Last Chance Grade Permanent Restoration Project

Structure Preliminary Geotechnical Report Alternative F Tunnel Operations and Maintenance Center

Submittal SUB-052d

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Del Norte County, U.S. 101,
PM 12.7/16.5

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Acronyms and Abbreviations

APEFZ	Alquist-Priolo Earthquake Fault Zone
APS	Advance Planning Study
ARS	Acceleration Response Spectrum
ASTM	American Society for Testing and Materials
Caltrans	California Department of Transportation
CGS	California Geological Survey
CSZ	Cascadia Subduction Zone
CTM	California Test Methods
k_h	horizontal seismic coefficient
LCG	Last Chance Grade
LiDAR	light detection and ranging
M	Mean Earthquake Moment Magnitude
MSE	Mechanically Stabilized Earth
MTD	Caltrans Memo to Designers
OMC	Operations and Maintenance Center
PGA	peak ground acceleration
PGR	Preliminary Geotechnical Report
PM	post mile
ppm	parts per million
Project	Last Chance Grade Permanent Restoration Project
SDC 2.0	Seismic Design Criteria Version 2.0
SFRDHA	Surface Fault Rupture Displacement Hazard Analysis
SI	slope inclinometer
SPGR	Structure Preliminary Geotechnical Report
SPT	standard penetration test
UCERF3	Uniform California Earthquake Rupture Forecast, Version 3
U.S. 101	U.S. Highway 101
USGS	United States Geological Survey
V_{s30}	shear wave velocity for the upper 100 feet
VWP	vibrating wire piezometer

1 INTRODUCTION

This Structure Preliminary Geotechnical Report (SPGR) has been prepared to support the Advance Planning Study (APS) for the Operations and Maintenance Center (OMC) of the proposed Alternative F design option for the Last Chance Grade Permanent Restoration Project (Project). The alignments and features considered in this report are current as of October 26, 2023 (Caltrans, 2023a), the geologic and geotechnical data gathered by and on behalf of the California Department of Transportation (Caltrans) through May 31, 2021, presented in the Preliminary Geotechnical Data Report (Final) dated July 2022 (Caltrans, 2022), and the preliminary geotechnical analyses and recommendations presented in the Preliminary Geotechnical Report (Final) (PGR) dated December 2023 (Caltrans, 2023b).

2 PROJECT DESCRIPTION

Caltrans is studying alternative alignments and design options for the Project on U.S. Highway 101 (U.S. 101). The location of the project is shown on Plate 1a. These studies are in response to the section of U.S. 101 between post mile (PM) 12.7 and PM 16.5, extending from Wilson Creek to approximately 10 miles south of Crescent City in Del Norte County (known as “Last Chance Grade” [LCG]) that has been progressively sliding towards the Pacific Ocean since the roadway was first constructed. Due to continual road deformation resulting from slope movement, ongoing construction and maintenance activities are necessary to keep U.S. 101 open to the traveling public. The Project is considering Alternatives X and F to provide a more reliable connection, reduce maintenance costs, and protect the economy, natural resources, and cultural landscapes.

Alternative F would involve constructing an approximately 6,000-foot (1.1-mile) tunnel east of the existing highway to avoid the most intense areas of known landslides and geologic instability.

This alternative would be located between about PM 13.5 and PM 15.7. Main components would include a tunnel, associated north and south portals and approaches, a bridge from the north portal to connect to existing U.S. 101, and an OMC. The proposed bridge and tunnel are addressed in separate SPGRs (SPGR-b and SPGR-c).

The OMC would be located south of the tunnel at PM 13.52, and would include a building, parking spaces, and outdoor storage, as well as maintenance, operations, and emergency equipment. The building would be an approximately 12-foot-tall, 18,000-square-foot, single-story structure founded on rigid shallow foundations.

Retaining walls with perimeter chain link fencing would be located around the OMC building and yard for security purposes and to provide a grade break that allows the OMC facilities to be placed below the existing ground surface.

Construction of the OMC would involve cutting into the hillside and regrading a portion of the existing highway to create an access road to the facility. It is anticipated that porous pavement would be used to filter stormwater. The building sanitary sewer system would follow traditional plumbing methods, but it would discharge to a 3,000-gallon septic holding tank. On-site storage tanks would be provided for water, diesel, gasoline, and propane.

Alternative F OMC plan and profile views are presented on the attached Plates 1b through 1d.

3 GEOTECHNICAL INVESTIGATION

To date, three phases of geotechnical investigations have been performed for the project, which were identified as Phase 1, Phase 2A, and Phase 2B. Some Phase 1 and 2B explorations were performed in the vicinity of the Alternative F OMC. Phase 2A explorations were completed along the existing highway alignment but not in the vicinity of the OMC.

The Phase 1 geotechnical investigation program was completed between February 5, 2018 and September 27, 2018 and is summarized in the Phase 1 geotechnical investigation memorandum by Caltrans Office of Geotechnical Design (2018), which is included in Appendix A of the Preliminary Geotechnical Data Report (Final) (Caltrans, 2022). Field investigation work performed within about 150 feet of the OMC yard area included the following:

- Drilling and sampling of boring RC-18-001 for subsurface characterization and to collect data for evaluation of geologic hazards. This borehole was converted to a monitoring well, and a vibrating wire piezometer (VWP) was installed to record groundwater measurements. A slope inclinometer (SI) was installed in another borehole at the same location (RC-18-002) to measure slope movement displacements. Surface-based geophysical surveys including one seismic refraction survey (SL-1) to image subsurface structures (e.g., landslides), aid in the lateral correlation of geotechnical borings, and provide data to aid the evaluation of engineering characteristics of rock and soil.
- Collection of instrumentation readings from the SI in borehole RC-18-002, through October 13, 2020.
- Data collection from the VWP installed in borehole RC-18-001 to measure water pressure at the depth of installation within the earthflow, through January 4, 2022.

