate Content (ppm)</i>
A-12-001	C634922	15'-20'	1567	7.12	N/A	N/A

The test results indicate that the site is NOT corrosive to foundation elements.

9. CONSTRUCTION CONSIDERATIONS

The following construction considerations and requirements should be included in the design and construction specifications for the proposed wall.

- Although groundwater was not encountered during drilling. Groundwater elevation fluctuates seasonally and may be encountered during drilling for CIDH piles.
- The contractor may encounter difficulties during drilling for the soldier pile below 30 ft due to the presence of hard rock. Proper drilling equipment should be considered for the encountered rock type.
- Installation of the CIDH piles should be performed in accordance with Section 49-4 of the 2010 Caltrans Standard Specifications.
- Drilling and concrete placement for CIDH pile construction shall be staggered. No open holes shall be adjacent.

9.1 UNDERDRAIN

In order to mitigate the groundwater, 200 feet long (between Stations 23+00 and 25+00), 4 feet deep underdrain at the toe of the hillside slope is needed. Use solid pipe (between Stations 25+00 and 26+25) at the end of the proposed underdrain to be outletted at the existing headwall at PM 1.82 marker (Station 26+25±). See the attached Exhibit B for details. Please consult with Hydraulics Branch regarding outletting the underdrain.

* * * * *

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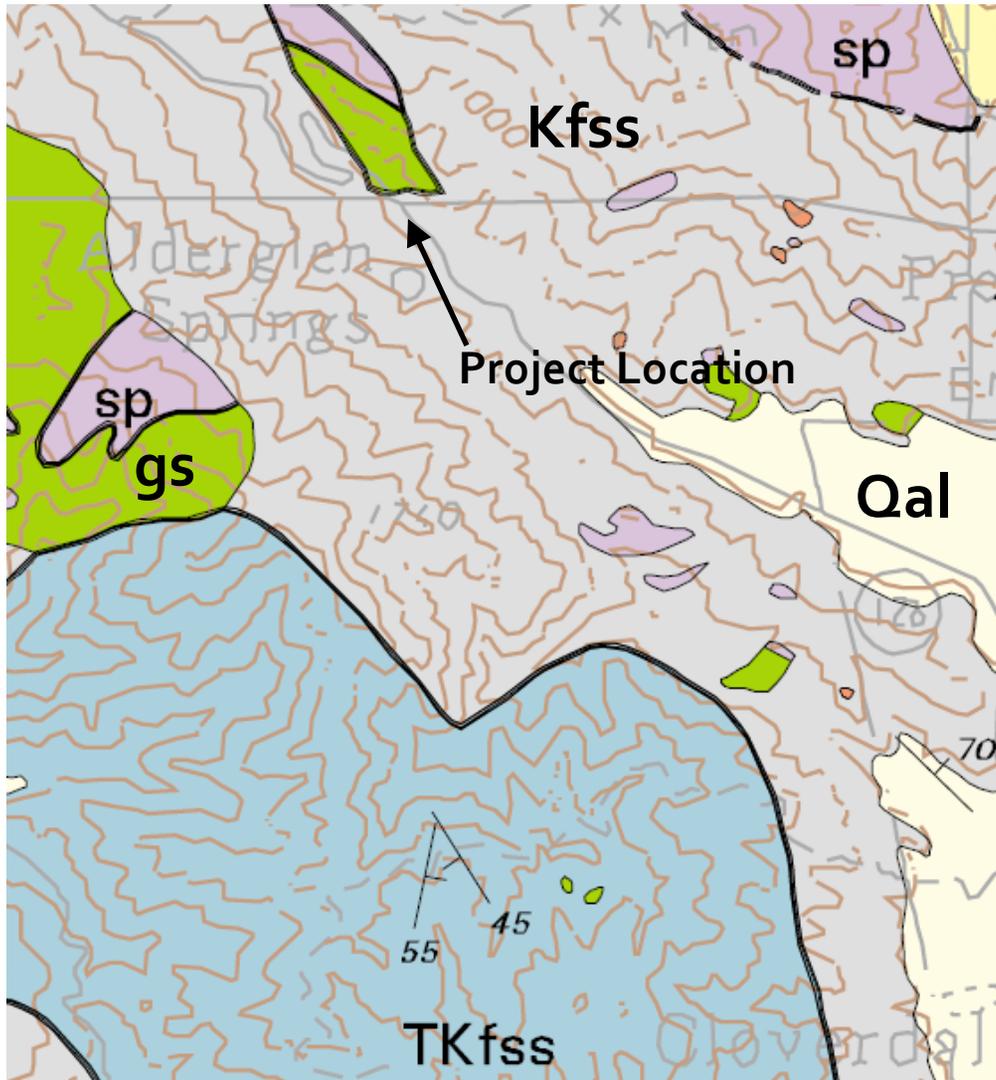
Any questions regarding the above recommendations should be directed to the attention of Ali Kaddoura/Mohammad Zabolzadeh at 510-286-4676/4831 or Hooshmand Nikoui at 510-286-4811, at the Office of Geotechnical Design-West, Branch A.

Attachments:

c: TPokrywka, HNikoui, MZabolzadeh, AKaddoura - (GS west), SRajendra (GS Support-Office Chief), RE_pending_File (Structure Construction), JStayton (DES OE), RWoo (District 04 ME), CCashin Hydraulics (District 04), RMusni PE (District 06 Design PE), HALmaguer (District 06 PM).

Kaddoura/Zabolzadeh/mm/ SON-128-PM 1.80 FR – 04-3G1200





Key

- Qal Alluvial fan and fluvial deposits (Quaternary)
- Franciscan Complex**
- TKfss Sandstone (late Eocene to Late Cretaceous, Maastrichtian)
- Kfss Sandstone (Late Cretaceous, Turonian to Campanian)
- gs Greenstone block
- sp Serpentinite block

MAP TAKEN FROM: U.S. Geological Survey: Geologic Map and Map Database of Western Sonoma, Northernmost Marin, and Southernmost Mendocino Counties, California By M.C. Blake, Jr., R.W. Graymer, and R.E. Stamski, 2002.

SCALE
Not to Scale



**DIVISION OF
ENGINEERING SERVICES**
GEOTECHNICAL SERVICES
GEOTECHNICAL DESIGN - WEST - BRANCH B

GEOLOGIC MAP

04-SON-128

Efis: 0400021276

PM 1.80

JANUARY 2013

FIGURE 1



MAP TAKEN FROM:
http://dap3.dot.ca.gov/shake_stable/

SCALE
 Not to Scale



**DIVISION OF
 ENGINEERING SERVICES**
 GEOTECHNICAL SERVICES
 GEOTECHNICAL DESIGN - WEST - BRANCH B

ARS Fault Map	
04-SON-128	Efis: 0400021276
PM 1.80	JANUARY 2013
FIGURE 2	

Liquefaction Susceptibility Map

Susceptibility Level

- Very High
- High
- Moderate
- Low
- Very Low

- Major Roads
- Local Roads



Scale: 1 inch = 0.68 miles

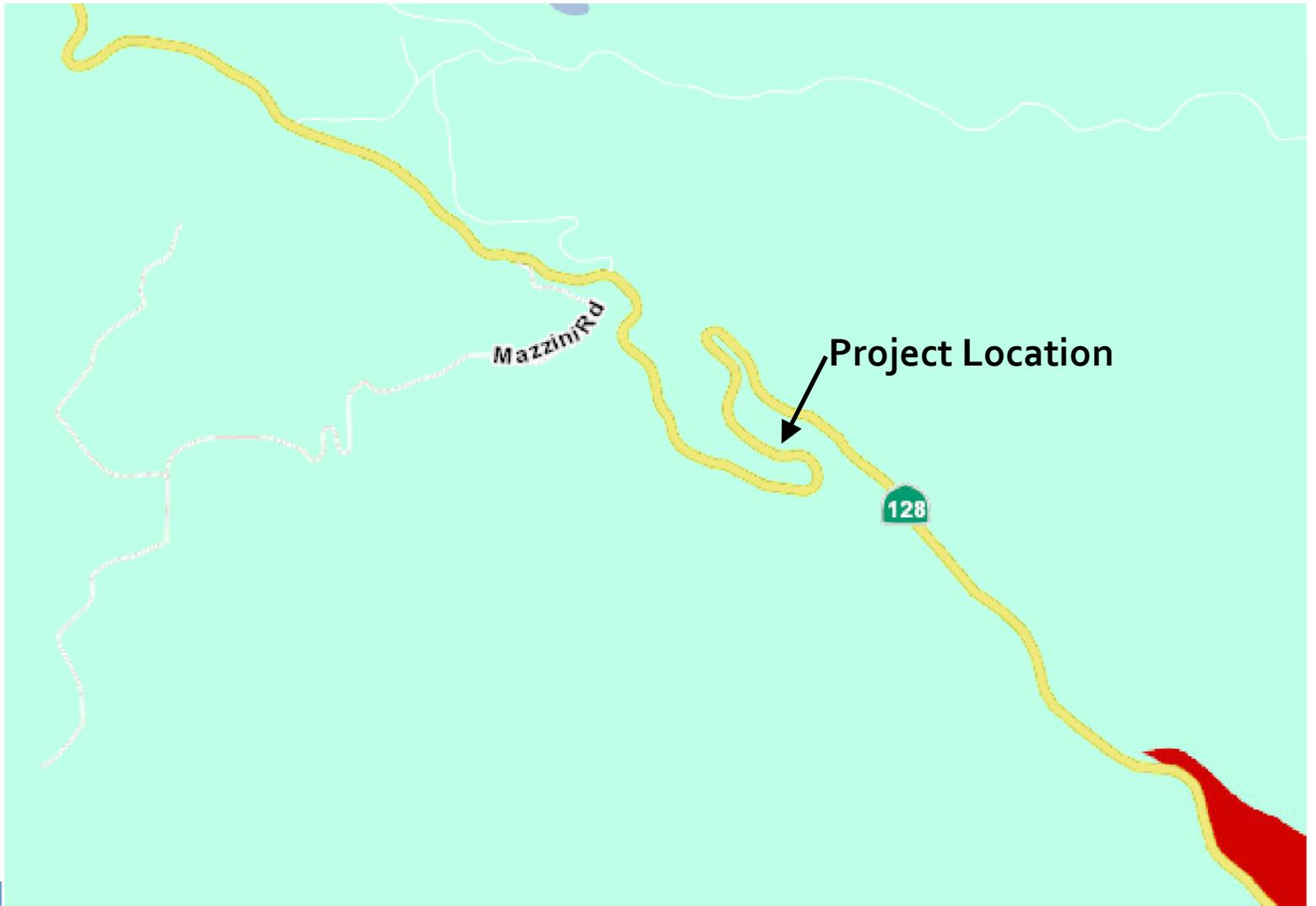
This map is intended for planning use only and is not intended to be site-specific. Rather, it depicts the general hazard level of a neighborhood and the relative hazard levels from community to community. Hazard levels are less likely to be accurate if your neighborhood is on or near the border between two zones. This information is not a substitute for a site-specific investigation by a licensed professional.

This map is available at <http://quake.abag.ca.gov>

Sources:
 This map is based on work by William Lettis & Associates, Inc. and USGS.
 USGS Open-File Report 00-444, Knudsen & others, 2000 and
 USGS Open-File Report 2006-1037, Witter & others, 2006

For more information visit:
<http://pubs.usgs.gov/of/2000/of00-444/>
<http://pubs.usgs.gov/of/2006/1037/>

ABAG Geographic Information Systems



SCALE
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DIVISION OF ENGINEERING SERVICES
 GEOTECHNICAL SERVICES
 GEOTECHNICAL DESIGN - WEST – BRANCH B

