

APPENDIX 3.7-C: HSR GUIDEWAY ENCLOSURE FOR THE GRASSLANDS ECOLOGICAL AREA



HIGH-SPEED RAIL: CONNECTING AND TRANSFORMING CALIFORNIA

Confidential/Internal Use

MEMORANDUM

Date: November 5, 2019

To: Gary Kennerley

From: Julian Bratina

CC: Dave Shpak

Subject: HSR Guideway Enclosure for the Grasslands Ecological Area

Introduction

This memorandum summarizes the efforts by the Authority to develop, analyze and review conceptual design options for an acoustic guideway enclosure. An enclosure that surrounds the train operating envelope and OCS equipment would provide a greater reduction in noise, visual, and bird strike impacts than noise barriers and line markers where the alignment passes through an important complex of wetlands. The Authority Director of Environmental Services commissioned this analysis in response to a request from the Grassland Water District and other stakeholders in the Grasslands Ecological Area.

Background

During the program level route identification efforts, the Authority selected an alignment across the Grasslands Ecological Area (GEA), a complex of wetlands measuring approximately 95,000 hectares in the San Joaquin Valley, at the narrowest point to minimize the impact of high-speed rail (HSR) on the area. The results of these efforts were published in the Bay Area to Central Valley HST Final EIR/S 2008 environmental document. During this program environmental stage, CHSRA committed to place approximately 3.0 miles of guideway on an elevated structure centered on Mud Slough to minimize the impact on the GEA.

Collaboration Diversity Excellence Innovation Safety Sustainability



Figure 1: Extent of HSR guideway across Grasslands Ecological Area

The Authority has been working with stakeholders in the GEA to evaluate the environmental impact of this decision, and potential methods of mitigation. In December of 2018, the Authority received a letter from the GEA Working Group that requested consideration of an enclosure structure similar to that used in China's Shenzen-Maoming HSR program. This is a structure that would fully enclose the guideway and overhead contact system, to mitigate visual and acoustic impacts on waterfowl and shorebirds living in and moving across the adjacent habitat.



Figure 2: Chenzen-Maoming Guideway Enclosure

Coincidentally, preliminary results of the Authority's ongoing evaluation of impacts to waterfowl and shorebirds in the GEA Important Bird Area proximate to Mud Slough indicated potential for visual, noise, and bird-strike impacts. The Authority agreed to evaluate the enclosure concept, determine whether a similar structure would be suitable for the GEA crossing, and what the structure's potential impacts would be.

Analysis

1. Design Development

The Engineering team evaluated the tubular concept, and produced a similar design that would enclose the guideway and the full extents of the CHSRA operating envelope. The structure primarily consisted of steel w-flange beams rolled into a circular shape, bolted together with gusset plates, and supported on the concrete viaduct structure. A circular steel frame would support precast concrete panels mounted around the structure, with OCS brackets hung inside the structure, and longitudinally reinforced by steel struts. The design concepts were subjected to preliminary structural assessments, including wind loading, support of OCS equipment, the loading on the viaduct structure, and considered different material types for sound attenuation.

There were two primary objectives of the enclosure: (1) to avoid the visual and acoustic impacts on waterfowl and shorebirds, and (2) to prevent bird strikes. While a noise barrier would encourage birds to fly higher over the guideway, it would not prevent nesting, foraging, or roosting within the operating envelope of the train. Also, the OCS equipment would protrude above the noise barriers and attract perching, and create a deadly obstacle to avian flight paths. A permeable enclosure was explored to preclude avian access, but discarded due to its inability to reduce acoustic and visual impacts, and the unacceptable maintenance challenges.

After the design and performance analyses revealed considerable weight and cost, the engineering team designed an alternative concept with equivalent functionality that would minimize the structure's weight and complexity, and probable cost.

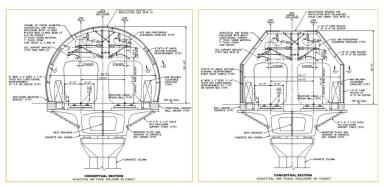


Figure 3: Tubular and Wall Panel Enclosure Concepts

2. Pressure Transient Analysis

A pressure transient (i.e. pneumatic) analysis was necessary to evaluate the impacts of the enclosure on HSR operations at full speed, the impacts to passenger comfort levels, and the impacts the train operation would have on the enclosure. In addition, the operation of a high-speed train within an enclosed space results in a pressure wave in front of and behind the train, that when exiting the enclosed space, would rapidly expand and could generate a loud percussive noise. To ensure the enclosure would not have a detrimental impact on the operation of the train and its surroundings, a preliminary pressure transient analysis was conducted.

The analysis looked at three scenarios: Two trains crossing in the enclosure, a single train passing through the enclosure, and the micro pressure waves at the exit portal. A one-dimensional analysis performed using the ThermoTun-Online software, commonly used for proof of concept, estimated the maximum pressure change to which train passengers and crew are subjected, the maximum/minimum pressures exerted on the enclosure structure, and the magnitude of the pressure wave at the enclosure portals.

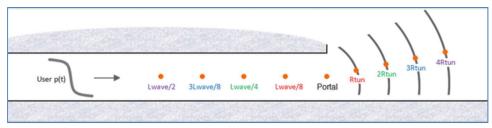


Figure 4: Illustration of the micro pressure waves analysis

To reduce the magnitude of the pressure wave within the enclosure, while minimizing the size of the structure, the designers proposed three openings to be located at the obvert of the enclosure. These openings, each 35% of the enclosure cross-sectional area and spaced out at quarter points along the length of the structure, reduced the estimated maximum pressure by 40% to stay within standard HSR operating parameters.

3. Noise Analysis

A noise analysis was necessary to evaluate the effectiveness of the structure and potential to attenuate noise impacts in the area. The analysis, using Cadna-A modeling software, also evaluated the performance of other structural noise mitigation options including; a noise barrier 14-ft above top of rail (TOR), a 17.5-ft noise barrier, and a 17.5-ft noise barrier with an angled cantilevered top edge (similar to the alternative enclosure concept) to provide a basis for functional comparison.

The acoustical model was used to evaluate the base condition and all four noise mitigation options to allow for direct comparison of results.

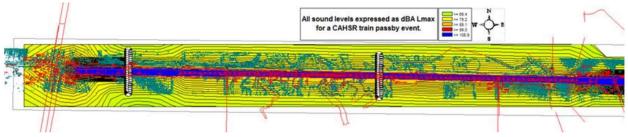


Figure 5: Isopleth Noise Contours

The level of noise reduction increases with the barrier height and extent of enclosure. However, higher levels of noise reduction provided by enclosure come at increasing costs of more complex structures. The results of the analysis showed that the permanent hearing damage criterion (140 dBA Lmax) would not be exceeded. However, temporary hearing damage, masking, and arousal criteria were exceeded and would require additional land based mitigation up to 300-ft from the track alignment.

4. Cost Estimates

A preliminary cost estimate was completed to evaluate the five options under review in the GEA: existing conditions (no mitigation), a noise barrier 14-ft above TOR, a noise barrier 17.5-ft above TOR, a tubular enclosure, and a wall panel enclosure. The cost estimates, supported by material quotes and reviewed by the Authority estimating department, included materials, labor, equipment, and viaduct

structural and foundation improvements. In addition to the capital cost estimates, a rough order of magnitude operations and maintenance (O&M) cost was calculated for the two enclosures as their complexity would result in higher maintenance costs. Land based compensatory mitigation costs were also estimated for each of the structural options. The potential to stack mitigation (i.e. consolidated mitigation for more than a single impact type) enabled an estimated low to high (i.e. separated mitigation for each impact type) range of mitigation costs.

Table 1: Concept level cost estimate

Structure	Noise	Capital Cost	Compensatory	Total ROM	ROM Additional	
Options	Reduction		Mitigation Cost*	Net Cost	O&M Cost	
					(average annual)	
None	0 dBA	N/A	\$20.5 to 33M	\$20.5 to 33M	N/A	
Noise Barrier	8 dBA	\$36M	\$12 to 19M	\$48 to 55M		
14-ft>TOR					< \$60K for 3 miles	
Noise Barrier	10 dBA	\$46M	\$9.5 to 15M	\$55.5 to 61M	< 300K IOI 3 IIIIles	
17.5ft>TOR						
Wall Panel	10+ dBA	\$90M±	\$9.5M to 15M	\$100.5M to		
Enclosure				106M	≈\$60K ± for 3	
Tubular	12 dBA	\$119M	\$7M to 11M	\$126 to 130M	miles	
Enclosure						

^{*}Stacked to Unstacked Mitigation

Conclusions

The results of the analysis showed that the two enclosures would support HSR operations and provide visual and acoustic mitigation at a greater level than a standard noise barrier mitigation measure. In addition, noise barriers lacked the ability to prevent bird strikes, and were therefore eliminated from consideration. The enclosures were deemed conceptually feasible, and due to the sensitivity of resources and stringent regulatory requirements, the Authority is proposing an enclosure as a mitigation measure for regulatory assurance, and technical efficiency. This approach requires further detailed design analysis, and engineering validation that is beyond the scope of preliminary engineering. Language for a proposed mitigation measure has been drafted for the Draft EIR/EIS to assure concept-level feasibility, performance, and efficacy:

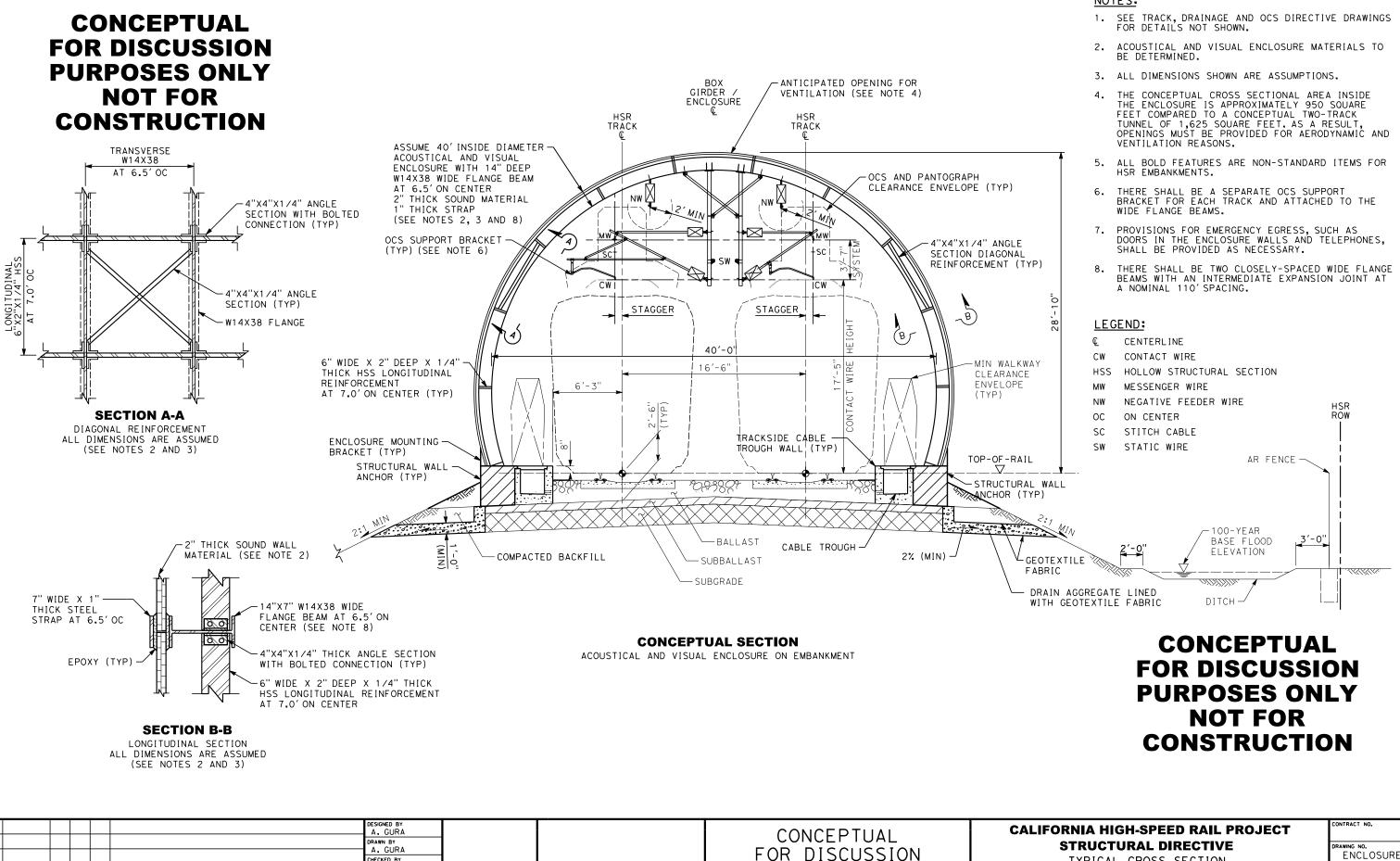
- Enclose HSR guideway and OCS continuously for 3.4 miles, centered approximately at Mud Slough. The final recommendation of 3.4 miles is the result of iterative design refinement between engineering and environmental science teams.
- Construct using opaque, nonglare materials that provide a minimum of 10 dBA attenuation of sound generated by HSR operations, as measured immediately outside the enclosure.
- Design in compliance with all HSR design, operations, and maintenance requirements.
- Build in conjunction with installation of track and OCS; completed before HSR train operations begin.

- Consult with CDFW, USFWS, GWD, the owner(s) of private properties affected by the 3.4-mile HSR project footprint, and other stakeholders as part of final design of the guideway enclosure.
- Implement in conjunction with compensatory mitigation, if quantitative modeling of final enclosure design demonstrates residual noise of 77 dBA or more, measured outside the HSR right-of-way.

Appendices

- 1. Tubular Enclosure on Embankment
- 2. Tubular Enclosure on Viaduct
- 3. Wall Panel Enclosure on Viaduct
- 4. Pressure Transient Analysis Memo
- 5. Noise Analysis Memo
- 6. Cost Estimates

Tubular Enclosure on Embankment



PURPOSES ONLY

NOT FOR CONSTRUCTION

CHECKED BY J. BRATINA

BY CHK APP

DESCRIPTION

CHARGE J. BRATINA

2/01/2019

ENCLOSURE 2 NO SCALE

TWO TRACK BALLASTED WITH ACOUSTICAL AND VISUAL ENCLOSURE

TYPICAL CROSS SECTION

AT-GRADE EMBANKMENT

HEET NO.

Tubular Enclosure on Viaduct

- 1. SEE STRUCTURE AND OCS DIRECTIVE DRAWINGS FOR DETAILS NOT SHOWN.
- ACCOUSTICAL AND VISUAL ENCLOSURE MATERIALS TO BE DETERMINED.
- 3. ALL DIMENSIONS SHOWN ARE ASSUMPTIONS.
- THE CONCEPTUAL CROSS SECTIONAL AREA INSIDE THE ENCLOSURE IS APPROXIMATELY 950 SQUARE FEET COMPARED TO A CONCEPTUAL TWO-TRACK TUNNEL OF 1,625 SQUARE FEET. AS A RESULT, OPENINGS MUST BE PROVIDED FOR AERODYNAMIC AND VENTILATION REASONS.
- ALL BOLD FEATURES ARE NON-STANDARD ITEMS FOR HSR STRUCTURES.
- THERE SHALL BE A SEPARATE OCS SUPPORT BRACKET FOR EACH TRACK AND ATTACHED TO THE WIDE FLANGE BEAMS.
- 7. PROVISIONS FOR EMERGENCY EGRESS, SUCH AS DOORS IN THE ENCLOSURE WALLS AND TELEPHONES, SHALL BE PROVIDED AS NECESSARY.
- THERE SHALL BE TWO CLOSELY-SPACED WIDE FLANGE BEAMS WITH AN INTERMEDIATE EXPANSION JOINT AT

LEGEND:

- CENTERLINE
- CONTACT WIRE
- HOLLOW STRUCTURAL SECTION
- MESSENGER WIRE
- NEGATIVE FEEDER WIRE
- ON CENTER
- SC STITCH CABLE
- STATIC WIRE

CONCEPTUAL FOR DISCUSSION **PURPOSES ONLY NOT FOR** CONSTRUCTION

A. GURA DRAWN BY CHECKED BY J. BRATINA CHARGE BY CHK APP DESCRIPTION 2/01/2019

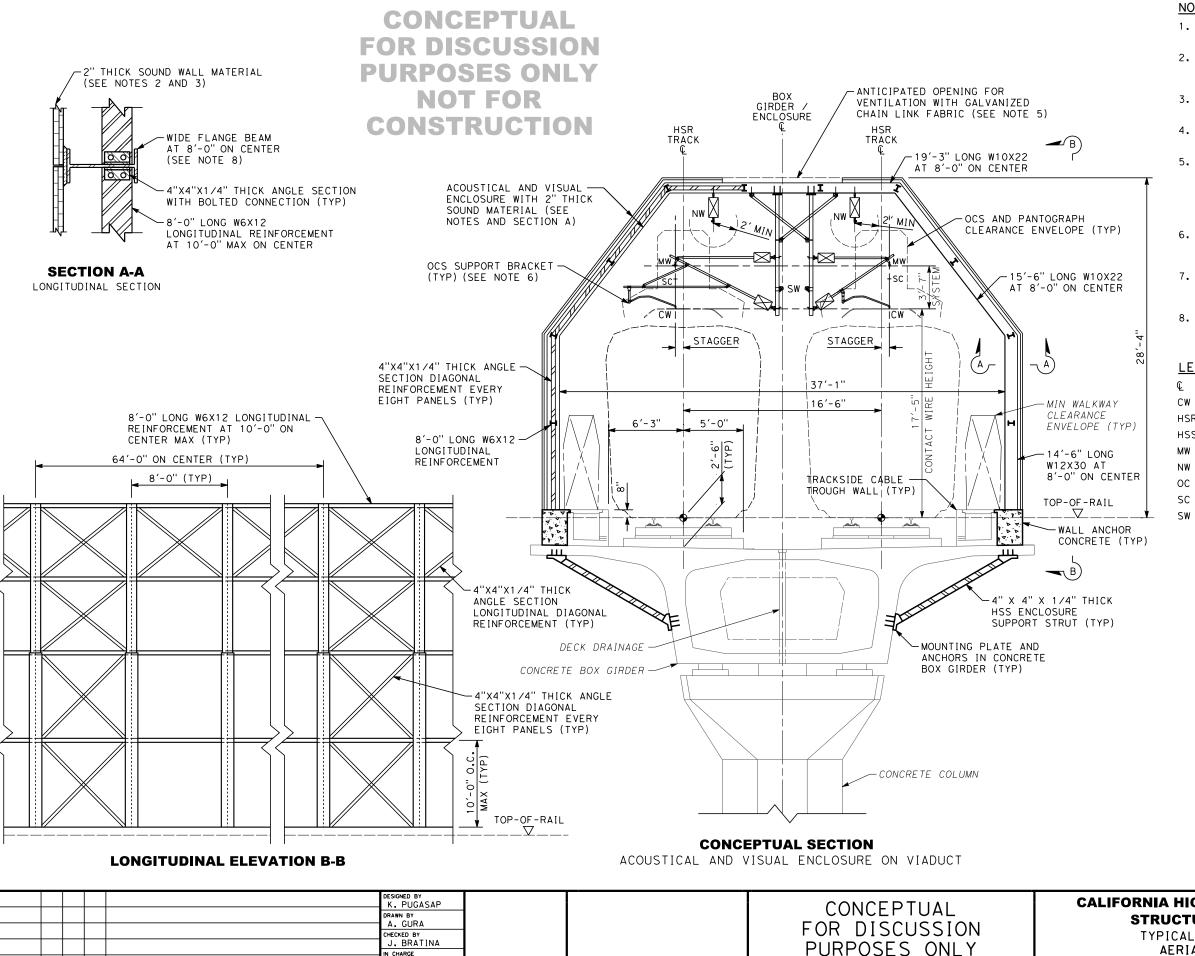
CONCEPTUAL FOR DISCUSSION PURPOSES ONLY NOT FOR CONSTRUCTION

CALIFORNIA HIGH-SPEED RAIL PROJECT STRUCTURAL DIRECTIVE

TYPICAL CROSS SECTION AERIAL STRUCTURE TWO TRACK NON-BALLASTED WITH ACCOUSTICAL AND VISUAL ENCLOSURE ENCLOSURE 1 NO SCALE

SHEET NO.

Wall Panel Enclosure on Viaduct



CHARGE
J. BRATINA

8/26/2019

DATE

BY CHK APP

DESCRIPTION

NOTES

- SEE STRUCTURE, TRACK, DRAINAGE AND OCS DIRECTIVE DRAWINGS FOR DETAILS NOT SHOWN.
- 2. ACOUSTICAL AND VISUAL ENCLOSURE MATERIALS WITH WEIGHT OF NO MORE THAN FIVE POUNDS PER SOUARE FOOT TO BE DETERMINED.
- ALL DIMENSIONS SHOWN ARE ASSUMPTIONS AND NOT BASED ON DETAILED DESIGN.
- 4. ALL BOLD FEATURES ARE NON-STANDARD ITEMS FOR HSR STRUCTURES.
- 5. THE CONCEPTUAL CROSS SECTIONAL AREA INSIDE THE ENCLOSURE IS APPROXIMATELY 930 SQUARE FEET COMPARED TO A CONCEPTUAL TWO-TRACK TUNNEL OF 1,625 SQUARE FEET. AS A RESULT, OPENINGS MUST BE PROVIDED FOR AERODYNAMIC AND VENTILATION REASONS.
- . THERE SHALL BE A SEPARATE OCS SUPPORT BRACKET FOR EACH TRACK AND ATTACHED TO THE WIDE FLANGE BEAMS.
- PROVISIONS FOR EMERGENCY EGRESS, SUCH AS DOORS IN THE ENCLOSURE WALLS AND TELEPHONES, SHALL BE PROVIDED AS NECESSARY.
- 8. THERE SHALL BE TWO CLOSELY-SPACED WIDE FLANGE BEAMS WITH AN INTERMEDIATE EXPANSION JOINT AT EVERY SUPPORT PIER.

LEGEND:

- © CENTERLINE
- CW CONTACT WIRE
- ISR HIGH-SPEED RAIL
- HSS HOLLOW STRUCTURAL SECTION
- MW MESSENGER WIRE
- NW NEGATIVE FEEDER WIRE
- OC ON CENTER
- SC STITCH CABLE
- SW STATIC WIRE

CONCEPTUAL
FOR DISCUSSION
PURPOSES ONLY
NOT FOR
CONSTRUCTION

CALIFORNIA HIGH-SPEED RAIL PROJECT STRUCTURAL DIRECTIVE

TYPICAL CROSS SECTION
AERIAL STRUCTURE
TWO TRACK NON-BALLASTED
WITH GUIDEWAY ENCLOSURE

NOT FOR CONSTRUCTION

DRAWING NO.

ENCLOSURE 1

NO SCALE

Pressure Transient Analysis Memo





DRAFT

Memorandum

DRAFT FOR INTERNAL DISCUSSION ONLY

DATE: April 12, 2019

TO: Julian Bratina

FROM: Silas Li

CC: Brian Sutliff, Steve Klein

SUBJECT: Pressure Transient Analysis for An Acoustic Enclosure

Introduction

This memorandum summarizes the pressure transient analysis at conceptual design level for a 3-mile long acoustic enclosure. There is an 0.75 mile approach embankment, then 1.5 mile viaduct over a wetland area, and then another 0.75 mile embankment section that would support the acoustic enclosure structure. The objective of the conceptual design is to verify the cross sectional area of the structure, the size of the proposed obvert openings, and the resulting magnitude of the pressure waves generated by high speed operations. Based on the results of the pressure transient analysis, information will be forwarded to the noise analysis team.

Three scenarios were identified for pressure transient analysis and are discussed below:

- 1. Two crossing trains in the acoustic enclosure
- 2. Single train in the acoustic enclosure
- 3. Micro pressure waves at the exit portal

A 1-dimensional (1D) analysis was performed using the ThermoTun-Online software [1] which is commonly used for proof of concept. The benefit of using 1D model is shorter simulation time. Performing 3D CFD (Computational Fluid Dynamics) analysis would take a few months, and exceed the project schedule of 4 weeks for proof of concept.

The ThermoTun-Online has some limitations. In particular, it cannot simulate 3-dimensional (3D) phenomena in detail and the effects of ceiling openings. It averages values over the tunnel cross-section and estimate these averages vary along the tunnel. The software cannot address multiple ceiling openings. Simulations were performed without ceiling openings. The quantity of openings and size were estimated based on a literature search and engineering judgement.

Assumptions

The following assumptions were made for the pressure transient analysis:

- Cross sections of the acoustic enclosure (tunnel) on viaduct and on embankment (Figures 1 and 2 below).
- Tunnel length = 4,828 m (3 miles)
- Cross-sectional area of tunnel = 88.2 m² (950 ft²)
- Tunnel radius = 4.7 m (15.4 ft)
- Length of train = 400 m (1312 ft)
- Cross-sectional area of train = 11 m² (118 ft²)
- Fanning friction coefficient = 0.008
- Loss coefficient, flow from open tunnel into annulus around train = 0.1
- Shape factor, flow from annulus around train into open tunnel = 0.5
- Speed of train = 354 kph (220 mph)
- Sealing time constant for leakage through coach bodies = 1 second
- Time of nose entry = 0 second (both trains)
- The medical health criteria is taken from TM 2.4.2 for basic high-speed train tunnel configuration.

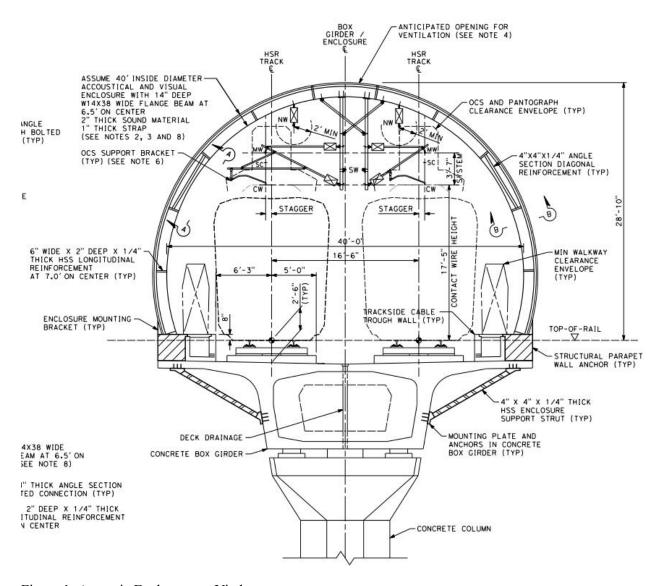


Figure 1: Acoustic Enclosure on Viaduct

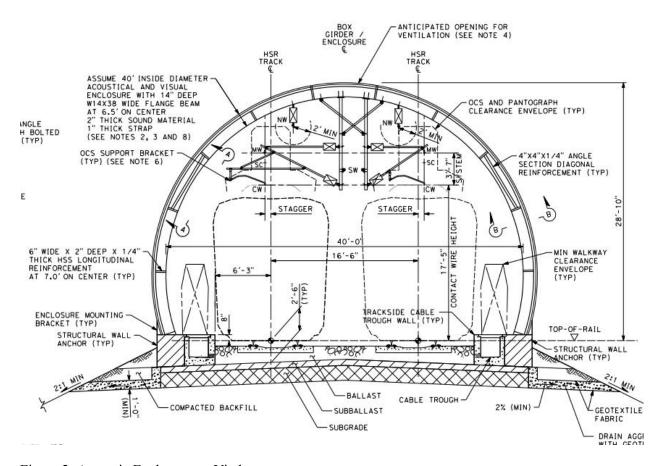


Figure 2: Acoustic Enclosure on Viaduct

Crossing Trains in Tunnel

Figure 3 below shows the output locations used in Figures 4 and 5 showing pressure results.