Liquefaction Susceptibility Map

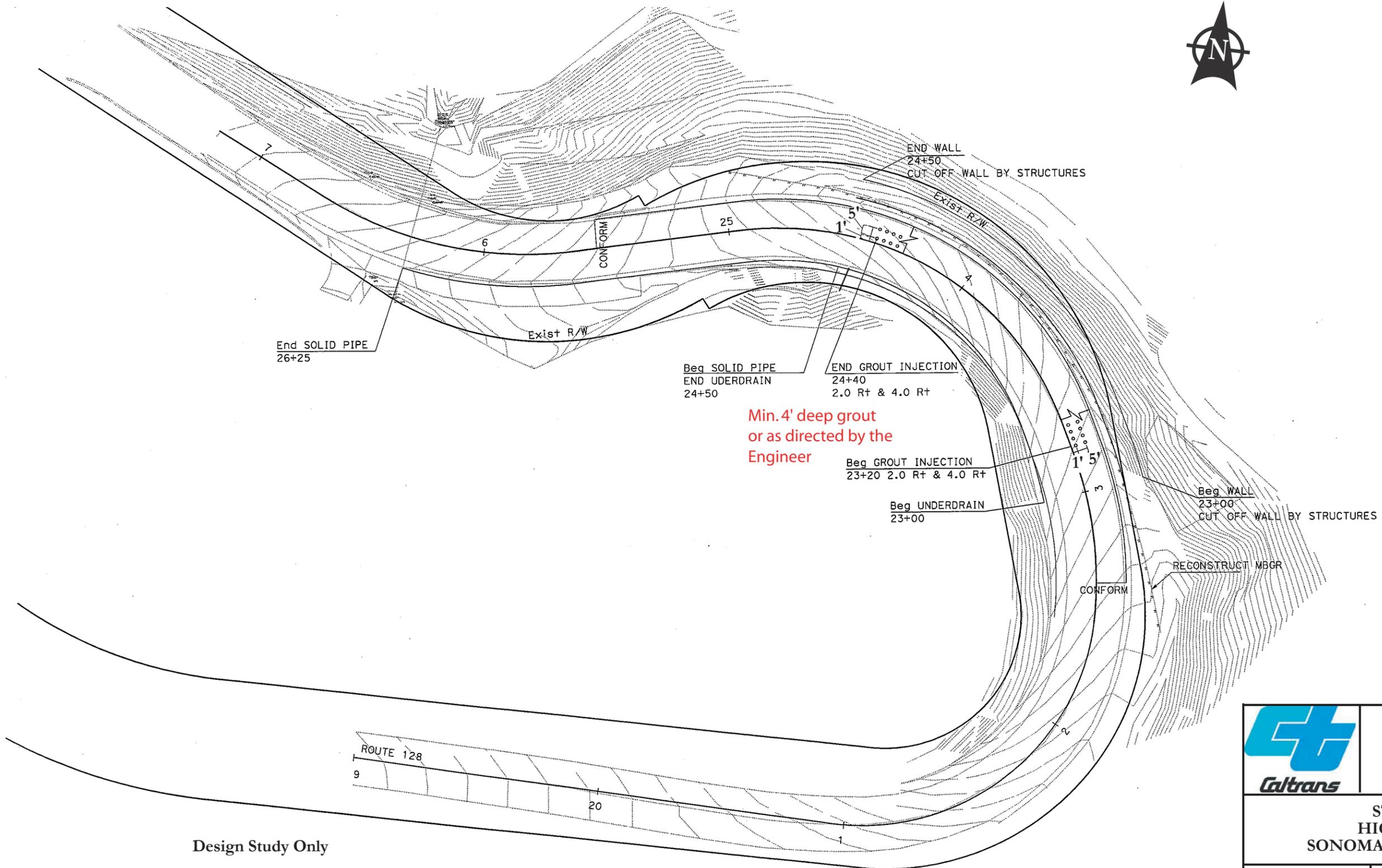
04SON-128

EFIS 0400021276

PM 1.80

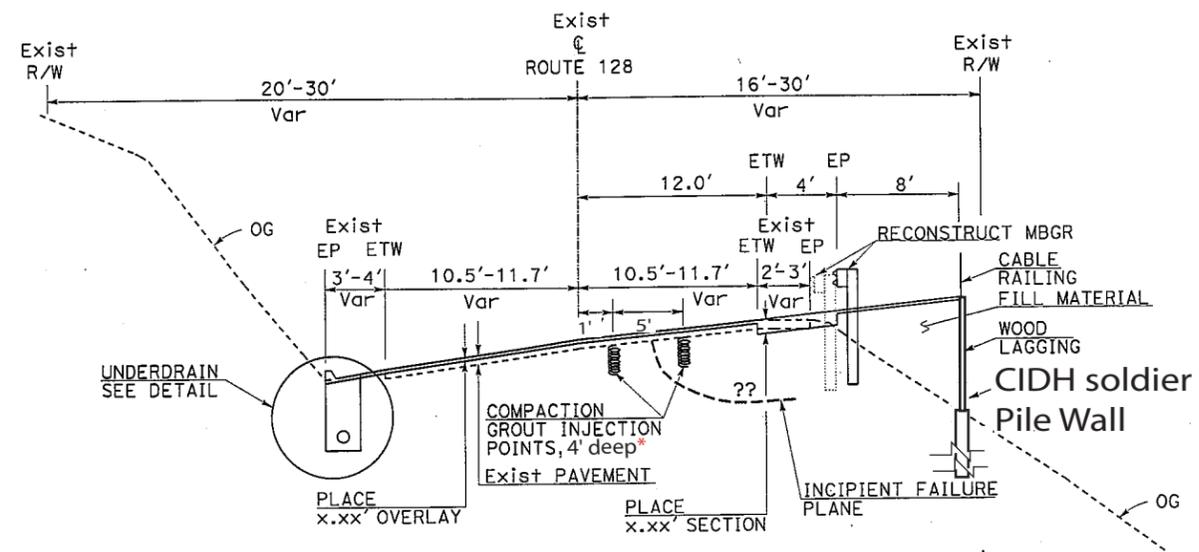
JANUARY 2013

FIGURE 3

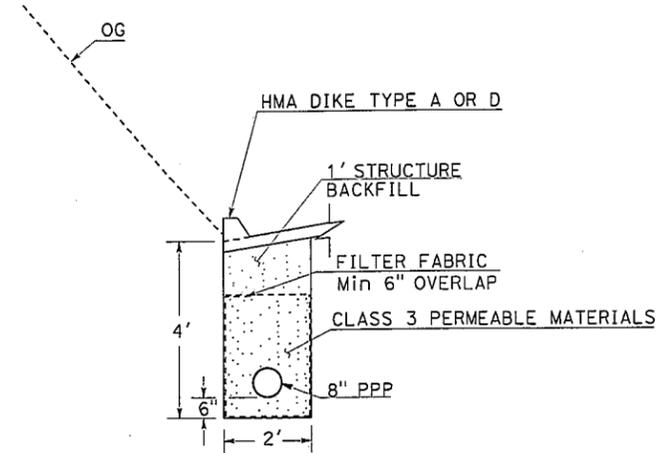


Design Study Only

	LAYOUT	
STORM DAMAGE HIGHWAY 128 P.M 1.8 SONOMA COUNTY, CALIFORNIA		
PROJECT EA. 04-3G1200	February 2013	EXHIBIT A



* Min. 4' deep grout
or as directed by the
Engineer



Design Study Only

	LAYOUT	
	STORM DAMAGE HIGHWAY 128 P.M 1.80 SONOMA COUNTY, CALIFORNIA	
PROJECT EA. 04-3G1200	February 2013	EXHIBIT B

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	128	1.8		

Ali Kaddoura 01-08-13
REGISTERED CIVIL ENGINEER

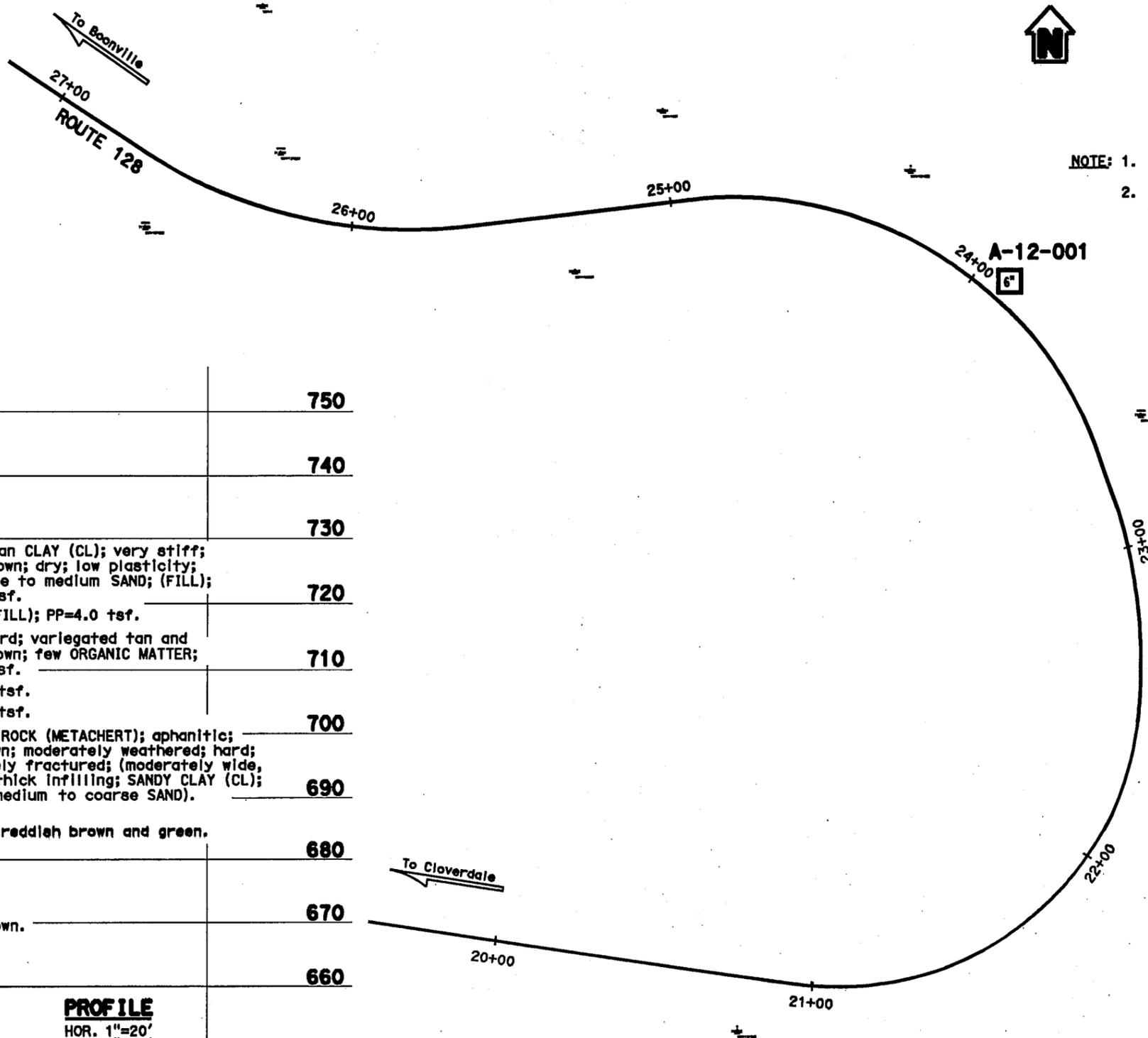
PLANS APPROVAL DATE

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

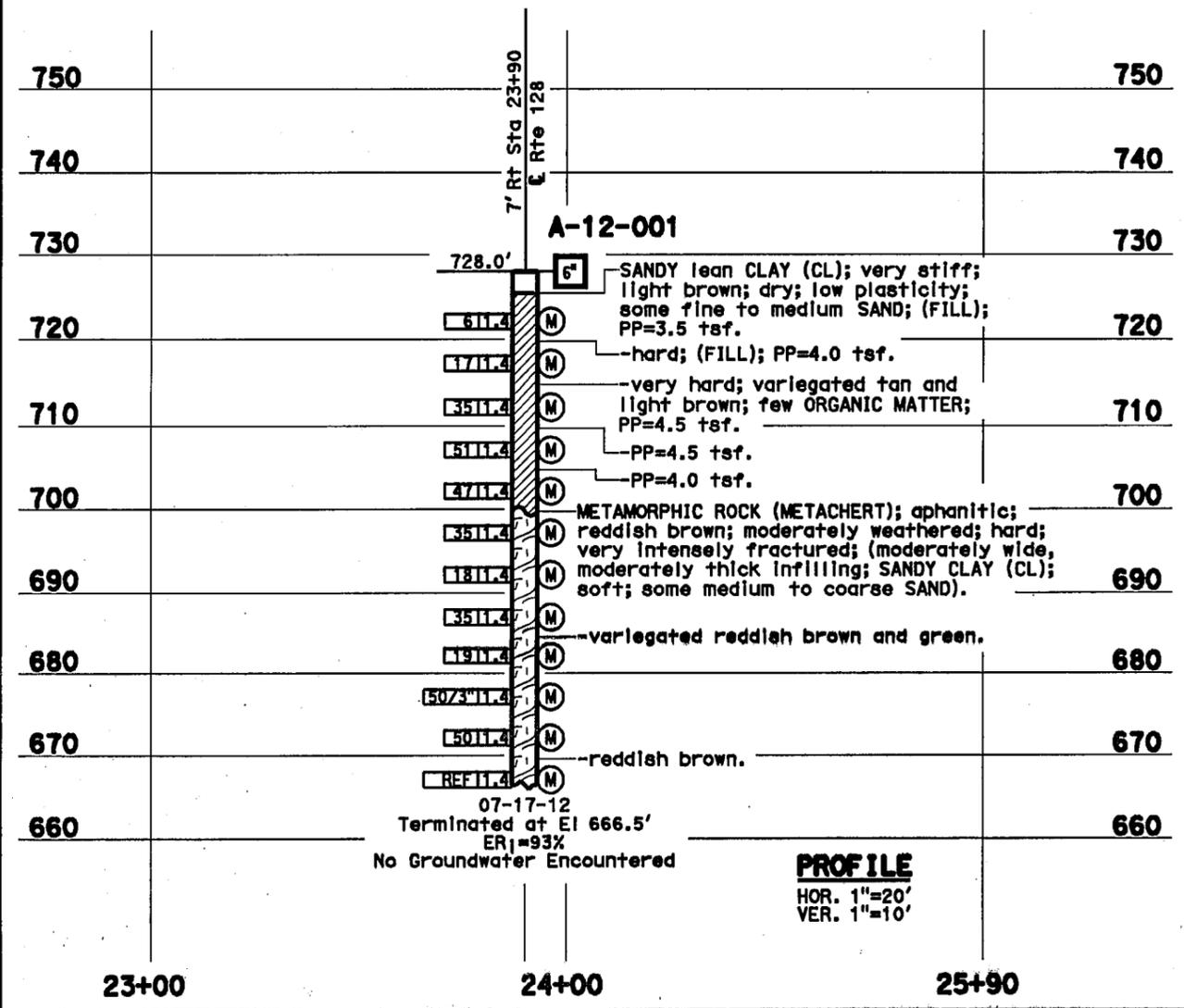
REGISTERED PROFESSIONAL ENGINEER
All K. Kaddoura
No. 55710
Exp. 12-31-14
CIVIL
STATE OF CALIFORNIA

BENCH MARK

Name: SUHV 121229,
Location: sta. 26+28,
17.4' Rt. of centerline
(Near PM 1.82).
N 2,069,417.27;
E 6,259,827.25;
Elev. 711.34'.