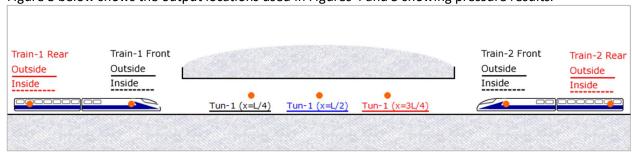


Figure 3: Crossing Trains in Tunnel

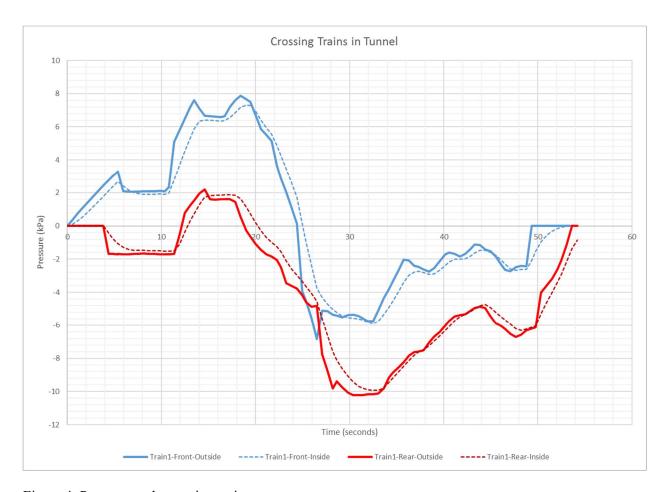


Figure 4: Pressure at the moving train

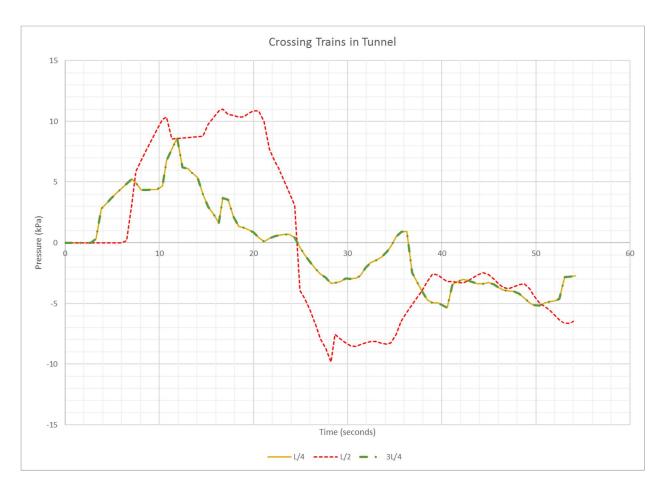


Figure 5: Pressure in the Tunnel

Single Train in Tunnel

Figure 6 below shows the output locations used in Figure 7 showing pressure results.

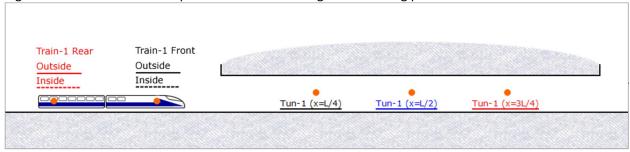


Figure 6: Single Train in Tunnel

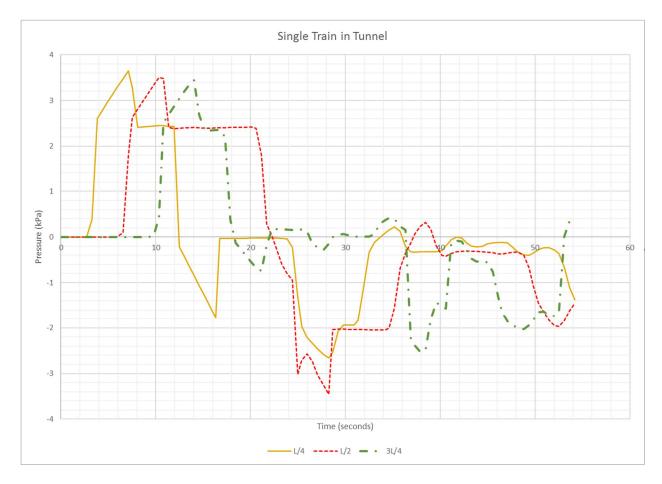


Figure 7: Pressure in the Tunnel

Micro Pressure Waves

Figure 8 below shows the output locations used in Figure 9 showing pressure results.

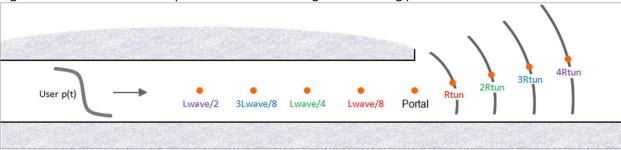


Figure 8: Micro Pressure Waves

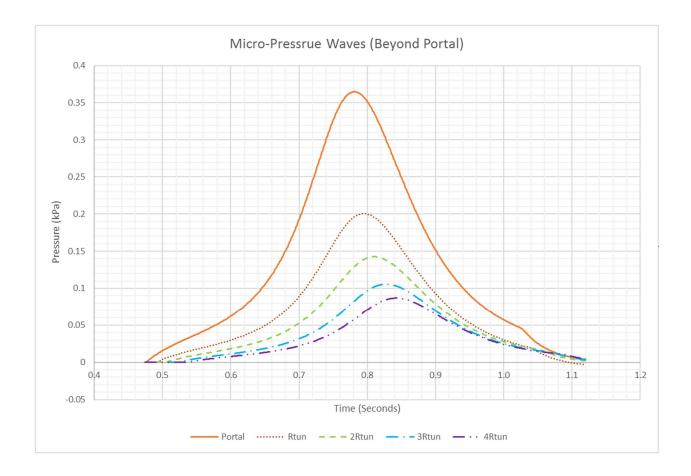


Figure 9: Micro Pressure Waves (Beyond Portal)

Discussions and Conclusions

Preliminary results for Crossing Trains in Tunnel (without Openings):

- Medical health criterion = 10 kPa (peak to peak pressure, Technical Memo TM 2.4.2)
- The maximum pressure change (peak to peak), to which train passengers and crews are subjected, would exceed 14.7 kPa for two trains passing at 354 kph.
- The maximum/minimum pressures on the tunnel structure would exceed +11.0 kPa / -9.8 kPa.

Preliminary results for Single Train in Tunnel (without Openings):

- The maximum pressure change (peak to peak) in the tunnel would be approximately 7.1 kPa.
- The pressure rise when the train entering the tunnel portal is 2.6 kPa.

Preliminary results for Micro-Pressure Waves (without Openings):

• The pressure at the portal is 365 Pa.

Pressure simulations were performed without ceiling openings. The quantity and size of ceiling openings were estimated based on literature search and engineering judgement. Reference [2] suggests that there was little benefit in increasing the number of shafts/openings above three. The cross-sectional area of air shafts/openings in tunnels should be around 10 to 35% of the area of the main tunnel. A total of 3 openings, spaced at approximately 0.75 miles apart could reduce the pressure by up to 40%.

For initial noise analysis, three openings are assumed at 1/4, 1/2 and 3/4 points of the tunnel length. Each opening is assumed to be 35% of the tunnel area or 31 m² (334 ft²). The presence of openings is assumed to reduce the maximum pressure by 40%. This is an estimate for proof of concept at this stage. The tunnels referenced in the literatures are based on particular tunnel configurations, tunnel length, train area and speeds. The initial noise analysis should include two scenarios: 1) higher pressure without openings; and 2) with 3 ceiling openings and 40% reduction in pressure. Detailed analysis, such as CFD and passenger comfort analysis, should be performed for the acoustic enclosure with ceiling openings during next phase of design.

References

- [1] ThermoTun Manual, www.thermotun-online.com
- [2] "High-Speed Rail Aerodynamic Assessment and Mitigation Report", Final Report Dec 2015, U.S. Department of Transportation, Federal Railroad Administration, Office of Research, Development and Technology, Washington, DC 20590,

Noise Analysis Memo





To: Julian Bratina

From: Erich Thalheimer

Date: June 25, 2019

Project Name: California High-Speed Rail Project

Project Number: 189229H

Subject: CAHSR Grasslands Noise Barrier Alternatives Comparison Tech Memo

Study Overview

This memo summarizes the technical analysis process and results of an acoustical mitigation assessment performed to determine the potential impact of the California High-Speed Rail Project on the Grasslands Ecological Area, and mitigation of such impact. The Grasslands Ecological Area (Grasslands) is home to several species of waterfowl that could be adversely affected by high-speed train noise. Thus, consideration is being given towards reducing the train noise footprint through the rail corridor within the Grasslands.

The proposed alignment runs east and west through the middle of the Grasslands for about 3 miles, from approximately Station 4930 to Station 5085. Parallel noise mitigation barriers on both sides of the tracks have been suggested as an appropriate mitigation technique. Four train noise barrier mitigation designs are considered in this assessment: (1) 14-ft noise barriers, (2) 17.5-ft noise barriers, (3) 17.5-ft noise barriers with a slanted cantilever top edge, and (4) a nearly-complete tunnel enclosure.

The Cadna-A® acoustical model, developed by DataKustik GmbH, was used to perform this study. Cadna-A is a general purpose, three dimensional, ray tracing acoustical model that implements ISO Standard 9613 for outdoor sound prediction and propagation. All four noise barrier alternatives were evaluated using the same Cadna-A model, thus allowing for direct comparison of the results.

This study was not scoped to recommend a preferred alternative. Rather, this study presents an evaluation of the acoustical benefits and consequences of the candidate noise barrier alternatives.

Noise Criteria Thresholds

Several noise criteria thresholds were previously established (by others) for this study to avoid disturbing, upsetting or harming waterfowl residing in the Grasslands area. The noise metric of choice for this study was the maximum sound level (Lmax) measured in A-weighted decibels (dBA) using an RMS 'slow' response time. The justification for this criterion is the desire to avoid startling the waterfowl by the quick onset of noise due to trains moving through the area. Use of the Lmax dBA 'slow' noise metric is consistent with recommendations in the Federal Railroad Administration (FRA) High-Speed Ground Transportation Noise and Vibration Impact Assessment Manual (2012).

The four noise criteria considered and evaluated through this study included the following:

- Permanent hearing damage (Lmax < 140 dBA)
- Temporary hearing damage (Lmax < 93 dBA)
- Avoidance of masking (Lmax < 84 dBA)
- Avoidance of arousal (Lmax < 77 dBA)



As Planned Condition

The current As Planned condition is shown in **Figure 1.** Trains passing through this section would involve CAHSR electric multiple unit (EMU) consists of approximately 660 feet in length, including their locomotives and cars, traveling at about 220 mph. This section of tracks within the Grasslands is relatively straight (east and west) but has a portion of elevated track on a 25-ft high top-of-rail viaduct from Station 4955 to Station 5051. The remainder of the tracks are at grade supported by embankment stone ballast, ranging in top-of-rail heights from 8-ft in the western end to 17-ft in the eastern end. The terrain and topography within 500 feet of both sides of the tracks is quite flat, with elevation changes of less than 10 feet.



Figure 1. Aerial View of CAHSR Grasslands Section

Cadna-A Noise Model

As previously noted, CAHSR train noise levels affecting the adjacent Grasslands were estimated using the Cadna-A® noise model developed by DataKustik GmbH. Cadna-A is a powerful, three dimensional, ray tracing acoustical model that implements ISO Standard 9613 for the prediction and propagation of outdoor sound.

Noise sources are input to the Cadna-A model as point, line and/or area components. Each source is characterized as emitting sound power levels (PWL) in octave bands or broadband A-weighted format. Attenuation due to distance, terrain and elevation differences, ground absorption, wind effects, foliage, building shielding, and attenuation from barriers and berms are computed in the model. The resulting sound pressure levels (SPL) are predicted at any receptor location(s) of interest.

The first step in configuring the Cadna-A model was to import geoshape project design files to serve as a base map of the area. In this manner, the exact alignment of the proposed CAHSR rail corridor could be modeled to a high degree of accuracy, including the topography data inherent in the geoshape files.



The two parallel tracks were then entered into the model at their respective elevations above grade. Cadna-A's optional FRA/FTA module was used in this case to simulate the methods and calculations described in FRA's High-Speed Ground Transportation Noise and Vibration Impact Assessment Manual (2012). The portion of tracks elevated on the viaduct section was assigned to be self-shielding due to the concrete guideway deck, and an adjustment of +3 dB was assigned to the elevated track sections consistent with FRA guidelines. The rest of the surrounding grounds were considered to be moderately acoustically absorptive (G = 0.5) for hard dirt/sand surfaces.

The four noise barrier alternatives were then entered into the Cadna-A model, including: (1) 14-ft noise barriers, (2) 17.5-ft noise barriers, (3) 17.5-ft noise barriers with a slanted cantilever top edge, and (4) a nearly complete tunnel enclose. The surfaces of the barriers facing the trains were assumed to be covered with a material with an average acoustical absorption coefficient of 0.85 NRC in order to reduce the performance degradation effect caused by reflective parallel barriers.

Noise receptors were entered into the model in traverse patterns at three locations, representative of each of the three different track conditions. One location was the approximate center of the track on ballast section towards the west near Station 4942; another location was the approximate middle of the elevated viaduct track near Station 5003; and the final location was the approximate center of the track on ballast section towards the east near Station 5067. The receptors were modeled as being 5 feet above the ground and were positioned in the traverse arrays every 50 feet out to a distance of 500 feet from the tracks (topographical data was not available beyond 500 feet).

Lastly, the noise model computed isopleth contours, or lines of equal loudness, for each of the four noise criteria thresholds (i.e. Lmax = 140, 93, 84 and 77 dBA). In doing so, the results could be presented so that the four respective noise impact zones (or noise criteria exceedance zones) can be clearly seen relative to one another.

Noise Barrier Results

The noise impact zones, or isopleth contour lines, for the As Planned (i.e. without barriers) and for the four noise barrier alternatives are shown in **Figures 2 thru 11**. Two figures, a western half and an eastern half, are provided for each scenario.

The results indicate that concern for permanent hearing damage (i.e. Lmax = 140 dBA) was unwarranted. The impact zone for 140 dBA would occur too close to the train itself to warrant any further concern. Therefore, each of the figures only shows isopleth lines for Lmax = 93, 84 and 77 dBA, respectively.

To be effective, a noise barrier must, at a minimum, break the line-of-sight between the noise source and the receptor. Noise barriers need to be very long relative to their height to avoid noise from flanking around the endpoints. In this manner, the height of the barrier becomes the most important aspect in determining its noise reduction effectiveness. The taller a noise barrier, the more noise reduction it will provide for receptors on the other side. The position of the barriers, relative to the noise source, was limited in this case to being erected along the CAHSR right-of-way (ROW).

As expected, the size of the noise impact zones gets smaller with each more substantial noise barrier alternative. Thus, the noise reduction provided by the 14-ft barrier is greater than the As Planned condition; the noise reduction provided by the 17.5-ft barrier is greater than the 14-ft barrier; the noise reduction provided by the 17.5-ft cantilever barrier is greater than the 17.5-ft barrier; and the noise reduction provided by the tunnel barrier is greater than the 17.5-ft cantilever barrier.



Table 1 summarizes the Cadna-A noise model results for the three traverse lines of discrete receptors (i.e. Western, Middle and Eastern). While the impact zone distances vary somewhat from point to point, the results in the table give an overview of the noise reduction benefits associated with each barrier alternative. The results in the table are approximations, rounded to nearest 50-ft increment. More exact definition of the noise impacts zones should be taken from the isopleth contour lines in **Figures 2 thru 11**.

Table 1. CAHSR Grasslands Noise Impact Zones and Noise Barrier Effectiveness

Design Scenario	Approximate Noise Impact Zones (Feet From Tracks)											
Track Segment	Western			Middle			Eastern					
Stations	Sta. 4930 to Sta. 4955			Sta. 4955 to Sta. 5051			Sta. 5051 to Sta. 5085					
Track Condition	Ballast TOR = 8 ft			Elevated TOR = 25 ft			Ballast TOR = 17 ft					
Noise Criteria	Perm	Temp	Mask	Arouse	Perm	Temp	Mask	Arouse	Perm	Temp	Mask	Arouse
As Planned	0	250	>500	>500	0	50	>500	>500	0	200	>500	>500
14 ft Barriers	0	<100	150	>500	0	<50	150	>500	0	<100	100	500
17.5 ft Barriers	0	<100	100	450	0	<50	150	>500	0	<100	100	400
17.5 ft Cantilever Barriers	0	<100	100	400	0	<50	150	500	0	<100	100	400
Tunnel Barriers	0	<100	100	300	0	<50	150	450	0	<100	100	300

Notes: Perm = Permanent hearing damage (Lmax < 140 dBA)

Temp = Temporary hearing damage (Lmax < 93 dBA)

Mask = Avoidance of masking (Lmax < 84 dBA)

Arouse = Avoidance of arousal (Lmax < 77 dBA)

As can be seen in the table, the provision of even a 14 ft tall barrier will provide significant noise reduction compared to the As Planned condition. The installation of taller or more comprehensive barriers would further reduce noise levels affecting the Grasslands, but at a less significant incremental rate, meaning there are diminishing returns for the additional costs involved with building larger barriers.

It is hoped that this study will aid CAHSR officials in considering these noise barrier alternatives from a quantitative perspective. Refinements to these noise barrier alternatives, or additional noise analyses are available upon request.

Disclaimer – This study only examined the acoustical aspects of the subject noise barriers. No attempt was made to estimate the costs of the barriers, or the structural requirements to build the barriers.



Figure 2. CAHSR Grasslands Noise Impact Zones As Planned Condition (Part 1 of 2)

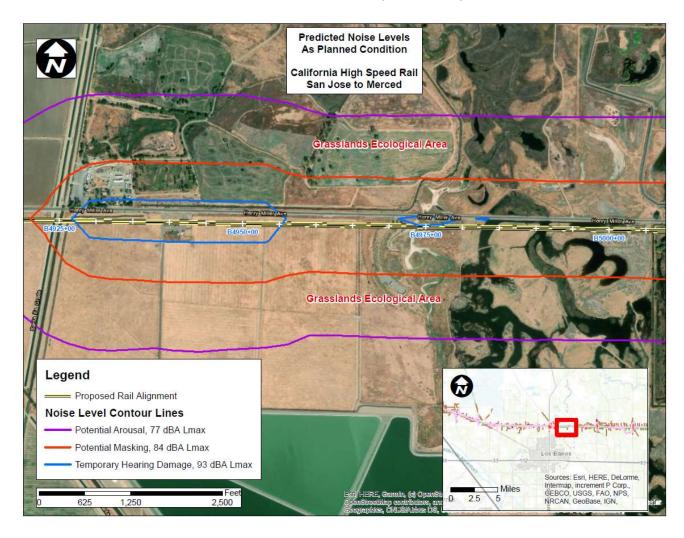




Figure 3. CAHSR Grasslands Noise Impact Zones As Planned Condition (Part 2 of 2)





Figure 4. CAHSR Grasslands Noise Impact Zones With 14-ft Noise Barriers (Part 1 of 2)

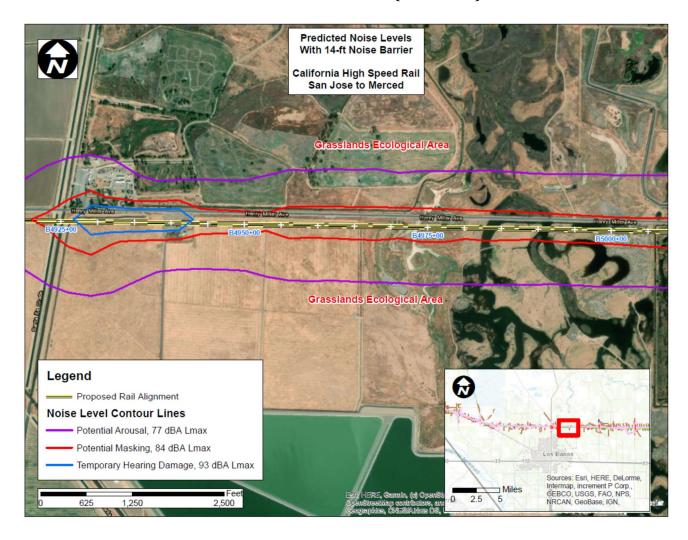




Figure 5. CAHSR Grasslands Noise Impact Zones With 14-ft Noise Barriers (Part 2 of 2)

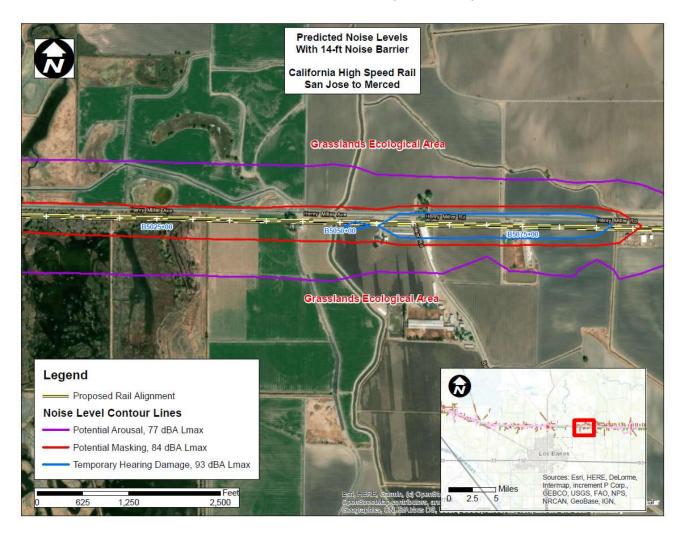




Figure 6. CAHSR Grasslands Noise Impact Zones With 17.5-ft Noise Barriers (Part 1 of 2)

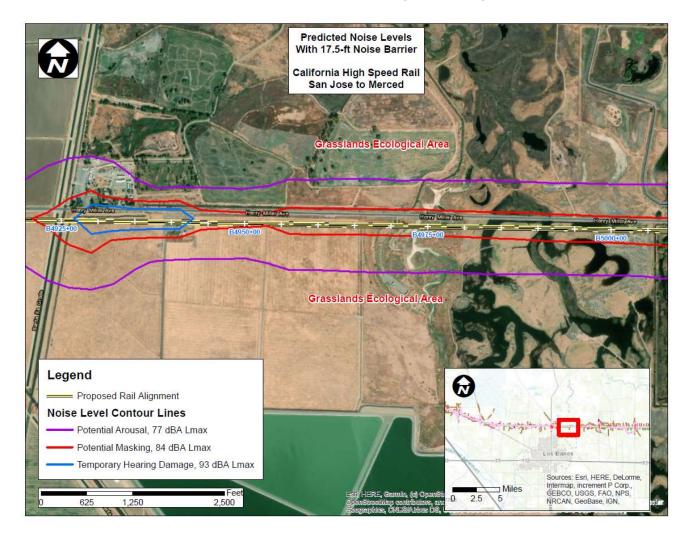




Figure 7. CAHSR Grasslands Noise Impact Zones With 17.5-ft Noise Barriers (Part 2 of 2)

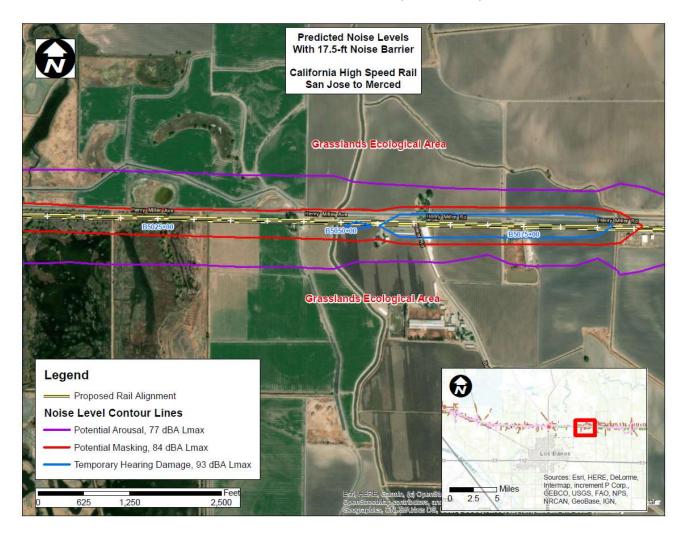




Figure 8. CAHSR Grasslands Noise Impact Zones With 17.5-ft Cantilever Noise Barriers (Part 1 of 2)

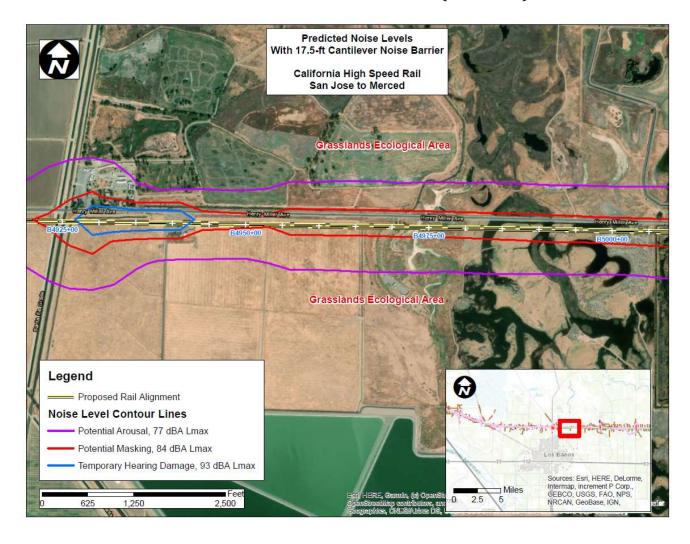




Figure 9. CAHSR Grasslands Noise Impact Zones With 17.5-ft Cantilever Noise Barriers (Part 2 of 2)

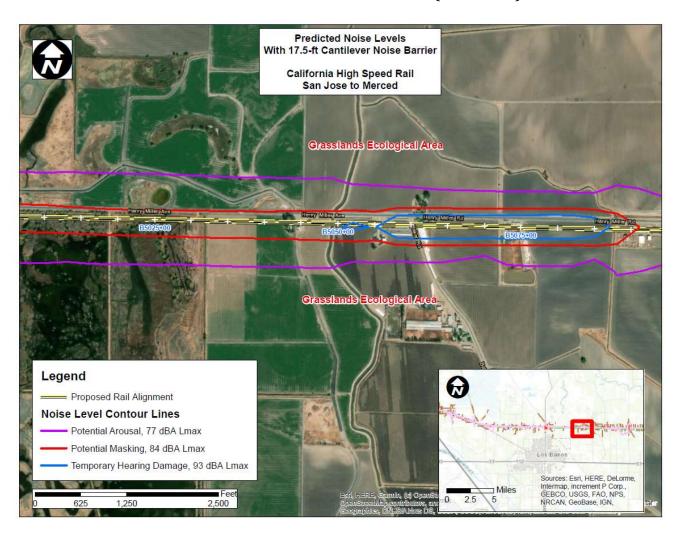




Figure 10. CAHSR Grasslands Noise Impact Zones With Tunnel Noise Barriers (Part 1 of 2)