- NOTE: 1. REF=Refusal.
2. PP=unconfined compressive strength (tsf) as measured by pocket penetrometer.



PLAN
1"=20'

ENGINEERING SERVICES		GEOTECHNICAL SERVICES		STATE OF CALIFORNIA		DIVISION OF ENGINEERING SERVICES		CIDH SEGMENTED PILE WALL	
FUNCTIONAL SUPERVISOR		DRAWN BY: M. Reynolds 08/12		DEPARTMENT OF TRANSPORTATION		OFFICE OF GEOTECHNICAL		LOG OF TEST BORINGS 1 of 1	
NAME: H. Nikouli		CHECKED BY: C. Rieden		FIELD INVESTIGATION BY: A. Kaddoura		DESIGN BRANCH		BRIDGE NO.	
						POST MILES 1.8			
006 CIVIL LOG OF TEST BORINGS SHEET		ORIGINAL SCALE IN INCHES FOR REDUCED PLANS		UNIT: 3660		PROJECT NUMBER & PHASE: 04000212760		CONTRACT NO.: 04-3q1200	
								DISREGARD PRINTS BEARING EARLIER REVISION DATES	

USERNAME => ST10822 DATE PLOTTED => 31-JAN-2013 TIME PLOTTED => 12:40

Memorandum

*Flex your power!
Be energy efficient!*

To: MR. JOHN C. MCMILLAN
Deputy Division Chief
Office Engineer
Division of Engineering Services

Date: February 21, 2013
File: 04-SON-128 PM 1.8
04-3G1200
Efis: 0400021276-0
Roadway Settlement

Attn: Rebecca Harnagel, Chief
Office of Plans, Specifications, and Estimates

From:  TIMOTHY J. POKRYWKA, Chief
Office of Geotechnical Design-West
Geotechnical Services
Division of Engineering Services

Subject: Non-Standard Contract Special Provision (NSSP) Concurrence

The following item is recommended by my staff for use as a contract special provision for this project:

Office

Office of Geotechnical Design – West
Hooshmand Nikoui – Senior 510-286-4811
Ali Kaddoura – Engineer 510-286-4676

Proposed Contract Special Provision

Compaction Grouting

This NSSP provides detailed construction specifications for using compaction grouting to mitigate settlement areas within the project limits on Route 128 in Sonoma County.

I concur with the recommendation for use of this non-SSP on this project. A copy of the specification is attached, although they may undergo further editing in the District prior to District PS&E transmittal to Headquarters OE. In addition, Thang Le of this Office is authorized to approve changes from the wording shown on the attachment, should other changes be needed.

MR. JOHN C. MCMILLAN
February 21, 2013
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If you have any questions or comments, please call the Project Engineer listed above.

Attachment:

c: TPokrywka (OGD-West)
HNikoui (OGD-West)
AKaddoura/ MZabolzadeh (OGD-West)
Project file

19-10 COMPACTION GROUTING

19-10.01 GENERAL

19-10.01A Summary

Section 19-10 includes specifications for performing compaction grouting at locations shown.

19-10.01A Definitions

Compaction grouting: A process where a very stiff, low slump of 0-2 inches, cement mortar grout is injected under high pressure through a grout pipe into the ground at various elevations or stages to displace and densify in-situ soils.

Compaction grouting cut-off criteria: Criteria to determine when to stop the injection of grout at any one stage

Grout injection point: A point on the pavement or slope surface to designate the location of the pipe insertion for grouting.

19-10.01B Submittals

Submit a grouting plan outlining the proposed work for compaction grouting. You may submit one plan or separate plans for each grouting operation. Refer to specific field locations by station and offset from baseline using survey techniques. The plan must include:

1. A list of personnel to be used in the project outlining their experience with compaction grouting
2. Grout mix design including material specifications
3. Equipment and methods for measuring and recording stroke and back pressures, including pressure surges at the top of the injection point.
4. Equipment and methods for measuring and recording pumping rates and grout volumes with calibration procedures and certification of the equipment
5. Description of the materials, equipment, including size and type, and methods to be used in each grouting operation, including inclination and depth of grout pipes, and increments in which the grout pipes will be withdrawn
6. Sample forms for drilling logs, grouting logs and monitoring logs
7. Detailed description of the proposed monitoring program for ground surface movement and distress to related freeway facilities such as pavement, storm drains, and utility conduits

The Engineer has 7 days to review the grouting plan. If revisions are required, resubmit 3 copies of the grouting plan. The Engineer has 7 days to review the revised plan.

19-10.01C Quality Control and Assurance

The grouting contractor must have a minimum of 5 years of experience in compaction grouting including placement of grout pipes and mixing and injecting grout. The grouting supervisor must have a minimum of 3 years experience and must be assisted by an experienced grouting foreman on each shift of each grouting operation.

19-10.02 MATERIALS

19-10.02A General

Reserved

19-10.02B Cement

Portland cement must be Type I or II and comply with section 90-1.02B (2) Hydraulic cement grout

Comply with ASTM C 1107.

19-10.02C Grout

Grout must be a combination of Portland cement, fine aggregate, coarse aggregate, and water. A stiff grout mix must be used. Materials must be thoroughly mixed and agitated to provide grout of uniform

consistency. The cement content of the grout must not be less than 7 pcf. Water must be added to the grout mix in an amount to provide a stiff slump of 0-2 inches under ASTM C 143.

19-10.02D Fine Aggregate

Fine aggregate must comply with section 90-1.02C(3). Fine aggregate must be well graded and have between 10 and 30 percent passing the no. 200 sieve and a minimum of 85 percent of content passing the no 8 sieve. Fine aggregate must be graded to eliminate sand blocking at the grout working pressures.

19-10.02E Coarse Aggregate

Coarse aggregate must comply with section 90-1.02C(2). Coarse aggregate must be no larger than 3/8" and comprise less than 15 percent of the total aggregate.

19-10.02F Water

Water for mixing must not contain:

1. Oil
2. Impurities at concentrations that cause either of the following results when compared to the same test using distilled or deionized water:
 - 2.1. Change of more than 25 percent in the setting time of cement when tested under ASTM C 191 or ASTM C 266
 - 2.2. Reduction by more than 5 percent in the mortar compressive strength at 14 days when tested under ASTM C 109
3. Chlorides as Cl or sulfates as SO₄ in excess of the values shown in the following table:

Type of concrete work	Maximum chloride as Cl ^a	Maximum sulfate as SO ₄ ^b
Nonreinforced	2,000 ppm	1,500 ppm

^aWhen tested under California Test 422

^bWhen tested under California Test 417

Water for core drilling operations must be from a local water supply. Water must not contain:

1. More than 1,000 parts per million of chlorides as CL
2. More than 1,300 parts per million of sulfates as SO₄
3. Impurities that cause concrete discoloration of surface etching

19-10.03 CONSTRUCTION

You will be provided with a surveyed baseline in each work zone where this work is to be performed. Determine on the ground, the vertical and horizontal projection of the exterior limits of all underground structures including conduits, irrigation systems and storm drains. Determine the location on the ground surface of each grout injection point and the elevation of each injection stage. On the pavement surface the grout injection points must consist of coring holes through the Portland cement concrete pavement.

Equipment used to mix and pump compaction grout must be specifically designed for that purpose.

The mixer must be batch type and equipped with suitable water meters. Sufficient mixer power must be provided to blend the ingredients into zero slump consistencies.

The pump must be capable of displacing zero slump grout and to maintain pressures from 0 to 600 psi with rates of displacement as low as 0.3 cubic feet per minute. Controls must be provided to enable the operator to vary the rate of displacement over its entire range uniformly while continuously pumping.

Grout pipes must be 2 to 3 inch steel casings with adequate strength to withstand the required jacking and pumping pressures.

The pumping system must be equipped with suitable automatic recording devices that continuously measure and record grout pressures including stroke, back, and surge at the top injection point; pumping rates and grout take for each hole; and total grout take per work shift. Calibrate the instruments for

measuring pressures, pumping rates, and volume. Submit 2 copies of the automatic records as informational submittals at the end of each work day.

Holes in pavement must not be cored more than 1 day before grout injection. Drilled holes must not remain open when precipitation is predicted within the following 24 hour period. Use the National Weather Forecast for weather predictions.

Push, drive, or drill the grout pipe to the specified depth of grouting. There must be no voids between the grout pipe and the surrounding soil to prevent grout leakage and premature upward movement of the grout pipes during grouting. If the grout hole is drilled to full depth and the grout pipe can't be advanced to the full depth of grouting, the grout hole must be cleaned and drilled again until the grout pipe can be advanced to the target depth. If the grout hole tends to collapse during drilling, the grout injection pipe must be advanced simultaneously with the drilling operation.

At each grout point, grout pipes must be advanced to the elevation shown.. If refusal is encountered before the specified depth is attained, notify the Engineer. Unless approved, the grout injection point is rejected and a new grout injection point must be drilled adjacent to the rejected hole and the grout pipe advanced to the depth shown. Grouting must be conducted in stages as the grout pipe is withdrawn. The interval between stages must not exceed 2 feet. The grout injection hole must not be greater than 0.4 inches in diameter than the outside diameter of the casing. Once grouting of a hole is started it must be completed in 1 continuous operation during 1 shift. If grouting is terminated for any reason before the full depth is grouted, that grout point is rejected. A new grout injection point must be drilled adjacent to the rejected hole and the grout pipe advanced to the depth shown.

The rate of grout injection must be not more than 10 cubic feet per minute at an individual grout injection point. Multiple grout injections may be conducted simultaneously.

The grout points must be designated as alternating rows of primary and secondary grout points. Two adjacent primary rows of grout points must be completely grouted before grouting the intermediate secondary row. Compaction grouting cut-off criteria includes:

1. Cut-off grout pressures or surface movement occurs in conjunction with low grout volumes
2. Excessive damage to the existing facilities such as pavement heave in excess of 0.125 inches.
3. Inject up to a maximum of 12 cf of the grout in each stage

During the grouting operation, monitor the existing freeway facilities including concrete pavement, barriers, storm drains, and unpaved embankment soils for indications of movement or distress. Establish and monitor a minimum of 5 survey reference points on the freeway pavement. Overhead poles, electroliers, and structures within 30 feet of active grout points must be monitored for movement.

Monitor and record the interior of storm drains for signs of distress such as deflection, heaving, or cracking. Distress of storm drainage pipe must trigger grout cut-off at any stage. When grouting stage is within 10 feet of the storm drain, grout pressure must not exceed 245 psi, unless authorized.

After compaction grouting is complete, voids in the structural section created by the coring operation must be cleaned and filled with hydraulic cement grout. You may extend the grout with clean pea gravel according to the grout manufacturer's recommendations. After placement of the hydraulic cement grout, the material, while still plastic, must be troweled smooth to match the pavement surface. The backfill material must not exhibit any evidence of depressions or surplus material above the level surface of the pavement.

Residue from grouting operations must not be allowed to flow across shoulders or lanes occupied by traffic; to flow into gutters or other drainage facilities; to flow beyond the highway; or to be left on the surface of the pavement or embankment.

Submit as an informational submittal 2 copies of completed recorded date for drilling and grouting at each injection point. Submit 1 copy immediately after completing the drilling and grouting at each individual grout injection point.

19-10.04 PAYMENT

Not Used

ET-31™ Guardrail End Treatment

Product Description Assembly Manual

Part No. 620182B

Created January 2013



TRINITY
HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

ET-31™ Guardrail End Treatment

Product Description Assembly Manual



2525 Stemmons Freeway
Dallas, Texas 75207



Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the ET-31™ Guardrail End Treatment. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been determined to meet the criteria for eligibility for reimbursement by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. A Trinity Highway Products, LLC representative is available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway Products at (888) 323-6374 or download from the website listed below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest ET-31™ Guardrail End Treatment information available to Trinity Highway Products at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway Products to confirm that you are referring to the most current instructions.

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Customer Service Contacts

Trinity Highway Products, LLC is committed to the highest level of customer service. Feedback regarding the ET-31™ Guardrail End Treatment, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below.

Trinity Highway Products:

Telephone:	(888) 323-6374 (U.S. Calls) (214) 589-8140 (International Calls)
Fax:	(214) 589-8423
E-mail:	product.info@trin.net
Internet: Trinity Highway Products, LLC	http://www.highwayguardrail.com

Regional Telephone Contacts:

Dallas, Texas	(800) 527-6050
Centerville, Utah	(800) 772-7976
Elizabethtown, Kentucky	(800) 282-7668
Girard, Ohio	(800) 321-2755
Orangeburg, South Carolina	(800) 835-9307
International	+1 214-589-8140

Important Introductory Notes

Proper assembly of the ET-31™ Guardrail End Treatment is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the ET-31™ Guardrail End Treatment. These instructions are to be used only in conjunction with the assembly of the ET-31™ Guardrail End Treatment and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Trinity Highway Products is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.



Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please have these instructions available for use and reference by anyone involved in the assembly of the product.



Warning: Ensure that all of the ET-31™ Guardrail End Treatment Warnings, Cautions, and Important Statements within the ET-31™ Guardrail End Treatment Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules ET-31™ Guardrail End Treatment

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the ET-31™ Guardrail End Treatment system. Additional copies of this Manual are immediately available from Trinity Highway Products by calling (888) 323-6374 or by email at product.info@trin.net. This Manual may also be downloaded directly from the websites indicated below. Please contact Trinity Highway Products if you have any questions concerning the information in this Manual or about the ET-31™ Guardrail End Treatment.

Always use appropriate safety precautions when operating power equipment and when moving heavy equipment or the ET-31™ Guardrail End Treatment components. Gloves, safety goggles, steel toe boots, and back protection should be used.

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

Safety Symbols

This section describes the safety symbols that appear in this ET-31™ Guardrail End Treatment Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

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



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

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment.



Warning: Do not assemble, maintain, or repair the ET-31™ Guardrail End Treatment until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important Statements within the Manual are completely followed. Please call Trinity Highway Products at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death.



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



Warning: Use only Trinity Highway Products parts that are specified herein for the ET-31™ Guardrail End Treatment for assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. **Do not utilize or otherwise comingle parts from other systems** even if those systems are other Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.



Warning: Do NOT modify the ET-31™ Guardrail End Treatment in any way. Failure to follow this warning could result in serious injury or death.



Warning: Ensure that the ET-31™ Guardrail End Treatment and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death.



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



Warning: Be aware of hazards of using compressed air (small objects may become projectiles). Failure to follow this warning can result in serious injury or death to the workers and/or bystanders.



Warning: DO NOT perform assembly, maintenance, or repair, if the ET-31™ Guardrail End Treatment site, shoulder, or traveled area is covered or encroached by road debris. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that the entire work zone site is well lighted at all times. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.



Warning: Use caution when working near public roads. Be mindful of vehicles in motion nearby. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.



Warning: Safety measures, incorporating traffic control devices, must be used to protect all personnel, while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders. Trinity Highway Products offers an economical and effective truck mounted attenuator, the MPS-350, for the protection of workers in work zones. For more information on the MPS-350, call (888) 323-6374 or visit the Trinity Highway Products website at www.highwayguardrail.com.



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



Warning: DO NOT place a Steel Yielding Treatment Post (SYTP™) at location No. 1. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: DO NOT place a Wood 6' 0" long Controlled Release Terminal (CRT) post at location No. 1. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: DO NOT bolt the Rail Panel in any fashion to the Post at location No. 1 in any of the ET-31™ Guardrail End Treatments. Doing so may impede the extrusion of the rail through the Head.

Note: The Head is attached to the No. 1 Post with an upper and lower 3/8" diameter fastener that has been shown to shear during impact within NCHRP 350 criteria.

Failure to follow this warning could result in serious injury or death in the event of a collision



Warning: Ensure that there is proper site grading for tube and post placement, as dictated by the state or specifying agency, pursuant to FHWA acceptance. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement for any posts. Surrounding posts with rigid pavement such as any thickness of concrete or asphalt will prevent post movement in the soil and is NOT allowed. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that all of the ET-31™ Guardrail End Treatment Warnings, Cautions, and Important Statements within the ET-31™ Guardrail End Treatment Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Always use safety precautions when performing assembly, maintenance or repair, mixing chemicals, and/or moving heavy equipment. Wear steel toe shoes, gloves, safety goggles, and back protection. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.



Warning: Ensure all Wood Blocks or Composite Blocks used with Steel Posts are routed to establish a fixed vertical orientation relative to the Posts. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Ensure that this assembly conforms with the guidance provided by the *AASHTO Roadside Design Guide*, including, but not limited to, those regarding placement on curbs or islands. Failure to follow this warning could result in serious injury or death in the event of a collision.



Warning: Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate. Failure to eliminate the interaction of soil or materials with the Bearing Plate will hinder the performance of the ET-31™ Guardrail End Treatment and could result in serious injury or death in the event of a collision.



Caution: Ensure before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment that no parts are frayed, damaged, or broken. Failure to follow this warning could result in serious injury to the workers and/or bystanders.



Warning: Do not place anything under the rail to post bolt head that would prevent the bolt from pulling through the Rail Panel. Failure to follow this warning could result in serious injury or death in the event of a collision.

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation Tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post insert	6' SYTP or short Foundation Tube with SYT Post Insert
Option 3	Long foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with Soil Plate and Wood Post Inserts	Short Foundation Tube with Soil Plate and Wood Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plate and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

For post locations 3 through 6, alternates to 6' SYT posts are:

- All Short Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

**ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 40'-7 1/2" (12.35 m)**

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

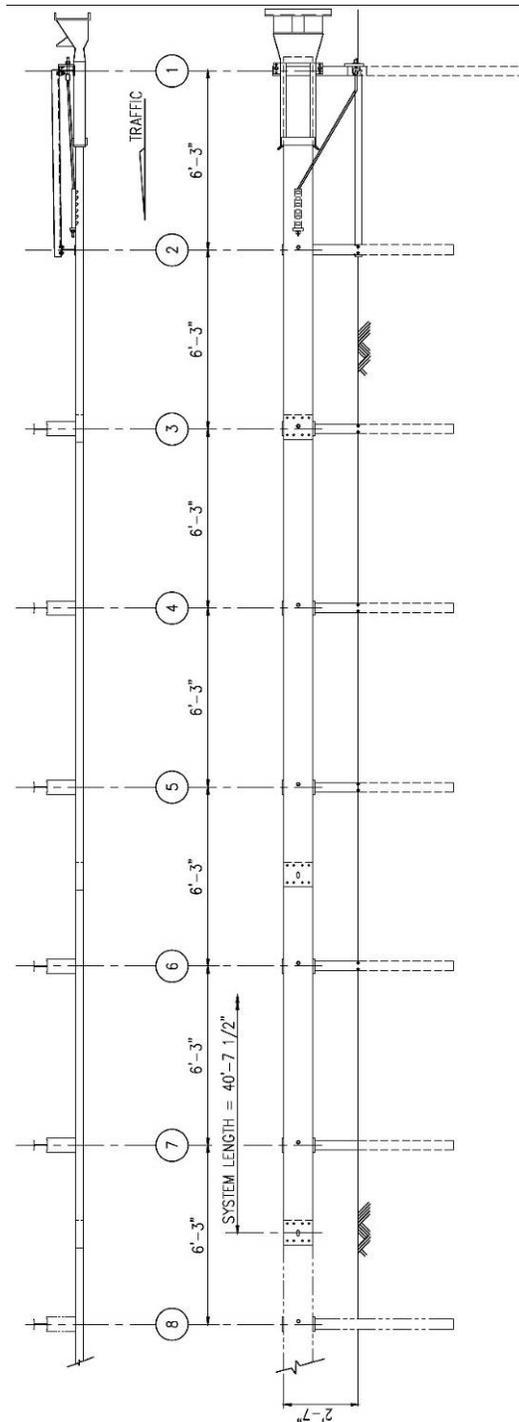


Figure 2 (TL-3)

[This drawing represents one version of the 40'-7 1/2" (12.38 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post insert	6' SYTP or short foundation Tube with SYT Post insert
Option 3	Long Foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with soil plates and Wood Post Inserts	Short Foundation Tube with soil plates and Wood Inserts
Option 5	Long foundation Tube with soil Post insert or Short Foundation Tube with soil plate and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post insert

For Post locations 3 through 6, alternates to 6' SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post insert
- Any combination of above options as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7:

- Steel or Wood line Post dictated by the state or specifying agency

**ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 46'-10 1/2" (14.29 m)**

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity standard layout drawings.

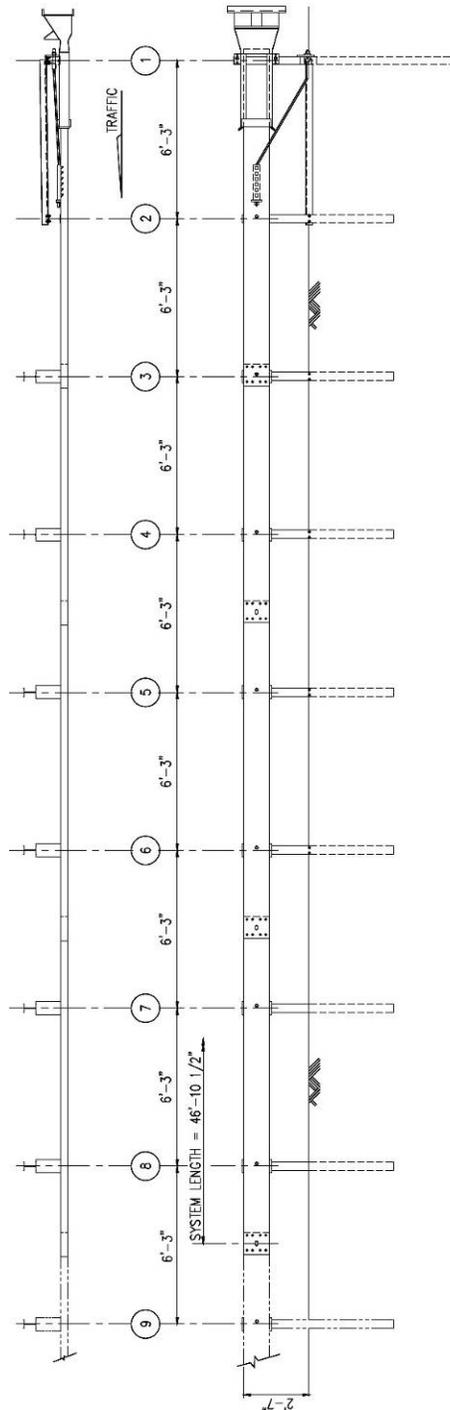


Figure 3 (TL-3)

[This drawing represents one version of the 46'-10 1/2" (14.29 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post Insert	6' SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with soil plates and Wood Post Inserts	Short Foundation Tube with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

The alternate to two 12' 6" (3.81 m) long rail elements is one 25' 0" (7.62 m) long rail element.

For Post locations 3 through 6, alternates to 6' SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7 and 8:

- Steel or Wood line Post dictated by the state or specifying agency

**ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 53'-1 1/2" (16.19 m)**

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity standard layout drawings.

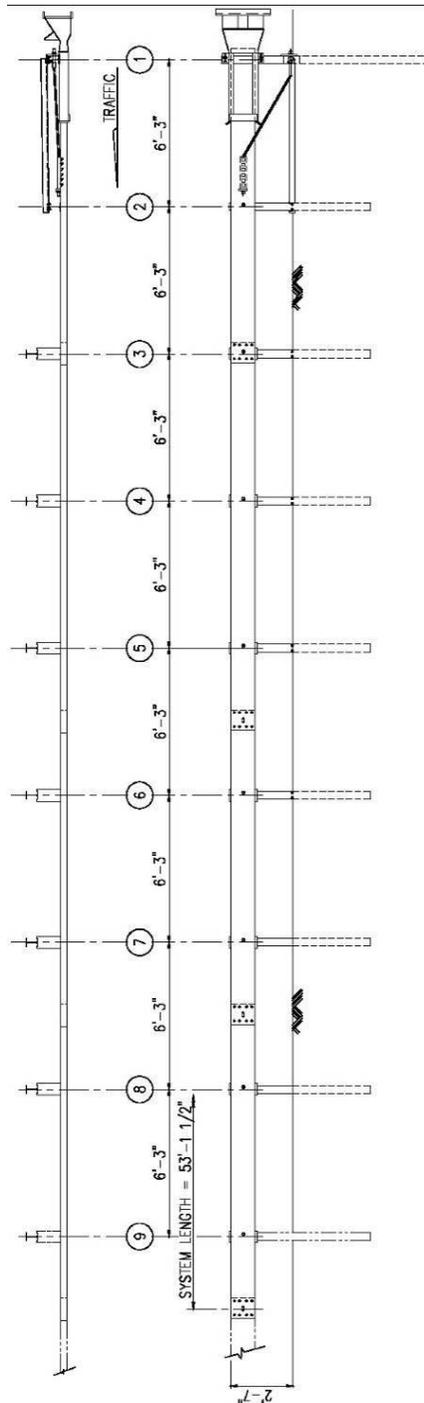


Figure 4 (TL-3)

[This drawing represents one version of the 53'-1 1/2" (16.19 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post insert	6' SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with Soil Plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

The alternate to two 12' 6" (3.81 m) long Rail Panel elements is one 25' 0" (7.62 m) long Rail Panel element.