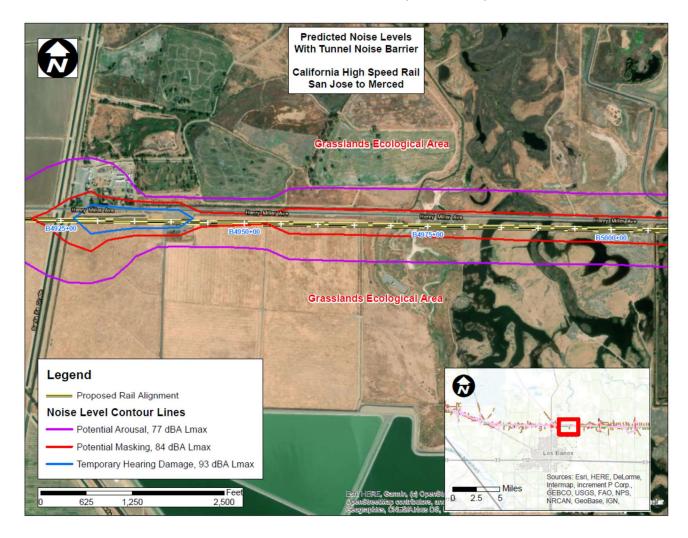
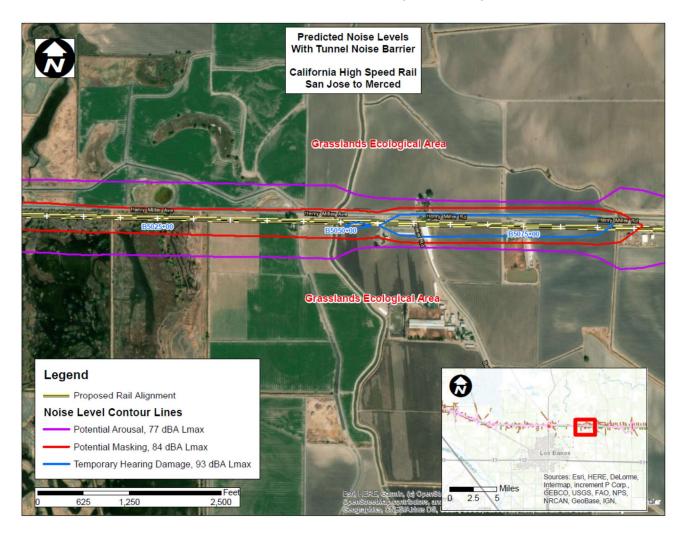




Figure 11. CAHSR Grasslands Noise Impact Zones With Tunnel Noise Barriers (Part 2 of 2)



Appendix 6

Cost Estimates

Engineer's Estimate 9/16/2019 R.3 1.5 mi Viaduct & 1.5 mi Embankment:

WBS					Total	Total	Total	Total	Direct	OH&P	Subtotal	Contingency	Total Direct	Unit
Item	Description	Quant.	Unit	MHRS	Labor	Eq.Rent	Perm.Matl.	Subc.	Cost	15%	Cost	15%	Cost	Cost
10.10	Standard Soundwall along 1.5 mi Viaduct:	15,840	LF	17,058	\$1,392,312	\$697,447	\$15,672,419	\$0	\$17,762,178	\$2,664,327	\$20,426,505	\$3,063,976	\$23,490,481	\$1,482.98
10.20	Standard Soundwall along 1.5 mi Embankment:	15,840	LF	14,622	\$1,187,781	\$279,223	\$11,630,203	\$3,863,006	\$16,960,213	\$2,544,032	\$19,504,244	\$2,925,637	\$22,429,881	\$1,416.03
10.20	Standard Soundwall along 1.5 IIII Ellibalikillelit.	13,640	LF	14,022	\$1,107,701	3273,223	\$11,030,203	\$3,003,000	\$10,900,213	\$2,344,032	\$19,504,244	\$2,923,037	322,423,861	\$1,410.03
10.30	F&I Line Markers along 3.0 mi of Track:	1,056	EA	1,320	\$78,207	\$42,124	\$12,143	\$0	\$132,475	\$19,871	\$152,346	\$22,852	\$175,198	\$165.91
	MEASURE #1 Total Construction Cost	31,680	LF	33.000	2,658,300	1,018,794	27,314,766	3,863,006	\$34.854.865	\$5,228,230	\$40,083,095	\$6,012,464	\$46,095,560	\$1,455.04
					2,000,000	_,,,,,,,,,,		2,222,222	, c , c , , c c	40,000	7,,	70,022,00	+ 10,000,000	7-7.00.0.
20	Tubular Enclosure along 1.5mi Viaduct:	7,920	LF	115,674	\$8,791,563	\$3,099,518	\$32,276,150	\$5,195,520	\$49,362,751	\$7,404,413	\$56,767,164	\$8,515,075	\$65,282,239	\$8,242.71
				115,674	\$8,791,563	\$3,099,518	\$22,170,609	\$6,893,723						
30	Tubular Enclosure along 1.5 mi Embankment:	7,920	LF	113,074	38,731,303	\$3,033,318	322,170,009	30,893,723	\$40,955,414	\$6,143,312	\$47,098,726	\$7,064,809	\$54,163,535	\$6,838.83
	MEASURE #2 Total Construction Cost:	15,840	LF	231,348	\$17,583,127	\$6,199,036	\$54,446,759	\$12,089,243	\$90,318,165	\$13,547,725	\$103,865,890	\$15,579,883	\$119,445,773	\$7,540.77
40	Wall Panel Enclosure along 1.5mi Viaduct:	7,920	LF	64,385	\$4,893,416	\$1,854,376	\$22,128,605	\$5,195,520	\$34,071,917	\$5,110,788	\$39,182,704	\$5,877,406	\$45,060,110	\$5,689.41
	1											. , , ,		
50	Wall Panel Enclosure along 1.5 mi Embankment:	7,920	LF	61,148	\$4,647,413	\$1,777,795	\$16,586,552	\$6,893,723	\$29,905,483	\$4,485,822	\$34,391,306	\$5,158,696	\$39,550,001	\$4,993.69
	MEASURE #3 Total Construction Cost:	15,840	LF	125,532	\$9,540,829	\$3,632,171	\$38,715,158	\$12,089,243	\$63,977,400	\$9,596,610	\$73,574,010	\$11,036,101	\$84,610,111	\$5,341.55
				1										

1.5 mi Viaduct & 1.5 mi Embankment:

Engineer's Estimate 9/16/2019 R.3

is mi Viaduct & 1.5 mi Embankment: Item Description	Quant.	Unit	Prod.	Crew	Davs	Man	Equip.	Labor	Equip.	Perm.Matl. Const.Matl.	Subc.	Total	Total	Total	Total	9/16/2019 Total	Direct
item Description	Quant.		Init/Hr	Hours	8HR/Day	Hrs	Equip. Hrs	Rate	Rent/Hr	Rate Rate	Rate	Labor	Eq.Rent	Perm.Matl.	Const.Matl.	Subc.	Cost
			Jnit/Hr	Hours	8нк/рау	Hrs	Hrs	Rate	Rent/Hr	Rate Rate	Kate	Labor	Eq.Kent	Perm.Mati.	Const.Mati.	Subc.	Cost
					<u> </u>												
10 Standard Sound Wall:					<u>Days</u>												
10.10 Standard Soundwall along 1.5 mi Viaduct:		LF	6.5	2,437	305											 	
Acrylite Sound Wall System , (Quote by Armtec Company), Assume 4 Bays/Day = 2 Hrs/Bay = 2Hr/13LF=6.5'/HR	269,280	SF								\$43.19				\$11,630,203		<u> </u>	\$11,630
90 TN RT Crane (Caltrans pg. 12 HCESP/GROVE/4760)	1	EA					2,437		\$173.95				\$423,903				\$423
Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/BOOM/50-74)	1	EA					2,437		\$47.31				\$115,291			1	\$115
Flatbed Truck (Caltrans pg.34 TRUCK/T&TT/28-36)	1	EA					2,437		\$39.96				\$97,379			í	\$97
Pickup Truck (Caltrans pg.34 TRUCK/T&TT/06-12)	1	EA					2,437		\$24.98				\$60,874			í	\$60
Carpenter Foreman		EA				2,437		\$86.27				\$210,233				í	\$210
Carpenter Journeyman		EA				9,748		\$83.93				\$818,124			1		\$818
Flatbed Teamster - GR 2		EA				2,437		\$64.23				\$156,524			1		\$156
Crane Operator - GR 2-A		EA			1	2,437		\$85.12			+	\$207,431			1		\$20
	1	EA				2,437		\$85.12				\$207,431					
Viaduct Structural Upgrade for 17ft high soundwall - Current Assumption is 2% of Viaduct cost														\$4,042,216			\$4,04
Subtotal						17,058						\$1,392,312		\$15,672,419		\$0	7-17-0
Unit Cost:						0.9						\$87.90	\$44.03	\$989.42	\$0.00	\$0.00	00 \$1,1
					Days												
0.20 Standard Soundwall along 1.5 mi Embankment:	15,840	LF	6.5	2,437	305											1	
16" CIDH Pile, 10 FT Long at 13' Spacing, (QTY = 15,840 LF @ 13' O.C. = 1218 EA @ 10 FT/EA = 12,184 LF), Quote Caltrans	12,184	LF								i	\$68.31		i i			\$832,289	39 \$83
4,000 Psi Pile Cap & Reinforcement, (QTY = 1.5' W x 3.5' H x 15,840 LF = 3,080 CY)		CY									\$984.00		i i		İ	\$3,030,717	
Acrylite Sound Wall System, (Cloude by Armtec Company), Assume 4 Bays/Day = 0.5 Bay/HR = 6.5 LF/HR		SF	-		1					\$43.19	+3300	1	† †	\$11,630,203	.t	,-,,/-1/	\$11,63
Ru yine 3 onu wan system, I Quote by Armite Company, Assume 4 bays/bay – 0.3 bayrine – 0.3 bryrine –		EA			l		2,437		\$49.64	ŷ-3.15	+	 	\$120,969	V11,000,200	†		\$11,03
					 						+				1		
Flatbed Truck (Caltrans pg_34 TRUCK/T&TT/28-36)		EA			!		2,437		\$39.96		+	-	\$97,379		1		\$9
Pickup Truck (Caltrans pg.34 TRUCK/T&TT/06-12)		EA			ļ		2,437		\$24.98				\$60,874		ļ		\$6
Carpenter Foreman		EA				2,437		\$86.27			1	\$210,233			l		\$21
Carpenter Journeyman		EA				7,311		\$83.93				\$613,593					\$61
Flatbed Teamster - GR 2	1	EA				2,437		\$64.23				\$156,524				1	\$15
Crane Operator - GR 2-A	1	EA				2,437		\$85.12				\$207,431				ĺ	\$20
Embankment Sound wall Structural Upgrade for 17ft height - Current Assumption is 12% of soundwall cost														\$1,859,185.11		í	\$1,85
Subtotal						14,622						\$1,187,781	\$279,223	\$11,630,203	ŚO	\$3,863,006	
Unit Cost						1.1					-	\$74.99		\$734.23			
Officest	+				Davis	1.1					+	\$74.55	\$17.03	3734.23	30.00	3243.00	8 31,0
					Days												
0.30 F&I Line Markers along 3.0 mi of Track:		EA	4	264	33												
Aerial Marker Balls, Model JX (Quote by Flight Light)		EA								\$151.17				\$12,547			
Bird-Flight Diverters, (Quote by Preformed Line Products)	1,056	EA								\$11.50				\$12,143			\$13
Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/BOOM/50-74)	2	EA					528		\$47.31				\$24,980			1	\$24
Flatbed Truck (Caltrans pg.34 TRUCK/T&TT/28-36)	1	EA					264		\$39.96				\$10,549			i	\$10
Pickup Truck (Caltrans pg.34 TRUCK/T&TT/06-12)	1	EA					264		\$24.98				\$6,595			ĺ	\$
Labor Foreman	1	FA				264		\$60.59				\$15,996				í	\$1
Laborer - GR 3	3	EA				792		\$57.14				\$45,255			1		\$45
Flatber Temster - GR 2		EA				264		\$64.23			-	\$16,957			1		\$16
	1	EA						\$04.23					642.424	44244			
Subtotal:						1,320						\$78,207	\$42,124	\$12,143		\$0	
Unit Cost:						1.3						\$74.06		\$11.50	\$0.00	\$0.00	
10 Total Typical Mitigation on 3mi of track		LF				33,000						\$2,658,300	\$1,018,794	\$27,314,766	\$0	\$3,863,006	934,854
20 Tubular Enclosure along 1.5mi Viaduct:	7,920	LF															
																1	
20.10 4,000 Psi Concrete Anchor Wall:	5,280	CY									\$984.00					\$5,195,520	20 \$5,19
(QTY = 3' W x 3' H x 7,920 LF = 2,640 CY x 2 EA = 5,280 CY)																í	
					Days											í	+
0.20 Furnish & Install Steel:	8,902,241	LB	1.000	8.902											1		+
	0,302,241		1,000	0,302	1,113						+				1		+
(OTY = 8,902,241 LB = 4,451.12 TN @ 20 MH/TN = 89,022.4 MHs @ 10 men Crew = 8,902.24 CH = 1,000 LB/CH)										4					<u> </u>		
Steel Rib - W14x38 Beam, (Quote by Durisol)		LB								\$1.51				\$5,898,998	 		\$5,89
Steel Straps - 1"x7"		LB								\$1.51				\$3,858,901			\$3,85
Struts 4" x 4" x 1/4" HSS		LB								\$1.51				\$489,283			\$48
Interior Cross Struts 4" x 4" x 1/4" Angle	521,580	LB								\$1.51				\$788,446	i	1	\$78
Longitudinal Braces 6" x 2" x 1/4" HSS	1,142,381	LB								\$1.51				\$1,726,880)	í	\$1,72
Fasteners 4" x 4" x 1/4"	96,941	LB								\$3.24			i i	\$314,015	il		\$31
Structural Plates 12" x 12" x 1/2"		LB			İ					\$1.51	1		i i	\$339,708	il .	í	\$33
Cable Tray 4" x 3" x 1/4"		LB	-		1					\$1.51	1	1	† †	\$208,317	1		\$20
Cause Tray = λ λ λ λ λ λ λ λ λ λ λ λ λ λ λ λ λ λ		EA			1		17.804		\$26.58	72.71	+	l	\$473,243	7200,317	 		\$47
					 		,				+				1		
Welding Machine (Caltrans Pg.34, WELD/AWM/250-500)		EA			!		8,902		\$9.49	———	+	-	\$84,482		1		\$8
Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel		EA			ļ		8,902		\$173.95			ļ	\$1,548,545		ļ		\$1,54
Crane Operator 2-A		EA				8,902		\$85.12			1	\$757,759			l		\$75
Iron Worker Foremen	1	EA				8,902		\$78.83				\$701,764					\$70
Iron Worker	8	EA				71,218		\$74.51				\$5,306,448			1		\$5,3
Subtotal:						89,022						\$6,765,970	\$2,106,270	\$13,624,548	\$0	\$0	\$0 \$22,49
Unit Cost	 		-		1	100.00				 	1	\$0,76	, , ,	\$1.53	\$0.00	\$0.00	
Officeost	+				Dave	100.00	l				+	30.70	ŞU.24	\$1.5	, 50.00	30.00	' ——'
																	•
0.30 Furnish & Install Aluminum Panels:	688,248	SF	258	2,665	<u>Days</u> 333						+		+		1		