For Post locations 3 through 6, alternates to 6' SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7 through 9:

- Steel or Wood line Post dictated by the state or specifying agency

**ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 2
System Length 21'-10 1/2" (6.68 m)**

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

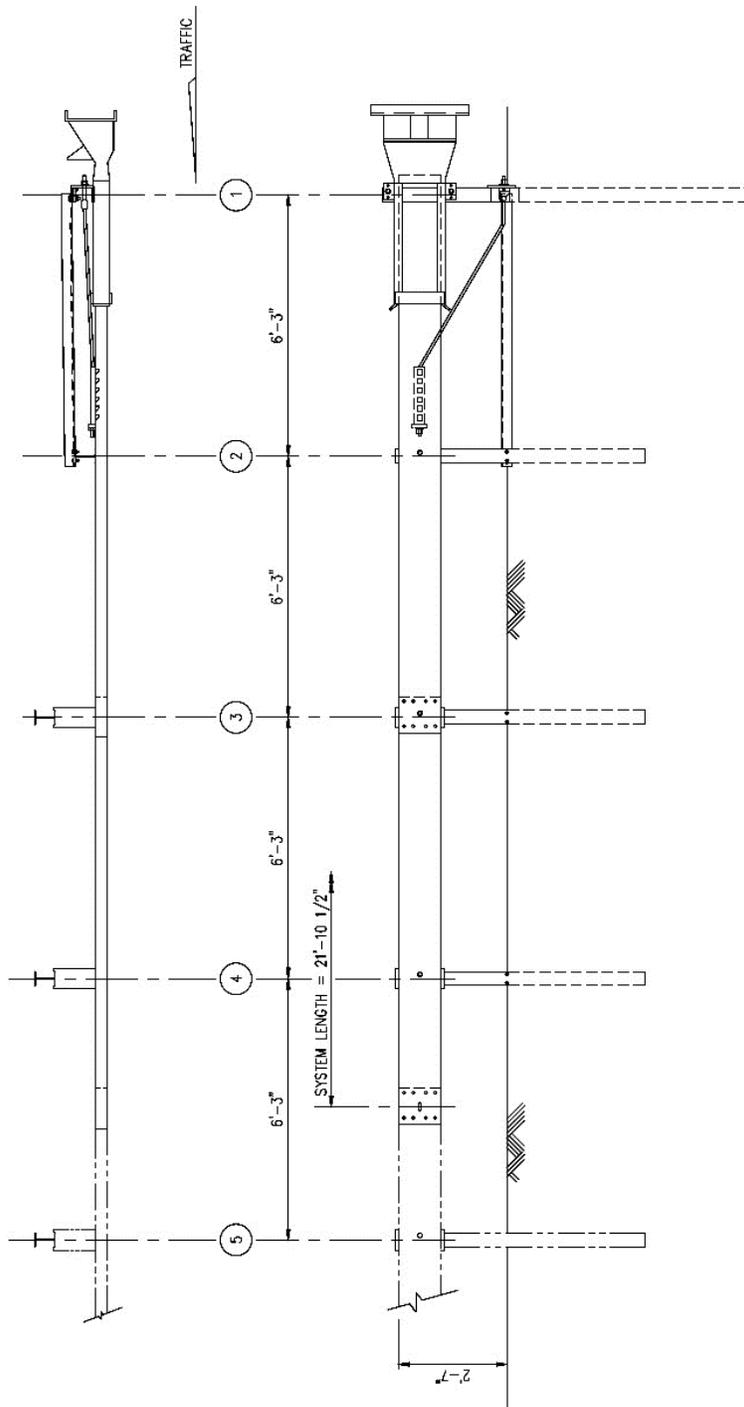


Figure 5 (TL-2)

[This drawing represents one version of the 21'-10 1/2" (6.68 m) system]

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post Insert	6' SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long Foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with Soil Plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

For Post locations 3 and 4, alternates to 6' SYT Posts are:

- All Short Foundation Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 2
System Length 28'-1 1/2" (8.57 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

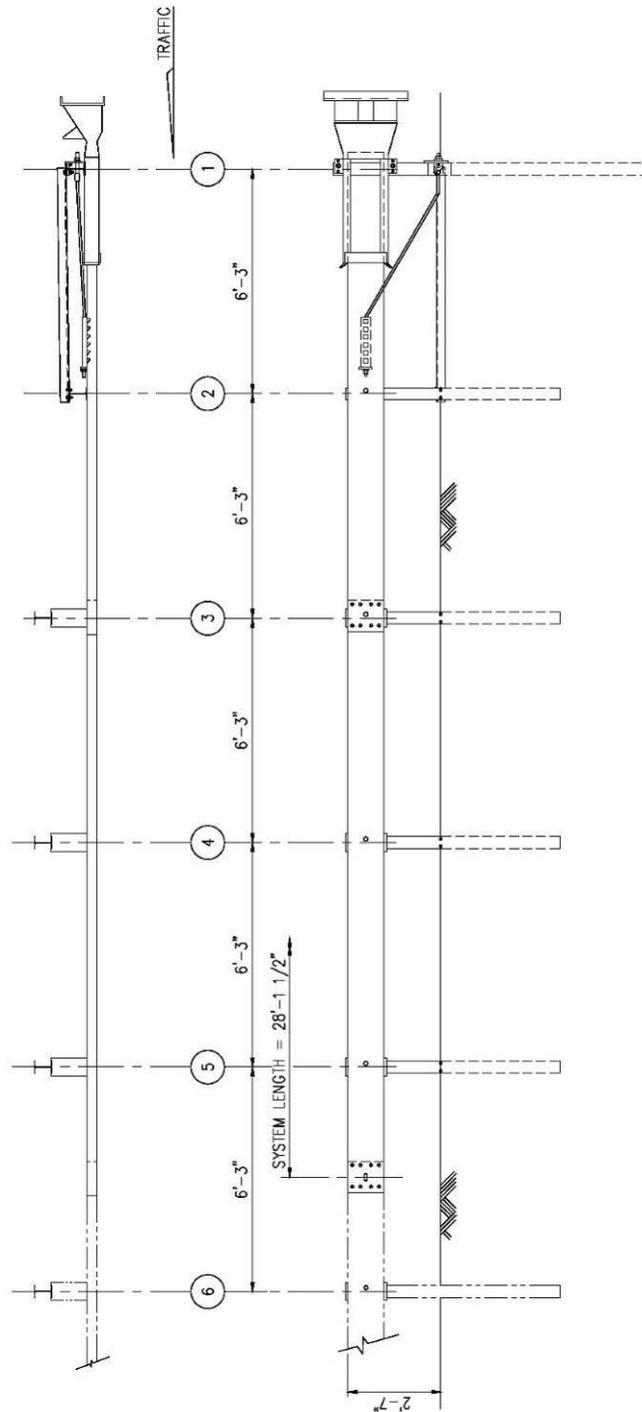


Figure 6 (TL-2)

[This drawing represents one version of the 28'-1 1/2" (8.57 m) system]

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	Post Location 2
Option 1	HBA Post	Short Foundation Tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post Insert	6' SYTP or short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long Foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with soil plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or short Foundation Tube with SYT Post Insert

For Post locations 3 and 4, alternates to 6' SYT Posts are:

- All Short Foundation Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post locations 5:

- Steel or Wood line Post dictated by the state or specifying agency

Bill of Materials English (Metric)



Warning: Use only Trinity Highway Products parts that are specified herein for the ET-31™ Guardrail End Treatment for assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. Do not utilize or otherwise comingle parts from other systems even if those systems are other Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

ET-31™ Guardrail End Treatment

(For specific materials and quantities, see state or specifying agency's options and Trinity standard layout drawings)

PN	Description
11G	12/12.5'3'-1.5"/S (2.67/3.81/0.952/S) (Guardrail)
32G	12/12.5'6' 3"/S (2.67/3.81/1.905/S) ANC (Guardrail)
60G	12/25'6' 3"/S (2.67/7.62/1.905/S) (Guardrail)
704A	Cable Anchor Bracket (unique to ET systems), with welded ears
705G	Pipe Sleeve - 2" STD Pipe x 51/2" (50 STD Pipe x 150 Pipe)
740G	6" x 8" x 4' 6" x 3/16 (152 x 203 x 1375 x 4.8) Tube Sleeve
749G	6" x 8" x 6' 0" x 3/16 (152 x 203 x 1830 x 4.8) Tube Sleeve (Alternate to using 740G and 766G)
758G	6" x 8" x 3'10"x 3/16" (252 x 203 x 1168 x 4.8) Tube Sleeve
766G	18" x 24" x 1/4" (460 x 610 x 16) Soil Plate
782G	8" x 8" x 5/8" (200 x 200 x 16) Bearing Plate (For Wood Post)
995A	ET-PLUS™ Extruder (Head)
3000G	Cable (Assembly) 3/4" x 6' 6" (19 x 1981)
3300G	5/8" (16) Round Washer
3340G	5/8" (16) HGR Nut
3391G	5/8" DIA. x 1 3/4" (16 DIA. x 45) Hex Head Bolt (High Strength)
3360G	5/8" DIA. X 1 1/4" (16 DIA. x 35) Splice Bolt (HGR)
3478G	5/8" DIA. x 7 1/2" (16 DIA. x 190) Hex Head Bolt
3497G	5/8" DIA. x 9 1/2" (16 DIA. x 240) Hex Head Bolt
3500G	5/8" DIA. x 10" (16 DIA. x 255) HGR Post Bolt
3580G	5/8" DIA. x 18" (16 DIA. x 460) HGR Post Bolt
3620G	5/8" DIA. x 22" (16 DIA. x 560) HGR Post Bolt
3700G	3/4" (19) Washer (F844)
3701G	3/4" (19) Washer (F436)
3704G	3/4" (19) Hex Nut
3717G	3/4" x 2 1/2" (19 x 75) Hex Head Bolt (High Strength)
3718G	3/4" x 3" (19 x 75) Hex Head Bolt (High Strength)
3900G	1" (25) Round Washer
3910G	1" (25) Hex Nut
4071B	Wood Post 6" x 8" x 6' 0" (150 x 200 x 1830) CRT

4075B	Wood Block 6" x 8" x 14" (150 x 200 x 355) DR
4076B	Wood Block 6" x 8" x 14" (150 x 200 x 355) DR Routed
4140B	Wood Post 5 1/2" x 7 1/2" x 4'-0 1/4" (140 x 190 x 1225)
4161B	HDPE spacer (SYTP™)
4228B	3/8" x 4" (10 x 100) Lag Screw
4254G	3/8" (10) Round Washer
4255G	3/8" (10) Fender Washer 1 1/2" OD (38)
4258G	3/8" (10) Lock Washer
4261G	3/8" DIA. X 1 1/2" (10 x 38) Hex Head Bolt (Grade 5)
4389G	7/16" (11) Round Washer
4390G	7/16" DIA. x 1 1/2" (11 x 38) GR. 5 Hex Head Bolt
4393G	7/16" (11) Lock Washer
4396G	7/16" (11) Hex Nut
4660B	Wood Block 6" x 12 3/8" x 14" (150 x 315 x 350) Routed
4699G	3/4" (19) Lock Washer
5148G	3/4" DIA. X 9 1/2" (19 DIA. x 240) Hex Head Bolt (High Strength)
5978B	Polymer Block 4 x 12 x 14 (100 x 305 x 350)
6120G	Wood Block 6" x 12" x 14" (150 x 305 x 350)
6321G	3/8" x 2' (10 x 50) Hex Head Bolt (Grade 5)
6405G	3/8" (10) Hex Nut
6907B	Polymer Block 4" x 7 1/2" x 14" (100 x 187 x 350) [King Block]
10967G	12/9'4.5/3'1.5/S (2.67/2.85/0.952/S) (Guardrail)
14328G	3' 9 7/8" Steel Yielding Treatment Post (SYTP™)
15000G	6' Steel Yielding Treatment Post™ (SYTP™)
19258A	8" x 8" x 5/8" (200 x 200 x 16) Bearing Plate With Two Ears/Tabs (For HBA Post)
19948G	1 3/4" x 10 GA x 1 3/4" (44 x 3 x 44) Plate Washer
20442G	12/15'7.5/3'1.5:2@6'3/S (2.67/4.76/.952:2@1.905/S) (Guardrail)
49398A	ET HBA™ Post #1 Top
33873A	ET HBA™ Post #1 Bottom
9852A	Strut (and Yoke Assembly)
32922G	6' 6" (1980) Angle Strut HBA™ / SYTP™ / Wood
33875G	6' 6" (1980) Angle Strut ET HBA™ (6'-3 C/C Slots)
33795G	6' 6" (1980) Angle Strut HBA™ / SYTP™
33730G	6' 7 1/2" (2020) Angle Strut SYTP™ / Wood
33847G	6' 9 1/8" (2060) Angle Strut SYTP™ / CRP

Delineation Options

PN	Description
6206B	Right Side 13" x 27 1/2" (325 x 700) Reflective Sheeting Amber
6207B	Left Side 13" x 27 1/2" (325 x 700) Reflective Sheeting Amber
6668B	Either Side 12" x 12" (305 x 305) Reflective Sheeting (Typically 2 required) Amber
3534B	Either Side 12" x 12" (305 x 305) Reflective Sheeting (Typically 2 required) Silver

Assembling the ET-31™ Guardrail End Treatment

Materials

As packaged, the NCHRP Report 350 ET-31™ Guardrail End Treatment includes all materials needed for a complete assembly. The pay limit will include a 34' 4.5" (10.48 m) system, 40' 7.5" (12.38 m) system, 46' 10.5" (14.29 m) system, or 53' 1.5" (16.19 m) system for TL-3 or 21' 10.5" (6.68 m) or 28' 1.5" (8.57 m) system for TL-2, unless otherwise specified in the contract plans.