1.5 mi Viaduct & 1.5 mi Embankment:

30 Total Tubular Enclosure along 1.5 mi Embankment

Wall Panel Enclosure along 1.5mi Viaduct:

(QTY = 3' W x 3' H x 7,920 LF = 2,640 CY x 2 EA = 5,280 CY)

40.10 4,000 Psi Concrete Anchor Wall:

40

20+30 Total of 1.5 mi Tubular Enclosure on Embankment and 1.5 mi Tubular Enclosure on Viaduct

Description Prod. Crew Days Man Equip. Labor Equip. Perm.Matl. Const.Matl. Subc. Total Total Total Total Direct Quant. Unit Total Unit/Hr Hours 8HR/Day Hrs Hrs Rate Rent/Hr Rate Rate Rate Labor Eq.Rent Perm.Matl. Const.Mat Subc. Cost 688,248 \$8,546,061 2" Aluminum Panel 1.64'W x 6.56'L, (Quote by Durisol) \$12.42 \$8,546,06 Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/BOOM/50-74) EA 10,661 \$504,353 \$504,35 Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) EA 2,665 \$9.49 \$25,29 Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel EA \$173.95 \$463,60 \$463,603 \$226,857 \$226,857 EA 2.665 Crane Operator 2-A \$85.12 Iron Worker Foremen FΔ 2.665 \$78.83 \$210.094 \$210.094 Iron Worker EA 21,321 \$74.51 \$1,588,642 \$1,588,642 Structural Modifications Viaduct Structural Upgrade for supporting enclosure - Assume 5% of viaduct structure cost (\$134,740,541/mi) \$10.105.54 \$10,105,541 Subtota 26,651 \$2,025,593 \$993,248 \$18,651,60 \$21,670,443 25.82 Unit Cost \$2.94 \$1.44 \$27.1 \$31.49 20 Total Tubular Enclosure along 1.5 mi Viaduct 7,920 LF 115,674 \$8,791,563 \$3,099,518 \$32,276,150 \$5,195,520 \$49,362,751 Unit Cost \$1,110.05 \$391.35 \$4,075.2 \$656.0 \$6,232.6 Tubular Enclosure along 1.5 mi Embankment: 7,920 LF Days 30.10 4,000 Psi Concrete Anchor Wall: 16" CIDH Pile, 10 FT Long at 13' Spacing, (QTY = 15,840 LF @ 13' O.C. = 1218 EA @ 10 FT/EA = 12,184 LF), Quote Caltrans 12,184 \$68.31 \$832,28 QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 6,160 CY \$984.00 \$6,061,43 \$6,893,723 30.20 Furnish & Install Steel: 8,902,241 LB 1,000 8,902 1,113 (QTY = 5,719,044 LB = 2,859.52 TN @ 20 MH/TN = 57,190.4 MHs @ 10 men Crew = 5,719 CH = 1,000 LB/CH) Steel Rib - W14x38 Beam, (Quote by Durisol) 3,902,357 \$5,898,99 \$5,898,998 Steel Straps - 1"x7 \$3,858,90 \$3,858,901 323,675 LB \$1.51 \$489,283 \$489,283 Struts 4" x 4" x 1/4" HSS 521 580 \$788,446 Interior Cross Struts 4" x 4" x 1/4" Angle I R \$1.51 \$788.446 Longitudinal Braces 6" x 2" x 1/4" HSS 1,142,381 \$1.51 \$1,726,880 \$1,726,88 asteners 4" x 4" x 1/4" 96,941 \$3.24 \$314,01 \$314,01 Structural Plates 12" x 12" x 1/2" 224,726 LB \$339,70 \$339,708 \$208.317 \$208.317 Cable Tray 4" x 3" x 1/4" 137.808 LB \$1.51 Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) EA 17.804 \$26.58 \$473,243 \$473,243 EA 8,902 \$9.49 \$84,482 Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) \$1,548,545 Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel EA 8,902 \$173.95 \$1,548,545 Crane Operator 2-A FA 8.902 \$85.12 \$757.75 \$757.759 Iron Worker Foremen FΔ 8 902 \$78.83 \$701.764 \$701 764 Iron Worker 8 EA 71,218 \$74.51 \$5,306,448 \$5,306,448 89,022 \$6,765,970 \$2,106,270 \$13,624,548 \$22,496,789 Subtotal Unit Cost 100.00 \$0.76 \$2.5 Days Furnish & Install Aluminum Panels: 30.30 333 688.248 SF 258 2.665 (QTY = 688,248 SF @ 10.76SF/Panel = 63,973 Panels @ 24 Panels/HR = 2,665.54 HRs = 258.24 SF/HR) 688,248 SF \$12.42 \$8,546,063 \$8,546,061 2" Aluminum Panel 1.64'W x 6.56'L, (Quote by Durisol) Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/BOOM/50-74) \$504,353 EA 10.661 \$47.31 \$504.35 2,665 \$9.49 \$25,29 Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) EA Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel FA 2.665 \$173.95 \$463,603 \$463,603 EA 2,665 \$85.12 \$226,857 \$226,857 Crane Operator 2-A Iron Worker Foremen EA 2,665 \$78.83 \$210,094 \$210,094 ron Worker EA 21,321 \$74.51 \$1,588,642 \$1.588.64 26,651 \$2,025,593 \$993,248 \$8,546,06 \$11,564,902

25.82

115.674

231,348

Unit Cos

Unit Cost:

7.920 LF

5,280 CY

15.840

7,920 LF

Engineer's Estimate 9/16/2019 R.3

\$2.94

\$8.791.563

\$1,110.05

\$17.583.127

\$984.00

\$3.099.518

\$6,199,03

\$391.35

\$12.4

\$22,170,609

\$54 446 7

\$2,799.3

\$0.00

\$16.80

\$40,955,414

\$90,318,16

\$5,195,520

\$5,171.14

\$6.893.723

\$12,089,243

\$5,195,520

\$870.42

1.5 mi Viaduct & 1.5 mi Embankment:

Engineer's Estimate 9/16/2019 R.3

Item Description		Quant.	Unit	Prod.	Crew	Days	Man	Equip.	Labor	Equip.	Perm.Matl. Const.Matl.	Subc.	Total	Total	Total	Total	Total	Direct
			U	Jnit/Hr	Hours	8HR/Day	Hrs	Hrs	Rate	Rent/Hr	Rate Rate	Rate	Labor	Eq.Rent	Perm.Matl.	Const.Matl.	Subc.	Cost
						Days												
40.20 Furnish & Install Steel:		4,005,774	LB	1,000	4,006													
(QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH)		4,005,774		2,000	4,000	301										1		
Steel Rib - VI 12x30 Beam 2 25 Winty TN = 40,400 Wints @ 10 Hieri Clew = 4040 Ch = 1,000 Cb/Ch)		863.082	LB				1	1	1	1	\$1.51	1		+	\$1,304,678			\$1,304,6
		,																
Steel Rib upper and top - W10x22 Beam		1,094,663	LB								\$1.51				\$1,654,747	`		\$1,654,
Struts 4" x 4" x 1/4" HSS		323,675	LB								\$1.51				\$489,283			\$489,2
Long - Interior Cross Struts 4" x 1/4" Angle		291,416	LB								\$1.51				\$440,520)		\$440,5
Lat - Interior Cross Struts 4" x 4" x 1/4" Angle		207,397	LB								\$1.51				\$313,512	1		\$313,5
Longitudinal Braces W6x12		950,400	LB								\$1.51				\$1,436,672			\$1,436,6
Fasteners 4" x 4" x 1/4"		96,941	LB								\$3.24				\$314,015			\$314,0
Structural Plates 12" x 1/2"		40,392	LB							1	\$1.51				\$61,059			\$61,0
												1		-				
Cable Tray 4" x 3" x 1/4"		137,808	LB								\$1.51				\$208,317			\$208,3
Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50)		2	EA					8,012		\$26.58				\$212,947				\$212,9
Welding Machine (Caltrans Pg.34, WELD/AWM/250-500)		1	EA					4,006		\$9.49				\$38,015				\$38,0
Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel		1	EA					4,006		\$173.95				\$696,804				\$696,8
Crane Operator 2-A		1	EA				4,006		\$85.12				\$340,971					\$340,9
Iron Worker Foremen		1	EA				4,006		\$78.83				\$315,775					\$315,7
Iron Worker			EA				32,046		\$74.51				\$2,387,762					\$2,387,7
non worker	Subtotal:	٥	LA						3/4.31			1		4047 755	\$6,222,803	\$n	40	
							40,058	 	 	1			\$3,044,508			, yo	\$0	7-0,0,0
	Unit Cost:						100.00			ļ	ļ		\$0.76	\$0.24	\$1.55	\$0.00	\$0.00	\$2
						Days		<u> </u>	<u> </u>							1		ļ
40.30 Furnish & Install Fiberglass Panels:		628,214	SF	258	2,433	304					<u> </u>							
(QTY = 628,214 SF @ 10.76SF/Panel = 63,973 Panels @ 24 Panels/HR = 2,665.54 HRs = 258.24 SF/HR)																		
x" Fiberglass Panel , (perSF Quote by SoundFighter)		628,214	SF					İ	İ	1	\$17.28	1			\$10,853,032	İ		\$10,853,0
Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/800M/50-74)		,	EA				1	9,731	l	\$47.31		1		\$460,360	, ,,,,,,,,,,,,	1		\$460,3
		4	EA				 	2,433	 	\$9.49	 	 		\$23,086		 		\$23,0
Welding Machine (Caltrans Pg.34, WELD/AWM/250-500)		1	EA EA				 	2,433	 	\$9.49	-	 		\$23,086 \$423,164		 		\$23,0
Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel		1						2,433		\$1/3.95				\$423,164				\$423,1
Crane Operator 2-A		1	EA				2,433		\$85.12				\$207,069					\$207,0
Iron Worker Foremen		1	EA				2,433	l	\$78.83				\$191,768					\$191,7
Iron Worker		8	EA				19,461		\$74.51				\$1,450,070					\$1,450,0
40.4 Structural Modifications																		
Viaduct Structural Upgrade for supporting enclosure - Assume 2.5% of viaduct structure cost (\$134,740,541/mi)								l	l									
Visitable Strategic Office (Strategic Visitable Visitable Strategic Cost (\$134), 40,5421 mg															\$5,052,770			\$5,052,7
															JJ,0J2,770			JJ,0JZ,1
								l	l									
	Subtotal:						24,327						\$1,848,907	\$906,610	\$15,905,802	\$0	ŚO	\$18,661,3
	Unit Cost:						25.82						\$2.94		\$25.32	\$0.00	\$0.00	
													7	7	7-0-0-	70.00	70.00	7
40 Total Wall Panel Enclosure along 1.5 mi Viaduct		7,920	1.5				64,385	1	1	1		1	\$4,893,416	\$1,854,376	\$22,128,605		\$5,195,520	\$34,071,9
40 Total Wall Panel Enclosure along 1.5 mi Viaduct		7,920	LF				64,385									ŞU		
	Unit Cost:												\$617.86	\$234.14	\$2,794.02	\$0.00	\$656.00	\$4,302
50 Wall Panel Enclosure along 1.5 mi Embankment:		7,920	LF			Days												
						Days												
50.10 4,000 Psi Concrete Anchor Wall:						Days										l l		
			+			<u>Days</u>				1		1						
16" CIDH Pile 10 FT Long at 13' Spacing (OTY = 15.840 F.@. 13' O.C. = 1218 FA.@. 10 FT/FA = 12.184 JF). Quote Caltrans		12 184	I.E.			Days						\$68.31					\$832.289	
16" CIDH Pile, 10 FT Long at 13' Spacing, (QTY = 15,840 LF @ 13' O.C. = 1218 EA @ 10 FT/EA = 12,184 LF), Quote Caltrans		12,184	LF CV			Days						\$68.31					\$832,289	¢c 902 7
16" CIDH Pile, 10 FT Long at 13' Spacing, (QTY = 15,840 LF @ 13' O.C. = 1218 EA @ 10 FT/EA = 12,184 LF), Quote Caltrans (QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY)		12,184 6,160	LF CY			Days						\$68.31 \$984.00					\$832,289 \$6,061,434	\$6,893,7
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY)		6,160	CY															\$6,893,7
(QTY = 3' W × 3.5' H × 7,920 LF = 3,080 CY × 2 EA = 6,160 CY) 50.20 Furnish & Install Steel:				1,000	3,682													\$6,893,7
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY)		6,160	CY	1,000	3,682													\$6,893,7
(QTY = 3' W × 3.5' H × 7,920 LF = 3,080 CY × 2 EA = 6,160 CY) 50.20 Furnish & Install Steel:		6,160	CY	1,000	3,682						\$1.51				\$1,304,678			\$6,893,7 \$1,304,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH)		6,160 3,682,099	CY LB	1,000	3,682						\$1.51 \$1.51				\$1,304,678 \$1,654,747			
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam		6,160 3,682,099 863,082 1,094,663	LB LB	1,000	3,682						\$1.51				\$1,654,747			\$1,304,6 \$1,654,7
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - WI 2x30 Beam Steel Rib - WI 2x30 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle		863,082 1,094,663 291,416	LB LB LB LB	1,000	3,682						\$1.51 \$1.51				\$1,654,747 \$440,520			\$1,304,6 \$1,654,7 \$440,5
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib - W12x30 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle		6,160 3,682,099 863,082 1,094,663 291,416 207,397	LB LB LB LB LB	1,000	3,682						\$1.51 \$1.51 \$1.51				\$1,654,747 \$440,520 \$313,512			\$1,304,6 \$1,654,1 \$440,5 \$313,5
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400	LB LB LB LB LB LB LB LB	1,000	3,682						\$1.51 \$1.51 \$1.51 \$1.51 \$1.51				\$1,654,747 \$440,520 \$313,512 \$1,436,672			\$1,304,6 \$1,654, \$440,5 \$313,5 \$1,436,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4"		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941	LB LB LB LB LB LB LB LB LB LB	1,000	3,682						\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24				\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015			\$1,304,6 \$1,654, \$440,5 \$313,5 \$1,436,6 \$314,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400	LB LB LB LB LB LB LB LB	1,000	3,682						\$1.51 \$1.51 \$1.51 \$1.51 \$1.51				\$1,654,747 \$440,520 \$313,512 \$1,436,672			\$1,304,6 \$1,654, \$440,5 \$313,5 \$1,436,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4"		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941	LB LB LB LB LB LB LB LB LB LB	1,000	3,682						\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24				\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015			\$1,304,6 \$1,654, \$440,5 \$313,5 \$1,436,6 \$314,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Long full dia Faces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4"		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682			7,364		\$26.58	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51			\$195,740	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,6 \$1,654,7 \$440,5 \$313,5 \$1,436,6 \$314,6 \$61,6 \$208,3
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50)		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682			7,364		\$26.58	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51			\$195,740 \$24,043	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,654,7 \$440,9 \$313,7 \$1,436,6 \$314,0 \$208,3 \$195,7
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Bearm Steel Rib upper and top - W10x22 Bearm Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.34, WELD/AWM/250-500) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500)		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682			3,682		\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51			\$34,943	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,6 \$1,654,5 \$440,9 \$313,5 \$1,436,6 \$61,0 \$208,5 \$195,5 \$34,6
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Long full dial Fances W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIs/31-50) Welding Machine (Caltrans Pg. 24, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682						\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51			\$34,943 \$640,501	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,6 \$1,654, \$440, \$313, \$1,436, \$314, \$61, \$208, \$195, \$344,
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long - Interior Cross Struts 4" x 1/4" Angle Gasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 09 Ton Grove RT-90 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682		3,682	3,682	\$85.12	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$313,420	\$34,943 \$640,501	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,(\$1,654,) \$440,(\$313,(\$1,436,(\$314,(\$208,(\$195,) \$34,(\$640,(\$313,4
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib - W12x30 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lot - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 12" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682		3,682	3,682		\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$313,420 \$290,260	\$34,943 \$640,501	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,6 \$1,654, \$440, \$313, \$1,436, \$314, \$61, \$208, \$195, \$344,
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682			3,682	\$85.12	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51			\$34,943 \$640,501	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059			\$1,304,(\$1,654,) \$440,(\$313,(\$1,436,(\$314,(\$208,(\$195,) \$34,(\$640,(\$313,4
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" nagle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 12" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen	Subtotal:	6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682		3,682 29,457	3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826	\$34,943 \$640,501	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317			\$1,304,6 \$1,654,1 \$440,1 \$313,1 \$1,436,6 \$208,1 \$195,7 \$44,6 \$208,1 \$313,4 \$640,1 \$313,4 \$290,0 \$2,2194,8
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" ngle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen	Subtotal:	6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682		3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304,1 \$1,654,1 \$440,1 \$313,2 \$1,436,6 \$314,1 \$61,1 \$208,1 \$34,1 \$640,0 \$313,1 \$290,2 \$2,194,1 \$9,403,1
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" ngle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen	Subtotal: Unit Cost:	6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682	460	3,682 29,457	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304,6 \$1,654,7 \$440,9 \$313,3 \$1,436,6 \$314,4 \$61,1 \$208,3 \$195,5 \$34,9 \$640,9 \$290,2 \$2,194,4 \$5,403,3
CITY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY Furnish & Install Steel: CITY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HVLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/Z50-500) Crane Operator 2-A Iron Worker Foremen Iron Worker Foremen Iron Worker Foremen Furnish & Install Fiberglass Panels:		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304, \$1,554, \$440, \$313, \$133, \$1,436, \$314, \$61, \$208, \$34, \$540, \$313, \$290, \$2,2194,
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L	1,000	3,682	460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304, \$1,554, \$440, \$313, \$133, \$1,436, \$314, \$61, \$208, \$34, \$540, \$313, \$290, \$2,2194,
QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) Furnish & Install Steel: QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib upper and top - V10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Long titudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 12" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 90 Ton Grow RT-990 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen Iron Worker Foremen Iron Worker Foremen Iron Worker Foremen Iron Worker Furnish & Install Fiberglass Panels:		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304, \$1,554, \$440, \$313, \$133, \$1,436, \$314, \$61, \$208, \$34, \$540, \$313, \$290, \$2,2194,
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W5x12 Fasteners 4" x 4" x 1/4" Angle Longitudinal Braces W5x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen Iron Worker Foremen Iron Worker Furnish & Install Fiberglass Panels: 60.30		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317 \$5,733,520 \$1.56	\$0	\$6,061,434	\$1,304,1 \$1,554,1 \$440,1 \$313,1 \$1,436,1 \$61,1 \$208,1 \$195,1 \$34,1 \$640,1 \$21,194,1 \$290,1 \$2,194,1 \$2,20,1 \$2,194,1 \$2,20,1 \$
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 12" x 12" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg.15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg.34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen Iron Worker Furnish & Install Fiberglass Panels: 50.30 [QTY = 628,214 SF @ 10.765F/Panel = 63,973 Panels @ 24 Panels/HR = 2,665.54 HRs = 258.24 SF/HR) x" Fiberglass Panel , (perSF Quote by SoundFighter)		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83 \$74.51	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185 \$0.24	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317	\$0	\$6,061,434	\$1,304, \$1,654, \$440, \$313, \$1,436, \$314, \$61, \$208, \$195, \$344, \$640, \$1313, \$290, \$2,194, \$9,403, \$1
(CITY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (CITY = 4,633,993 LB = 2320 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Bearm Steel Rib upper and top - W10x22 Bearm Long - Interior Cross Struts 4" x 4" x 1/4" Angle Lat - Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scissor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 90 Ton Grow RT-990 (Caltrans pg. 12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen Iron Worker (CITY = 62, 21.45 FR @ 10.765F/Panel = 63.973 Panels @ 24 Panels/HR = 2,665.54 HRs = 258.24 SF/HR) Aerial Boom Manlift 60' (Caltrans pg. 15 HYLFT/BOOM/50-74)		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB SF SF			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682 9,731	\$85.12 \$78.83 \$74.51	\$9.49 \$173.95	\$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185 \$0.24 \$460,360	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317 \$5,733,520 \$1.56	\$0	\$6,061,434	\$1,304,0 \$1,654, \$440,1 \$313,3 \$1,436,1 \$314,4 \$61,1 \$208, \$195,5 \$34,1 \$540,0 \$2,194,1 \$2,290,1 \$2,194,1 \$2,290,1 \$2,194,1 \$313,4 \$2,200,1 \$2,200,
(QTY = 3' W x 3.5' H x 7,920 LF = 3,080 CY x 2 EA = 6,160 CY) 50.20 Furnish & Install Steel: (QTY = 4,639,993 LB = 232.0 TN @ 20 MH/TN = 46,400 MHs @ 10 men Crew = 4640 CH = 1,000 LB/CH) Steel Rib - W12x30 Beam Steel Rib upper and top - W10x22 Beam Long - Interior Cross Struts 4" x 4" x 1/4" Angle Long-Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Angle Longitudinal Braces W6x12 Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2" Cable Tray 4" x 3" x 1/4" Man Scisor Lift (Caltrans Pg. 15, HYLFT/SCIS/31-50) Welding Machine (Caltrans Pg. 34, WELD/AWM/250-500) Crane 90 Ton Grove RT-990 (Caltrans pg.12 HCESP/GROV/RT-990) - Unload Steel Crane Operator 2-A Iron Worker Foremen Iron Worker Foremen Iron Worker Furnish & Install Fiberglass Panels: 50.30 (QTY = 628,214 SF @ 10.765F/Panel = 63,973 Panels @ 24 Panels/HR = 2,665.54 HRs = 258.24 SF/HR) x * Fiberglass Panel , [perSF Quote by Soundfighter]		6,160 3,682,099 863,082 1,094,663 291,416 207,397 950,400 96,941 40,392 137,808 2 1 1 1 1 8	LB LB LB LB LB LB LB LB LB LB LB LB LB L			460 ————————————————————————————————————	3,682 29,457 36,821	3,682 3,682	\$85.12 \$78.83 \$74.51	\$9.49	\$1.51 \$1.51 \$1.51 \$1.51 \$3.24 \$1.51 \$1.51 \$1.51 \$1.51		\$290,260 \$2,194,826 \$2,798,506	\$34,943 \$640,501 \$871,185 \$0.24	\$1,654,747 \$440,520 \$313,512 \$1,436,672 \$314,015 \$61,059 \$208,317 \$5,733,520 \$1.56	\$0	\$6,061,434	\$1,30 \$1,65 \$44 \$31 \$1,43 \$51 \$6 \$20 \$19 \$3 \$44 \$31 \$31 \$14 \$3 \$44 \$4 \$3 \$44 \$4 \$4 \$4 \$4 \$4 \$4 \$4 \$4 \$4 \$4 \$4 \$4

1.5 mi Viaduct & 1.5 mi Embankment:

1.5 mi Vi	duct & 1.5 mi Embankment:																	9/16/2019	R.3
Item	Description	Quant.	Unit	Prod.	Crew	Days	Man	Equip.	Labor	Equip.	Perm.Matl.	Const.Matl.	Subc.	Total	Total	Total	Total	Total	Direct
				Unit/Hr	Hours	8HR/Day	Hrs	Hrs	Rate	Rent/Hr	Rate	Rate	Rate	Labor	Eq.Rent	Perm.Matl.	Const.Matl.	Subc.	Cost
	Crane Operator 2-A	1	EA				2,433		\$85.12					\$207,069					\$207,069
	Iron Worker Foremen	1	EA				2,433		\$78.83					\$191,768					\$191,768
	Iron Worker	8	EA				19,461		\$74.51					\$1,450,070					\$1,450,070
	Subtot	al:					24,327							\$1,848,907	\$906,610	\$10,853,032	\$0	\$0	\$13,608,549
	Unit Co	st:					25.82							\$2.94	\$1.44	\$17.28	\$0.00	\$0.00	\$21.66
50	Total Wall Panel Enclosure along 1.5 mi Embankment	7,920	LF				61,148							\$4,647,413	\$1,777,795	\$16,586,552	\$0	\$6,893,723	\$29,905,483
	Unit Co	st:												\$586.79	\$224.47	\$2,094.26	\$0.00	\$870.42	\$3,775.94
40+50	Total of 1.5 mi Wall Panel Enclosure on Embankment and 1.5 mi Wall Panel Enclosure on Viaduct	15,840	LF				125,532							\$9,540,829	\$3,632,171	\$38,715,158	\$0	\$12,089,243	\$63,977,400