Note: Concrete footings or foundations are not required.

Recommended Tools

- 9/16" (14 mm) Socket or wrench
- 15/16" (24 mm) Socket or wrench
- 1 1/4" (32 mm) Socket or wrench
- 1 1/2" (38 mm) Socket or wrench
- Augers
- Post pounders (commonly used in driving Posts)
- Locking pliers
- Tape measure

Recommend Tools for Repair

- Acetylene torch to cut off extruded rail
- Heavy-duty chain to remove the ET-PLUS™ Extruder (Head)
- Locking pliers or Channel Lock pliers
- Sledge hammer
- Post removal tool and other normal guardrail tools
- Eye bolts connected to heavy duty chain (to remove the Posts from Tubes)
- Vehicle to pull the Extruder (Head) from the damaged rail

Note: The above list(s) of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority, and the authority's selected contractor performing the assembly of the system at the authority's specified site. It is the province of the engineer working under the authority of the local highway authority that owns and has specified this product as to whether or not they wish to use the Extruder (Head) again after impact. Trinity makes no recommendation in this regard.

Site Preparation

When the Guardrail is placed in-line with edge of the shoulder (without any offset), a 25:1 or flatter straight flare over the length of the systems can be used to position the ET-PLUS™ Extruder (Head) further away from the edge of the shoulder. Site grading may be necessary for assemblies beyond the edge of the shoulder for the proper placement of the steel tubes and the CRT Posts. Use the state or specifying agency's standard specifications and drawings for the site grading. Trinity does not direct grading. Complete all grading before the start of the assembly of the ET-31™ Guardrail End Treatment. See *Assembly of the ET-31™ Guardrail End Treatment on a Curve* section for the layout of the ET-31™ Guardrail End Treatment on a curve on Page 24.

If the system is deployed on a curve, see *Assembly of the ET-31™ Guardrail End Treatment on a Curve* section on Page 24. When placing the ET-31™ Guardrail End Treatment outside or inside the curve, the ET-31™ Guardrail End Treatment must be straight over the length of the system. If there are special field conditions encountered when assembling the ET-31™ Guardrail End Treatment, contact the state or specifying agency's engineer. Trinity Highway Products LLC, at (888) 323-6374, is available for consultation with that agency.

Post Placed in Rigid Material

Provide the proper leaveout (the specified area of open space in the pavement) around a Post when assembling the Post in any thickness of concrete or asphalt. The top surfaces of any grout or other backfill placed in the rigid material leaveout **MUST be low enough** so that it does not restrict smooth release of the Anchor Cable Bearing Plate at Post 1 or otherwise obstruct or constrain the 3/8" shear bolts or the 3/4" hinge bolts of the HBA Post. The assembly shall not impede in any fashion the hinging-action or release mechanism of the No. 1 HBA post by burying it in rigid material (asphalt, concrete, rigid soil, etc.)

For leaveout information, please consult the applicable state or specifying agency. Additional source of leaveout information or details can be found in the U.S. Department of Transportation, Federal Highway Administration, Memorandum B 64-B, dated 3/10/04. Trinity can provide this FHWA memo upon request.

Assembling the ET-31™ Guardrail End Treatment on a Curve

When the ET-31™ Guardrail End Treatment is placed on a curve, use the following layouts. All offsets are measured to the face of the rail. Under no circumstances shall the guardrail within the ET-31™ Guardrail End Treatment pay limit be curved.

- Outside the curve: With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus the value in Table 1. Consult state or specifying agency drawings for details.
- Inside the curve (radius greater than 1000 feet): With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus the value in Table 1. Consult state or specifying agency drawings for details.
- Inside the curve (radius 1000 feet or less): With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus one foot maximum in Table 1. Consult state or specifying agency drawings for details.

Table 1

ET-31™ Length	Outside the Curve Max Offset	Inside the Curve With a Radius Greater Than 1000 Feet Max Offset	Inside the Curve With a Radius 1000 Feet or Less Max Offset
53' 1.5"	24 Inches	24 Inches	12 Inches
46' 10.5"	18 Inches	18 Inches	12 Inches
40' 7.5"	18 Inches	18 Inches	12 Inches
34' 4.5"	12 Inches	12 Inches	12 Inches
28'-1 1/2"	12 Inches	12 Inches	12 Inches
21'-10 1/2"	12 Inches	12 Inches	9 Inches

Assembling the Posts

Complete the following steps when assembling HBA™ Posts, Steel Yielding Treatment Posts™ (SYTP™), foundation tube with wood Posts and wood CRT Posts. For non-breakaway posts, follow the agency's assembly instructions. For placing posts in rigid pavement, also see the Post Assembled in Rigid Material section.

Assembling HBA™ Post

Assembling HBA™ Bottom Post – Post Location 1

Complete the following steps to assemble the HBA™ Bottom Post:

Step	Actions
1.	Arrange the HBA™ bottom (PN-33873A) posts so that the large hole (13/16" [21 mm]) is placed downstream (away from the impact end of the system).
2.	Select Option A or Option B for this assembly.
Option A	Drive the HBA™ Bottom Post with an approved driving head to a depth of approximately 72" (1830 mm).
Option B	<ol style="list-style-type: none">1. Drill a 12" (300 mm) maximum diameter pilot hole approximately 72" (1830 mm) deep.2. Insert the bottom HBA™ Post in the hole.3. Backfill the holes with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction. <p>Note: In either option, the optimum depth will have the 13/16" (21 mm) hole in the post plates (ears/tabs) even with the finished grade.</p>

Assembling HBA™ Top Post

Complete the following steps to assemble the HBA™ Top Post, after the Bottom Post has been assembled:

Step	Actions
1.	Place the Top Post (PN-49398A) at Post 1, by aligning the holes of the post plates (ears) on the top and bottom posts. Note: The Top Post's post plates (ears) can be attached on either side of the Bottom Post's post plates (ears).
2.	Insert a 3/8" (10 mm) diameter x 2" (50 mm) hex head high strength bolt (PN-6321G) through the 7/16" (11 mm) holes of the post plates (ears) on the Top and Bottom Posts.
3.	Place a 3/8" (10 mm) washer (PN-4252G) and a 3/8" (10 mm) lock washer (PN-4258G) under a 3/8" (10 mm) hex nut (PN-6405G) on the inserted bolts to secure. Note: The bolts can be assembled so the nuts are on the inside or outside of the post plates (ears).
4.	Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
5.	Insert a 3/4" (19 mm) diameter x 2 1/2" (63 mm) hex head high strength bolt (PN-5148G) in the 13/16" (21 mm) hole of the HBA™ Post 1 post plates on the side opposite the strut. Do not assemble the 3/4" (19 mm) bolt on the strut side of Post 1, until the strut is ready to be assembled. Note: The bolts can be assembled so the nuts are on the inside or outside of the post plates (ears).
6.	Place a 3/4" (19 mm) washer (PN-3701G) and a 3/4" (19 mm) lock washer (PN-4699G) under a 3/4" (19 mm) hex nut on the inserted bolt to secure.
7.	Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.

Assembling the Steel Yielding Treatment Post™ (SYTP™)

The SYTP™ can be driven or assembled in a tube. For SYTP™ assembly in a tube, see the *Assembling the SYTP™ in Tubes* section. The SYTP™ can be assembled at all locations EXCEPT at location 1. Complete the following step to assemble the SYTP™:



Warning: Do NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.

Placing the 6' (1.83 m) SYTP™

Step	Actions
1.	Drive all the 6' 0" SYTP™ (PN-15000G) to the optimum depth where the centers of the four yielding holes through the flange are at the ground line.
	Warning: DO NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Foundation Tubes

Complete the following steps to assemble foundation tubes.

6' 0" Foundation Tube (Post locations 1 and/or 2)

Step	Actions
1.	Assemble a 5/8" x 7 1/2" (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8" (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-749G) as a post stop. Use 2 bolts when the SYTP is assembled. Use 1 bolt when a Wood Post is assembled. Note: Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See <i>For Driven Foundation Tube Assembling</i> or <i>For Pilot Hole Foundation Tube Assembly</i> sections for assembly instructions.
3.	Assemble the foundation tubes at locations 1 and 2. Use the strut as a guide for the spacing of the tubes. Note: Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

4' 6" Foundation Tube with Soil Plate (Post locations 1 and/or 2)

Step	Actions
1.	Bolt the Soil Plate (PN-766G) to the Foundation Tube (PN-740G) with two 5/8" x 7 1/2" (16 mm x 190 mm) hex head bolts (PN-3478G) and 5/8" (16 mm) HGR nuts (PN-3340G) (no washers). Note: Do not over tighten the nuts and deform the tubes; this will complicate post replacement.
2.	The foundation tube can be placed by driving or with a pilot hole. See <i>For Driven Foundation Tube Assembly</i> or <i>For Pilot Hole Foundation Tube Assembly</i> sections for assembly instructions.
3.	Assemble the foundation tubes at locations 1 and 2. Use the strut as a guide for the spacing of the tubes. If the Soil Plate is utilized, position it on the downstream side of the post (away from the Impact Head). Note: Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

4' 6" Foundation Tube (Post locations 2 - 6, per state specifications):

Step	Actions
1.	Assemble a 5/8" x 7 1/2" (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8" (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-749G) as a post stop. Use 2 bolts where the SYTP is placed. Use 1 bolt when a wood post is attached. Note: Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See <i>For Driven Foundation Tube Assembly</i> or <i>For Pilot Hole Foundation Tube Assembly</i> sections for Assembly instructions.
3.	Assemble the foundation tubes. Use the strut as a guide for the spacing of the tube at location 2. Note: Do not drive tubes with the wood post inserted; this will complicate post replacement.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

3' 10" Foundation Tube (Post locations 2 - 6, per state specifications):

Step	Actions
1.	Assemble a 5/8" x 7 1/2" (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8" (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-758G) as a post stop. Use 2 bolts where the SYTP is deployed. Use 1 bolt when a wood post is deployed. Note: Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See <i>For Driven Foundation Tube Assembly</i> or <i>For Pilot Hole Foundation Tube Assembly</i> sections for Assembly instructions.
3.	Assemble the foundation tubes. Use the strut as a guide for the spacing of the tube at location 2. Note: Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the Posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembly Options for Foundation Tubes

Complete the following steps to place foundation tubes.

For Driven Foundation Tube Assembly

Step	Actions
1.	Drive the foundation tubes (with an appropriate driving head) to the optimum depth, where the top of the tube is 2 5/8" (67 mm) above the finished grade. Note: Take extra care to prevent settlement or lateral displacement of the tubes, to ensure the posts attach to the guardrail, correctly.
2.	Ensure that the finished guardrail height will be approximately 31" (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
3.	Ensure that the tubes do not project more than 4" (100 mm) above the finished grade.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

For Pilot Hole Foundation Tube Assembly

Step	Actions
1.	Drill a 12" (300 mm) maximum diameter pilot hole approximately 49" (1245 mm) deep for the 3' 10" (1168 mm) long foundation tube, 57" (1450 mm) deep for the 4' 6" (1370 mm) long foundation tube or 75" (1905 mm) for the 6' 0" (1830 mm) long foundation tube. If the foundation tube has a soil plate, use Option A or B with this step.
Option A	Cut slots for the soil plates out by hand or by using a rock bar and then follow all of the steps of Option A for 4' 6" tube with soil plate, above.
Option B	Drill three adjacent 12" (300 mm) maximum diameter holes or one 24" (610 mm) maximum diameter hole to accommodate the soil plate / tube assembly and then follow all of the steps of Option A for 4' 6" tube with soil plate, above. Note: Take extra care to prevent settlement or lateral displacement of the tubes, to ensure the posts attach to the guardrail correctly.
	Warning: Ensure that the proper leaveout (specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction.
3.	Ensure that the finished guardrail height will be approximately 31" (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
4.	Ensure that the tubes do not project more than 4" (100 mm) above the finished grade.

Assembling the SYTP™ in Tubes (Post Locations 2 through 6)

Step	Actions
1.	Attach the 3' 9 7/8" (1.16 m) SYTP™ (PN-14328G) in tubes.
	Warning: DO NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.
	Warning: Ensure that the proper leave out (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Follow the instructions in the <i>Assembling the Strut</i> section, Step 5.
3.	Except at Post 1, assemble the SYTP™ in a tube at locations required for the system with the four yielding holes (through the flange) at the top of the tube.
4.	From the embankment side of the tube, insert a 5/8" x 9 1/2" (16 mm x 240 mm) hex head bolt (PN-3497G) through the tube, the spacer (PN-4161), and the SYTP™
5.	Place a 5/8" (16 mm) HGR nut (PN-3340G) on the inserted bolt, to secure the SYTP™ to the tube. Note: Do not over tighten the nut and deform the tubes; this will complicate post replacement.

Assembling Wood Posts in Tubes

Complete the following steps to assemble wood posts in tubes:

Step	Actions
1.	Insert Pipe Sleeve (PN-705G) in post (PN-4140B) and assemble the wood post in the steel tube at location 1.
2.	Assemble Wood Post(s) (PN-4140B) in tubes at locations required for the system, as dictated by the state or specifying agency.
3.	Insert a 5/8" x 9 1/2" (16 mm x 240 mm) hex head bolt (PN-3497G) through the Foundation Tube and the Wood Post at all locations EXCEPT locations 1 and 2. Note: The bolt must be assembled from the embankment side, to aid in possible post replacement.
4.	Place a 5/8" (16 mm) HGR nut (PN-3340G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. Note: Do not over tighten the bolts and deform the tubes; this will complicate post replacement.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Wood CRT Posts

Complete the following steps to assemble the wood CRT posts:

Step	Actions
1.	Assemble the Wood Posts (PN-4071B) at locations required for the system, spaced at 6' 3" (1270 mm) apart. Select Option A or Option B to place the CRT posts.
Option A	Drive posts into the ground.
Option B	<ol style="list-style-type: none"> 1. Drill 12" (300 mm) maximum diameter pilot holes approximately 44" (1120 mm) deep. 2. Insert the 6' 0" (1830 mm) Wood Posts into these holes. 3. Backfill the holes with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction.
	Note: In either option within Step 1, the bottom of the upper 3 1/2" (90 mm) hole in the post is approximately at the finished grade.
	Warning: DO NOT assemble 6' 0" CRT post at location 1 and 2. Failure to follow this warning could result in serious injury or death in the event of a collision.
	Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Foundation Tubes, HBA™ Posts, or SYTP™ when Encountering Rock

Complete the following steps to assemble foundation tubes, HBA™ posts or SYTP™ when encountering rock:

Step	Actions
1	Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification.
Option A	If rock is encountered and 20 inches (510 mm) or less of the full length post or foundation tube remains to be embedded:
	<ol style="list-style-type: none"> 1. Drill a 12" to 16" (300 mm to 400 mm) diameter hole into the rock. 2. Drill holes 2" (50 mm) deeper than the required embedment depth. 3. Place granular material or small pieces of the drilled rock in the bottom 2" (50 mm) of the hole for drainage. 4. Assemble the tube or post into the hole. Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction.
	Note: If compactable, the material removed from the hole may be used for backfill.

Option B	<p>If rock is encountered and more than 20 inches (510) of the full length post or foundation tube remains to be embedded:</p> <ol style="list-style-type: none"> 1. Drill a 12" to 16" (300 mm to 400 mm) diameter hole 22" (560 mm) deep into the rock. 2. Cut off the embedded portion of the tube or post so the Guardrail will be at the proper mounting height. Cutting off the bottom of the embedded portion of full length post or foundation tube is permitted only when a minimum of 20" (510 mm) embedment into rock can be achieved. 3. Place granular material or small pieces of the drilled rock in the bottom 2" (50 mm) of the hole for drainage. 4. Assemble the tube or post in the hole. Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction. <p>Note: If compactable, the material removed from the hole may be used for backfill.</p>
	<p>Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.</p>

Assembling the Strut

Complete the following steps when assembling the strut:

Note: For all strut assemblies, the assembler must provide a shallow valley or trough for assembly of the strut, since a portion of the angle strut will be below grade.

Assembling the Strut with HBA™ Post at Post 1 and SYTP™ at Post 2

Complete the following steps to assemble the strut.

At Post 1

Step	Actions
1.	<p>Place the angle strut on the outside flanges of the HBA™ post.</p> <p>Note: The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground. The strut may be attached either on the traffic side or the field side of the posts.</p>
2.	<p>Assemble a 3/4" (19 mm) diameter x 2 1/2" (63 mm) hex head high strength bolt (PN-3717G) in the 13/16" (21 mm) hole of the HBA™ Post 1 post plates. Place the bolt through the top and bottom post's post plates and through the strut.</p>
3.	<p>Place a 3/4" (19 mm) washer (PN-3700G) and a 3/4" (19 mm) lock washer under a 3/4" (19 mm) hex nut on the end of the bolt to secure.</p>
4.	<p>Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)</p>

For Angle Strut with 6' SYTP™ at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33795G) on the embankment side of the SYTP™. (The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 7/16" (11 mm) round washer (PN-4389G) on the two 7/16" (11 mm) diameter x 1 1/2" (38 mm) hex head high strength bolts (PN-4390G).
3.	Insert the two bolts through the two slotted holes of the strut and the yielding diameter holes of the SYTP™, at Post 2.
4.	Place a 7/16" (11 mm) lock washer (PN-4393G) and a plate washer (PN-19948G) under a 7/16" (11 mm) hex nut (PN-4388G) on the ends of inserted bolts. When in the correct position, plate washer is placed against yielding holes of the post and under the lock washer and nut.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Angle Strut with SYTP™ in Tube at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the tube. (The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, spacer (PN-4161), and the SYTP™ at Post 2.
4.	Place a 3/4" (19 mm) washer (PN-3701G) under a 3/4" (19 mm) hex nut on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) Note: Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement.

Assembling the Strut with Wood CRT Post in Tube at Post 1 and SYTP™ at Post 2

Complete the following steps to assemble the strut:

At Post 1

Step	Actions
1.	Place the Angle Strut on the embankment side of the Foundation Tube.
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, the Foundation Tube, and the Wood Post.
4.	Place a second washer under a 3/4" (19 mm) hex nut (PN-3704G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Angle Strut with 6' SYTP™ at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33730G) on the embankment side of the SYTP™. (The Strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 7/16" (11 mm) round washer (PN-4389G) on the two 7/16" (11 mm) diameter x 1 1/2" (38 mm) hex head high strength bolts (PN-4390G).
3.	Insert the two bolts through the two slotted holes of the strut and the yielding diameter holes of the SYTP™, at Post 2.
4.	Place a 7/16" (11 mm) lock washer (PN-4393G) and a plate washer (PN-19948G) under a 7/16" (11 mm) hex nut (PN-4388G) on the ends of inserted bolts. When in the correct position, the plate washer is assembled against the yielding holes of the post and under the lock washer and nut.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement)

For Angle Strut with SYTP™ in Tube at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the tube. (The Strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, spacer (PN-4161), and the SYTP™ at Post 2.
4.	Place a 3/4" (19 mm) washer (PN-3701G) under a 3/4" (19 mm) hex nut on the end of the inserted bolt
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) Note: Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement

Assembling the Strut with Wood Posts in Soil Tubes (Post Locations 1 and 2)

Complete the following steps to assemble the strut:

For Angle Strut

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the Foundation Tubes.
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, the Foundation Tube, and the Wood Post.
4.	Place a second washer under a 3/4" (19 mm) hex nut (PN-3704G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Channel Ground Strut

Step	Actions
1.	Place the slotted yokes of the Ground Strut (PN-9852A) over the Foundation Tubes.
2.	Place a 5/8" (16 mm) round washer (PN-3300G) on a 5/8" (16 mm) diameter x 9 1/2" (240 mm) hex head bolt (PN-3497G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, and the Wood Post.
4.	Place a second washer under a 5/8" (16 mm) HGR hex nut on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) Note: Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement.

Assembling Offset Blocks and Rail Panels

The ET-31™ Guardrail End Treatment uses a 12' 6" (3.81 m) Rail Panel (PN-32G). Depending on the state or specifying agency standards, a combination of the following Rail Panels will be used for their system: 9' 4 1/2" (2.86 m) Rail Panel (PN-10967G), 15' 7 1/2" (4.76 m) Rail Panel (PN-20442G), 12' 6" (3.81 m) Rail Panel (PN-11G), or 25' (7.62 m) Rail Panel (PN-60G).



Warning: DO NOT bolt the Rail Panel to the post at location 1 in any of the ET-31™ Guardrail End Treatment. Failure to follow this warning could result in serious injury or death in the event of a collision.

Splicing the Rail Panels

Complete the following steps to splice the rail panels:

Step	Actions
1.	Lap the Treatment rail in the direction of traffic, unless the state or specifying agency's policy dictates otherwise. EACH RAIL PANEL MUST BE STRAIGHT WITH NO VISIBLE DISTORTIONS OR BLEMISHES SUCH AS CURVES, DENTS, CUTS, TEARS, EXTRA HOLES, CUT-OUTS, CORROSION OR SIGNS OF PAST REPAIRS. Rails with distortions that could compromise its ability to resist compressive load induced by the Head during head-on impacts shall not be used.
2.	Splice the Rail Panels together with eight 5/8" x 1 1/4" (16 mm x 32 mm), HGR splice bolts (PN-3360G), and 5/8" (16 mm) HGR hex nuts.
	Warning: USE ONLY PROPER LENGTH SPLICE BOLTS (1-1/4" LONG) which have Trinity's "TRN" identifying mark stamped into the top of the bolt head. Failure to follow this warning could result in serious injury or death in the event of a collision.
3.	Tighten the bolts. (There is no torque requirement.)

Assembling the Offset Block and Rail Panel to Wood Posts (Posts 3 through 6)

Complete the following steps to attach the Offset Blocks and Rail Panels to the Wood Posts:

Step	Actions
1.	1. At locations with Wood Posts and Wood Blocks, insert a 5/8" (16 mm) diameter 22" (560 mm) HGR post bolt (PN-3620G) through the Rail Panel, Offset Block (PN-4660B), and the Post. Note: Offset Blocks are NOT used at post locations 1 and 2, but are used at all other locations.
	Warning: Do NOT bolt the Rail Panel to the post at location 1 in any of the ET-31™ Guardrail End Treatment. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Place a 5/8" (16 mm) round washer (PN-3300G) under a 5/8" (16 mm) HGR nut (PN-3340G).
3.	Tighten the bolts. (There is no torque requirement for these bolts.)
4.	Secure the Offset Block by toe nailing the Block to the Post or the Post to the Block, with two 16d hot-dipped galvanized nails approximately 3" (75 mm) from the top of the Post or Block, one on each side, to prevent it from rotating.

Assembling the Offset Block and Rail Panel to SYTP™ (Posts 3 through 6)

Complete the following steps to attach the Offset Blocks and Rail Panels to the SYTP™:

Step	Actions
1.	At locations with Steel Yielding Treatment Post™ (SYTP™) with Offset Blocks, insert a 5/8" (16 mm) diameter x 14" (355 mm) HGR post bolt (PN-3540G) through the Rail Panel, routed Wood (PN-4076B) or Composite (PN-6707B) Blockout, and the SYTP™. Note: Offset Blocks are NOT used at post locations 1 and 2. For SYTP™ Inserts, there are two sets of holes in the SYTP™ for attaching the rail. Use the holes in the SYTP™ that will place the rail at the correct height.
	Warning: DO NOT bolt the Rail Panel to the post at location 1 in any of the ET-PLUS™ systems. Failure to follow this warning could result in serious injury or death in the event of a collision.

	Warning: Ensure all Wood Blocks or Composite Blocks used with steel posts are routed. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Place a 5/8" (16 mm) round washer (PN-3300G) under a 5/8" (16 mm) HGR nut (PN-3340G) on the inserted bolt.
3.	Tighten the bolts. (There is no torque requirement for these bolts.)

Assembling the Rail Panel to the Post without Offset Block at Post 2

Complete the following steps to attach the Rail Panel to the Post without Offset Block at Post 2:

Step	Actions
1.	Select Option A or Option B to attach the Rail Panel without Offset Block at Post 2:
Option A	<p>For Wood Post:</p> <ol style="list-style-type: none"> 1. Insert a 5/8" (16 mm) diameter x 10" (255 mm) HGR post bolt (PN-3500G) through the Rail Panel and the Wood Post at location 2. 2. Place a 5/8" (16 mm) round washer (PN-3300G) under a 5/8" (16 mm) HGR nut (PN-3340G) on the inserted bolt. Tighten the bolts. (There is no torque requirement for these bolts.)
Option B	<p>For SYTP™:</p> <ol style="list-style-type: none"> 1. Insert a 5/8" (16 mm) diameter x 1 1/4" (31 mm) HGR bolt (PN-3360G) through the Rail Panel and the hole in the SYTP™. <p>Note: For SYTP™ Inserts use the hole in the SYTP™ that will place the Rail Panel at the correct height. (If there are two sets of holes in the SYTP™ for attaching the Rail Panel.)</p> <ol style="list-style-type: none"> 2. Place a 5/8" (16 mm) round washer (PN-3300G) under a 5/8" (16 mm) HGR nut (PN- 3340G) on the inserted bolt.