Engineer's Estimate

tem	Item Description	Quantity	Length/EA	Total Length	Weight/LF	Weight/EA	Total Weight
	Tubular Enclosure along 1.5mi viaduct	EA	FT	FT	LB	LB	LB
1	Steel Rib - W14x38 beam	1,224	83.90	102,693.60	38	3,188.20	3,902,356.80
2	Steel Straps - 1"x7"	1,224	86.9	106,365.60	24	2,085.60	2,552,774.40
3	Struts 4" x 4" x 1/4" HSS	2,448	11	26,928.00	12.02	132.22	323,674.56
4	Interior Cross Struts 4" x 4" x 1/4" Angle	8,064	9.8	79,027.20	6.6	64.68	521,579.52
5	Longitudinal Braces 6" x 2" x 1/4" HSS	13,824	6.875	95,040.00	12.02	82.64	1,142,380.80
6	Fasteners 4" x 4" x 1/4"	29,376	0.5	14,688.00	6.6	3.30	96,940.80
7	Structural Plates 12" x 12" x 1/2"	11,016				20.4	224,726.40
8	Cable Tray 4" x 3" x 1/4"	3	7,920	23,760	5.8	45,936.00	137,808.00
							8,902,241.28
9	Noise Mitigation Panels, 2" Thick	688,248	SF				
	(Acrylic, Wood Pulp Comp., or Concrete)						
	(Acrylic, Wood Pulp Comp., or Concrete)						
Item		Quantity	Length/EA	Total Length	Weight/LF	Weight/EA	Total Weight
ltem	Item Description Enclosure along 1.5mi embankment	Quantity	Length/EA FT	Total Length FT	Weight/LF LB	Weight/EA LB	Total Weight LB
Item 1	Item Description						
	Item Description Enclosure along 1.5mi embankment	EA	FT	FT	LB	LB	LB
1	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam	EA 1,224	FT 83.90	FT 102,693.60	LB 38	LB 3,188.20	LB 3,902,356.80
1 2	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7"	1,224 1,224	FT 83.90 86.9	FT 102,693.60 106,365.60	LB 38	LB 3,188.20	LB 3,902,356.80
1 2 3	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet	1,224 1,224 2	FT 83.90 86.9 7,920	FT 102,693.60 106,365.60 15,840.00	LB 38 24	LB 3,188.20 2,085.60	LB 3,902,356.80 2,552,774.40
1 2 3 4	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle	1,224 1,224 2 8,064	FT 83.90 86.9 7,920 9.8	FT 102,693.60 106,365.60 15,840.00 79,027.20	LB 38 24 6.6	LB 3,188.20 2,085.60 64.68	LB 3,902,356.80 2,552,774.40 521,579.52
1 2 3 4 5	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS	1,224 1,224 2 8,064 13,824	FT 83.90 86.9 7,920 9.8 6.875	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00	LB 38 24 6.6 12.02	LB 3,188.20 2,085.60 64.68 82.64	LB 3,902,356.80 2,552,774.40 521,579.52 1,142,380.80 96,940.80
1 2 3 4 5 6	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4"	1,224 1,224 2 8,064 13,824 29,376	FT 83.90 86.9 7,920 9.8 6.875	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30	LB 3,902,356.80 2,552,774.40 521,579.52 1,142,380.80 96,940.80 224,726.40 137,808.00
1 2 3 4 5 6	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2"	1,224 1,224 2 8,064 13,824 29,376 11,016	83.90 86.9 7,920 9.8 6.875 0.5	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00 14,688.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30 20.4	521,579.52 1,142,380.80 96,940.80 224,726.40
1 2 3 4 5 6	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2"	1,224 1,224 2 8,064 13,824 29,376 11,016	83.90 86.9 7,920 9.8 6.875 0.5	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00 14,688.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30 20.4	LB 3,902,356.80 2,552,774.40 521,579.52 1,142,380.80 96,940.80 224,726.40 137,808.00

tem	Item Description	Quantity	Length/EA	Total Length	Weight/LF	Weight/EA	Total Weight
	Wall Panel Enclosure along 1.5mi viaduct	EA	FT	FT	LB	LB	LB
1	Steel Rib - W12x30 beam	990	29.06	28,769.40	30	871.80	863,082.00
2	Steel Rib upper - W10x22 beam	990	50.26	49,757.40	22	1,105.72	1,094,662.80
3	Struts 4" x 4" x 1/4" HSS	2,448	11	26,928.00	12.02	132.22	323,674.56
4	Long - Interior Cross Struts 4" x 4" x 1/4" Angle	990	44.6	44,154.00	6.6	294.36	291,416.40
5	Belt - Interior Cross Struts 4" x 4" x 1/4" Angle	124	253.9	31,423.84	6.6	1,675.94	207,397.33
6	Longitudinal Braces W6x12	9,900	8.000	79,200.00	12	96.00	950,400.00
7	Fasteners 4" x 4" x 1/4"	29,376	0.5	14,688.00	6.6	3.30	96,940.80
8	Structural Plates 12" x 12" x 1/2"	1,980				20.4	40,392.00
9	Cable Tray 4" x 3" x 1/4"	3	7,920	23,760	5.8	45,936.00	137,808.00
							4,005,773.89
10	Noise Mitigation Panels, 2" Thick	628,214	SF				
	Fiberglass, apprx. 5psf		<u> </u>				
	The Iglass, apprix spsi						
	Therefores, apprix spor						
	Tibergiass, apprix. Spsi						
tem	Item Description	Quantity	Length/EA	Total Length	Weight/LF	Weight/EA	Total Weight
tem		Quantity EA	Length/EA FT	Total Length FT	Weight/LF LB	Weight/EA LB	Total Weight LB
tem	Item Description	•					LB
	Item Description Enclosure along 1.5mi embankment	EA	FT	FT	LB	LB	
1	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam	EA 1,224	FT 83.90	FT 102,693.60	LB 38	LB 3,188.20	LB 3,902,356.8
1 2	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7"	1,224 1,224	FT 83.90 86.9	FT 102,693.60 106,365.60	LB 38	LB 3,188.20	LB 3,902,356.8 2,552,774.4
1 2 3	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet	1,224 1,224 2	FT 83.90 86.9 7,920	FT 102,693.60 106,365.60 15,840.00	LB 38 24	LB 3,188.20 2,085.60	LB 3,902,356.8
1 2 3 4	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4"	1,224 1,224 2 8,064	83.90 86.9 7,920 9.8	FT 102,693.60 106,365.60 15,840.00 79,027.20	LB 38 24 6.6	LB 3,188.20 2,085.60 64.68	LB 3,902,356.8 2,552,774.4 521,579.5
1 2 3 4 5	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS	1,224 1,224 2 8,064 13,824	FT 83.90 86.9 7,920 9.8 6.875	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00	LB 38 24 6.6 12.02	LB 3,188.20 2,085.60 64.68 82.64	LB 3,902,356.8 2,552,774.4 521,579.5 1,142,380.8 96,940.8
1 2 3 4 5 6	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4"	1,224 1,224 2 8,064 13,824 29,376	FT 83.90 86.9 7,920 9.8 6.875	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30	LB 3,902,356.8 2,552,774.4 521,579.5 1,142,380.8 96,940.8 224,726.4 137,808.0
1 2 3 4 5 6 7	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2"	1,224 1,224 2 8,064 13,824 29,376 11,016	FT 83.90 86.9 7,920 9.8 6.875 0.5	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00 14,688.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30 20.4	LB 3,902,356.8 2,552,774.4 521,579.5 1,142,380.8 96,940.8 224,726.4 137,808.0
1 2 3 4 5 6 7	Item Description Enclosure along 1.5mi embankment Steel Rib - W14x38 beam Steel Straps - 1"x7" Concreter Parapet Interior Cross Struts 4" x 4" x 1/4" Angle Longitudinal Braces 6" x 2" x 1/4" HSS Fasteners 4" x 4" x 1/4" Structural Plates 12" x 12" x 1/2"	1,224 1,224 2 8,064 13,824 29,376 11,016	FT 83.90 86.9 7,920 9.8 6.875 0.5	FT 102,693.60 106,365.60 15,840.00 79,027.20 95,040.00 14,688.00	LB 38 24 6.6 12.02 6.6	LB 3,188.20 2,085.60 64.68 82.64 3.30 20.4	LB 3,902,356.8 2,552,774.4 521,579.5 1,142,380.8 96,940.8 224,726.4

Engineer's Estimate 9/16/2019 R.1

	Description	Quant.	Unit	Prod.	Crew	Durations	Man	Equip.	Labor	Equip.	Perm.Matl.	. Const.Matl	. Subc.	Total	Total	Total	Total	Total	Total
Activity				Unit/Hr	Hours	8HR/Day	Hrs	Hrs	Rate	Rent/Hr	Rate	Rate	Rate	Labor	Eq.Rent	Perm.Matl.	Const.Matl.	Subc.	Cost
																	L		
	4,000 Psi Pile Cap (Standard Sound Wall 1.5 mi Embankment):	15,840	LF			<u>Days</u>													
10	Fabricate Wall Forms:	4,200	SF	49.00	86	10.7													
	Pre-Fab Supplies Flat	4,200	SF									\$0.49					\$2,046		\$2,0
	5/8" Plywood	5,460	SF									\$1.62					\$8,866		\$8,8
	Form Lumber	14,700	BF									\$0.54	ı				\$7,956	1	\$7,9
	185 CFM Diesel Comp. (Pg.1, AIRCP/PORT/016-025)	1	EA					86		\$16.81					\$1,441				\$1,4
	Generator 10 KW (pg.6, ELGEN/GEN/008-015)	1	EA					86		\$7.50)				\$643				\$6
	Carpenter Foreman	1	EA				86		\$86.27	7				\$7,395					\$7,3
	Carpenter Prefab	3	EA				257		\$83.93	3				\$21,582					\$21,
	Total Fabricate Forms						343							\$28,977	\$2,084	\$0	\$18,868	\$0	\$49,
	Unit Cost:						12.25							\$6.90	\$0.50		\$4.49	\$0.00	\$11
						Days													
20	Erect & Strip Wall Forms:	93,139	SF	70.40	1,323	165											1		
	Surface Form Oil	93,139	SF									\$0.04	ı				\$4,033		\$4,0
	Set/Strip Wood Form Supplies	121,081	SF									\$1.35	5				\$163,838		\$163,
	Pickup Truck (Caltrans pg.34 TRUCK/T&TT/06-12)	2	EA					2,646		\$24.98	3				\$66,097				\$66,
	185 CFM Diesel Comp. (Pg.1, AIRCP/PORT/016-025)	2	EA					2,646		\$16.81	L				\$44,479		1		\$44,
	Generator 10 KW (pg.6, ELGEN/GEN/008-015)	2	EA					2,646		\$7.50)				\$19,845				\$19,
	Carpenter Foreman	2	EA				2,646		\$86.27	7				\$228,270			1		\$228,2
	Carpenter Prefab	6	EA				7938		\$83.93	3				\$666,236					\$666,2
	Total Erect & Strip Wall Forms						10,584							\$894,507	\$130,421	\$0	\$167,871	\$0	\$1,192,7
	Unit Cost:						8.80							\$9.60	\$1.40		\$1.80	\$0.00	\$12
30	Rebar - Furnish/Install (Black):	647,010	LBS										\$0.97					\$627,599.70	\$627,6
						Days													
40	Place Concrete:	2,588.04	CY	14.70	176	22											1		
	4000 psi Concrete	2,588.04	CY								\$118.00					\$305,389			\$305,3
	Conc. Vib/Place Supply	2,588.04	CY									\$1.52	2				\$3,922		\$3,9
	Pickup Truck (Caltrans pg.34 TRUCK/T&TT/06-12)	1	EA					176		\$24.98	3				\$4,398				\$4,3
	Conc. Pump 36 M (Pg.5, CONPM/SHWG/1058)	1	EA					176		\$107.63	3				\$18,949				\$18,9
	185 CFM Diesel Comp. (Pg.1, AIRCP/PORT/016-025)	1	EA					176		\$16.81					\$2,960				\$2,9
	Generator 10 KW (pg.6, ELGEN/GEN/008-015)	1	EA					176		\$7.50)				\$1,320				\$1,
	Conc. Pump Operator GR 5	1	EA				176		\$79.53	3				\$14,002					\$14,
	Laborer Foreman	1	EA				176		\$60.59					\$10,667					\$10,
	Concrete Vibratorman - GR 2	1	EA				176		\$57.26	5				\$10,081					\$10,
	Concrete Laborer - GR 2	3	EA				528		\$57.26	5				\$30,243					\$30,
	Total Place Concrete						1,056							\$64,993	\$27,627	\$305,389	\$3,922	\$0	\$401,
	Unit Cost:						2.45							\$25.11		\$118.00	\$1.52	\$0.00	\$155
						Days													
50	Wet Finish:	19,958	SF	107.34	185.9	23													
-	Wood float Supplies	19,958	SF	<u> </u>		-			†		1	\$0.09			†		\$1,728		\$1,
	Screed Supplies	19,958	SF	<u> </u>					†		1	\$0.09			†		\$1,728		\$1,
	Cement Mason Foreman	1	EA				185.9		\$68.01			, 5.55		\$12,646					\$12,
	Cement Mason/Conc. Finisher	1	EA	<u> </u>			185.9		\$65.67		1			\$12,210					\$12,
		Subtotal:					372							\$24,856	\$0	\$0	\$3,457	\$0	\$28,
		Unit Cost:		1			53.7		-					\$1.25	\$0.00		\$0.17	\$0.00	\$20,
	<u>I</u>			1		Days	55.7		-					Ų1.23	\$5.00		75.27	\$5.55	
60	Dry Finish:	93,139	SF	138.36	673	84.1			 	<u> </u>	+		<u> </u>	 	 		 		
	Conc. Finish Supplies	93,139	SF	155.50	073	02				 	1	\$0.03	1	†			\$3,025	 	\$3,
	Point/Patch Supplies	93,139	SF	1					1	1	1	\$0.03		+	1		\$9,074		\$9,
	Cement Mason Foreman	33,133	EA	1		-	673	-	\$68.01	1	1	50.10	1	\$45,782		-	75,074	++	\$45,

	Cement Mason/Conc. Finisher	3	EA				2019	\$65.67			\$132,620					\$132,620
	Subtotal:	1	i				2693				\$178,402	\$0	\$0	\$12,099	\$0	\$190,501
	Unit Cost:						34.6				\$1.92	\$0.00		\$0.13	\$0.00	\$2.05
		1	i			Days										
70	Water Cure:	113,098	SF	224.50	504	63.0										
	Water Cure	113,098	SF							\$0.04				\$4,920		\$4,920
	Concrete Finish Laborer - GR 2	2	EA				1008	\$57.26			\$57,692					\$57,692
	Subtotal:		i				1008				\$57,692	\$0	\$0	\$4,920	\$0	\$62,612
	Unit Cost:		1				112.25				\$0.51	\$0.00	\$0.00	\$0.04	\$0.00	\$0.55
	Total 4,000 Psi Pile Cap (Standard Sound Wall 1.5 mi Embankment):	/ //					16,055				\$1,249,427	\$160,132	\$305,389	\$211,136	\$627,600	\$2,553,684
	Unit Cost:	15,840	LF													\$161.22
	Unit Cost:	2,588.04	CY													\$986.72