Assembling the Cable Anchor Assembly

The Cable Anchor Bracket (PN-704A) is secured to the Rail Panel, by inserting the square protruding hooks / lugs on the bracket into the square slots in the rail panel. The Cable Anchor Bracket is locked into place, by pulling the bracket towards the impact end of the unit, making sure the hooks / lugs are well seated into the square holes.

Complete the following steps to assemble the Cable Anchor Bracket assembly:

Step	Actions
1.	Slide one end of the Cable (PN-3000G) into the Cable Anchor Bracket and the other end through Post 1.
2.	Place a 1" (25 mm) washer (PN-3900G) and 1" (25 mm) hex nut (PN-3910G) on the end of the cable that extends through the Cable Anchor Bracket. Turn the nut, until at least 2 threads are completely through the nut.
3.	Place the Bearing Plate (PN-19258A with two side ears/tabs on the steel post, PN-782G with no side ears/tabs on Wood Post) on the impact side of Post 1 where the Cable extends through the Post. The Cable Bearing Plate MUST BE oriented with the "long" dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5" (125 mm) from one edge and 3" (75 mm) from the opposite edge. The two ears/tabs on the Bearing Plate (PN-19258A) must straddle the left and right side of the HBA hinge assembly.
4.	If applying the Bearing Plate with no side ears/tabs (PN-782G) to a wood post at Post 1, drive two 16d hot-dipped galvanized nails along the top edge of the bearing plate and bend over to prevent the bearing plate from rotating.
	Warning: Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate. Failure to eliminate the interaction of soil or materials with the Bearing Plate will hinder the performance of the ET-31™ Guardrail End Treatment and could result in serious injury or death in the event of a collision.
5.	Place a 1" (25 mm) washer under a nut on the end of the Cable extending through Post 1.
6.	Restrain the Cable with locking pliers at the end being tightened, to avoid twisting the Cable.
7.	Tighten the hex nuts on the Cable ends, until the Cable is taut. The Cable is considered taut when it does not deflect more than 1" (25 mm) when pressure is applied by hand in an up or down direction.
8.	The shank portion of the Anchor Cable MUST BE positioned so it bears on the bottom edge of the web of the HBA post. The shank portion of the Anchor Cable must also be centered so that the Bearing Plate bears uniformly on both flanges of Post 1.

Assembling the ET-PLUS™ Extruder (Head)

Complete the following steps to assemble the ET-PLUS™ Extruder (Head):

Step	Actions
1.	Place the ET-PLUS™ Extruder (Head) (PN-995A) over the end of the Rail Panel as the final piece to attach to the assembly. Note: The ET-PLUS™ Extruder (Head) can be used on the left or right hand shoulder.
2.	Push the ET-PLUS™ Extruder (Head) as far as it will go onto the front-most Rail Panel, making sure the Rail Panel is fully engaged into the full length of the channel guide attached to the Head until it stops.
3.	Assemble the ET-PLUS™ Extruder (Head) with channel guide attached to it approximately parallel to the ground. The upper and lower attachment tabs welded to the guide chute have three holes in each to provide a means to level the Head (See following steps).
4.	Select Option A or Option B for the ET-PLUS™ Extruder (Head) assembly.
Option A	For Wood post: <ol style="list-style-type: none"> Place the ET-PLUS™ Extruder (Head) against the Wood Post, at location 1. Choose the hole in the tab welded to the guide chute that is closest to the center of the Post. Drill a 1/4" (6 mm) pilot hole to avoid breaking the lag screw during assembly. Screw one 3/8" (10 mm) diameter x 4" (100 mm) lag screw (PN-4228B) through the top and bottom tab. The lag screw must be screwed into the Wood Post to prevent it from pulling out or cracking the post. DO NOT OVER TIGHTEN, causing the threads in the Wood Post to strip.
Option B	For HBA™ post: <ol style="list-style-type: none"> Place the ET-PLUS™ Extruder (Head) against the HBA™ post, at location 1. Place a 3/8" (10 mm) round washer (PN-4254G) onto a 3/8" (10 mm) diameter x 1 1/2" (38 mm) hex head bolt (PN-4261G). Insert this bolt through the tab welded to the side of the guide channel attached to the ET-PLUS™ Extruder (Head) and then through the hole in the flange of HBA™ Post. Place a 3/8" (10 mm) fender washer (PN-4255G) under a 3/8" (10 mm) nut (PN-6405G) onto the inserted bolt. A larger fender washer is used to cover the relatively large hole in the flange of the HBA Post. Repeat this assembly step for the top and bottom tabs. When completed, the Head will be attached to the HBA post via an upper and lower 3/8" diameter hex head bolt (PN-4261G). Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.

Delineation Option for the ET-31™ Guardrail End Treatment

Apply High Intensity Reflective Sheeting (PN-6206B [Right Side] or PN-6207B [Left Side]) on the front face of the ET-PLUS™ Extruder (Head), per the state or specifying agency's *Manual on Uniform Traffic Control Devices* (MUTCD) for options or proper delineation. Alternate Reflective Sheeting is PN-6668B. The Alternate Reflective Sheeting requires two pieces and may be rotated for proper right or left delineation.

Note: The Reflective Sheeting is an option to the ET-31™ Guardrail End Treatment and needs to be ordered separate from the ET-31™ Guardrail End Treatment package.

Assembly Checklist

State: _____ Project: _____

Date: _____ Location: _____

- The leaveout (the specified area of open space in the pavement) around the Posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement for any posts placed in rigid pavement such as any thickness of concrete or asphalt.
- The finished guardrail height is approximately 31" (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
- Any site grading needed was completed, before the start of the assembly of the ET-31™ Guardrail End Treatment.
- The Steel Tubes or Post Plates (ears) to the HBA™ bottom post do not protrude more than 4" (100 mm) above the finished grade measured by the American Association of State Highway and Transportation Officials (AASHTO) 5' (1.5 m) cord method. Site grading may be necessary to meet this requirement.
- The 3/4" (19 mm) bolts connecting the tops of the HBA™ Bottom Post to the bottom of the HBA™ Top Post are tightened to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
- The 3/8" (10 mm) bolts connecting the tops of the HBA™ Bottom Post to the bottom of the HBA™ Top Post are tightened to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
- The bolts at the top of the Steel Tubes are not over tightened. The walls of the Steel Tubes are not collapsed.
- If an Angle Strut was utilized, the bolts connecting the Angle Strut are 3/4" (19 mm) DIA. high strength.
- The ET-PLUS™ Extruder (Head) is pushed as far as it will go on the Rail Panel, ensuring the Rail Panel is fully engage into the channel guide that is welded to the Extruder (Head).
- The two 3/8" diameter bolts holding the ET-PLUS™ Extruder (Head) to Post 1 are snug and the channel guide welded to the Head is approximately parallel to the finished grade.
- The Cable Anchor Bracket is locked into place, by pulling the Bracket towards the impact end of the unit, making sure the hooks / lugs are well seated into the square holes.
- The shank portion of the Anchor Cable MUST BE positioned vertically flush against the bottom web of the top section of the HBA Post. The shank portion of the Cable MUST also be centered so that the Bearing Plate bears uniformly on both flanges of Post 1.
- Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate.

- The hex nuts on the Cable ends are tightened, until the Cable is taut. The Cable is considered taut, when it does not deflect more than 1" (25 mm) when pressure is applied by hand in an up or down direction.
- Do not place anything under the rail to post bolt head that would prevent the bolt from pulling through the Rail Panel.
- The Bearing Plate is placed on the front of Post 1 where the Cable extends through the Post. The Cable Bearing Plate MUST BE oriented with the "long" dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5" (125 mm) from one edge and 3" (75 mm) from the opposite edge. If the Bearing Plate has two "ears/tabs", these need to straddle the left and right side of the No. 1 Post and be on the upper side of the plate.
- The top surfaces of any grout or other backfill placed in the mow strip "leave out" must be low enough so that it does not engage the Bearing Plate or otherwise obstruct or constrain the 3/8" (10 mm) shear bolts or the 3/4" (19 mm) hinge bolts of the HBA Post
- Any Wood Offset Blocks used have been toe nailed to the Wood Posts.
- If backfilled, make sure the backfill material around the Posts is properly compacted.
- Each HBA™ Post has two bolts on either side of the Post with the larger bolt downstream of the smaller bolt (away from the Impact Head).
- The SYTP™ holes are at the finished grade.
- The Wood CRT Post has two 3 1/2" (90 mm) breakaway holes (checked prior to assembly). They are located parallel to the roadway with the top hole located approximately at the finished grade.
- The tube bolts are attached with the nuts on the pavement side of the Tube for ease of future removal.
- The Rail Panels are lapped correctly and not attached to the Posts at locations identified for the system.
- Each Rail Panel used in the ET-31™ pay length is straight, with no visible distortions or blemishes such as curves, dents, cuts, tears, extra holes, cut-outs, corrosion, or signs of past repairs.
- The Reflective Sheeting is correctly positioned on the Extruder face.
- Ensure that this assembly conforms with the guidance provided by the *AASHTO Roadside Design Guide*, including, but not limited to, those regarding placement on curbs.

Maintenance and Repair

Always keep the Manual in a location where it is easily accessed by persons who assemble, maintain, or repair the ET-31™ Guardrail End Treatment. If you have any questions concerning the information in this Manual or about the ET-31™ Guardrail End Treatment, contact Trinity Highway Products at 888-323-6374.

Maintenance

Complete the following steps, periodically, to check the safety of the system:

Step	Actions
1.	Ensure the nuts have not been removed from the Cable. Replace nuts, if needed.
2.	Ensure the end fitting on the Anchor Cable MUST BE positioned vertically, up flush against the bottom web of the top section of the Post. The end fitting of the Cable MUST be centered horizontally so that the Bearing Plate bears uniformly on both flanges of Post 1.
3.	Ensure the Cable is taut. The Cable is considered taut when it does not deflect more than 1 inch when pressure is applied by hand in an up or down direction. Tighten Cable if needed.
4.	Ensure the Bearing Plate has not rotated. Note: The Cable Bearing Plate MUST BE oriented with the “long” dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5” (125 mm) from one edge and 3” (75 mm) from the opposite edge.
5.	Ensure Wood Blocks are in place and in good condition, as defined by the state or specifying agency.
6.	Ensure the Block Outs have not rotated. Correct the Block Out position and reattach the 16d hot-dipped galvanized nails, if needed.

Repair

Complete the following steps to repair the ET-31™ Guardrail End Treatment:

Step	Actions
1.	Set up necessary traffic control at the accident site and then remove any debris that has encroached onto the traveled way or shoulder.
2.	Take inventory of the damaged system and determine what parts are reusable, as defined by the state or specifying agency and what parts need to be replaced.
3.	Check the ET-PLUS™ Extruder (Head) for damage. The determination as to whether or not the Head is reusable rests entirely within the discretion of the DOT or other appropriate highway authority. Before reusing a Head, please make sure that an experienced, trained engineer for the highway authority inspects the Head to his or her satisfaction and authorizes its reuse. For consideration of reuse of the Extruder Head, the rail guide chute must be fully intact and not distorted in any way; the slot that flattens the rail shall not be excessively distorted in any way; the slot that flattens the rail shall not be excessively distorted; the front impact face must not be excessively distorted, and all the original welds must be intact. Again before reusing a Head, a trained DOT or applicable highway authority engineer shall inspect it and authorize its reuse.
4.	Check the Anchor Cable and Cable Anchor Bracket for damage. (The Bearing Plate, nuts, washers, and Cable Anchor Bracket are rarely damaged.)
5.	Obtain the Trinity Highway Products parts that need to be replaced from Trinity Highway Products. (See <i>Tools Required</i> section for a list of recommended tools for the repair of the ET-31™ Guardrail End Treatment.)

6.	Return to the repair site with the replacement parts and tools needed.
7.	Cut off the extruded rail near the ET-PLUS™ Extruder (Head). Do not cut the ET-PLUS™ Extruder (Head) from the non-extruded rail.
8.	Secure a chain to the ET-PLUS™ Extruder (Head).
9.	Attach the chain to a truck frame while the other end of the Rail Panel is still connected to the downstream Posts (away from the Impact Head) to provide anchorage.
10.	Pull the ET-PLUS™ Extruder (Head) off the Rail Panel.
11.	Remove any damaged Rail Panel(s).
12.	Remove the broken Posts from the Steel Tubes.
13.	Remove all damaged CRT, SYTP™, or HBA™ Posts. Undamaged HBA™ Posts can be reset.
14.	Remove and discard any rubber bumpers or construction legs.
15.	Reconstruct the system following the assembly instructions after the site has been cleared of damaged debris.
16.	Attach proper delineation for the repaired system in accordance with the state or specifying agency's <i>Manual on Uniform Traffic Control Devices</i> (MUTCD).

Notes:



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