The Phase 2A geotechnical investigation program was completed between February 5, 2018 and September 27, 2018. Field investigation work performed for this program within about 800 feet south of the OMC yard area include the following:

- Drilling and sampling of one boring (RC-19-004) for subsurface characterization and to collect data for evaluation of geologic hazards.
- Collection of instrumentation readings from the SI in borehole RC-19-004, through February 6, 2020.
- Data collection from the VWP installed in borehole RC-19-004 to measure water pressure at the depth of installation within the earthflow, through February 15, 2021.

The Phase 2B geotechnical investigation program included field reconnaissance mapping by geologists from Caltrans, Kleinfelder, and SHN Consulting Engineers and Geologists on May 4 through 6, 2020 and field exploration work September 22 through January 14, 2021.

Details of the Phase 2B program, including laboratory testing results, are provided in the Preliminary Geotechnical Data Report (Final) (Caltrans, 2022). Field investigation work performed for this program within approximately 800 feet west and northwest of the OMC yard area included the following:

- Drilling and sampling of one boring (RC-21-001) approximately 800 feet northwest of the OMC yard area for subsurface characterization and to collect data for evaluation of geologic hazards.
- Surface-based geophysical surveys including a seismic refraction line (SL-42) approximately 250 feet west of the OMC yard area to image subsurface structures (e.g., landslides), aid in the lateral correlation of geotechnical borings, obtain information on rippability for earthwork grading, and provide data to aid the evaluation of engineering characteristics of rock and soil.
- Collection of instrumentation readings from the SI in RC-21-001 to measure slope movement displacements, through December 1, 2022.
- Data collection from VWPs installed in borehole RC-21-001 to measure water pressure at the depth of installation within the earthflow, through February 11, 2023.
- A time domain reflectometry cable was installed in borehole RC-21-001 to measure displacement depths through deformation; however, no data was available from Caltrans as of May 31, 2021.

Borings RC-18-001, RC-19-004, and RC-21-001 were advanced and logged in conformance with Caltrans (2010) Soil and Rock Logging, Classification, and Presentation Manual. All laboratory tests were performed in general accordance with California Test Methods (CTM) or American Society for Testing and Materials (ASTM) standard. Field and laboratory testing intervals are shown on the borehole records. Boring RC-18-002 was not sampled.

4 GEOTECHNICAL CONDITIONS

4.1 Geology

The LCG project is located within the Coast Ranges geomorphic province of California, near the Klamath Mountains, which lie approximately 10 miles to the east. The site is located approximately 90 miles north of the Mendocino Triple Junction, which is the crustal intersection of the Pacific, North American, and Gorda/Juan de Fuca tectonic plates. North of the triple junction, the Gorda/Juan de Fuca plate is being subducted eastward beneath the North America plate along the Cascadia Subduction Zone (CSZ), which extends approximately 800 miles from northern California to Vancouver Island, British Columbia. As is true for other coastal regions of northern California, Oregon, and Washington, the project site overlies the interface associated with the subducting crustal plate. This subduction interface is a low angle, east-dipping “megathrust” fault capable of generating great earthquakes of high magnitude (>M8.5).

The Coast Ranges in the LCG project area are underlain by regionally extensive Mesozoic- and Cenozoic-age rocks of the Franciscan Complex, an assemblage of mostly marine sedimentary materials accreted to the continental margin. The LCG site is within the Eastern belt of the Franciscan Complex (Delattre and Rosinski, 2012; Aalto, 1989), which is the oldest, least sheared, and most highly metamorphosed of the three belts (McLaughlin et al., 2000).

The Franciscan Complex at the LCG project site consists of two primary units: argillite-matrix Melange and a variety of Broken Formation units that originated as turbidite deposits of interbedded sandstone and shale. The Melange is interpreted as a large submarine landslide deposit that is in depositional contact with the underlying Broken Formation turbidite sequence (Aalto, 1989). Subsequent extensive accretion-related deformation has resulted in pervasive shearing and complex structural relationships within the two primary bedrock types.

The location of the proposed OMC is mapped as Landslide Deposits within the Earthflow Complex (Caltrans, 2022). The primary geologic hazards for the proposed OMC are landslides and seismicity. The landslides near the OMC are characterized as an active earthflow complex with ongoing downslope movement. Geomorphic evidence suggests the earthflows move in localized, episodic events and/or creep with movement of about 1 to 2 inches per year.

Earthquakes are another geologic hazard for the OMC. It is unclear what the magnitude of movement would be during a large regional seismic event. Seismic ground motions, as described in Section 8, may be significant and large enough to activate many of the nested landslides as well as create large displacement movement (measured in feet) along the basal failure surfaces.

4.2 Surface Conditions

The OMC would be located on the northeast side of U.S. 101, approximately 1,000 feet north of the Vista Point overlook in the area of the active earthflow landslide complex. The surface topography in this area is characterized by gently rolling, irregular slopes. In general, the surface topography at the location of the proposed OMC slopes downward towards the south to southwest. The slopes range from approximately 2.5H:1V to 6H:1V in steepness. The LiDAR survey shows several relatively flat areas in the location of former structures near U.S. 101 north of the proposed OMC (Caltrans, 2023b). The ground elevation near the OMC ranges from approximately 350 to 410 feet. Surface water drainage is anticipated to flow generally to the south to southwest.

4.3 Subsurface Conditions

At the proposed OMC, subsurface conditions include earthflow landslide deposits underlain by Franciscan Complex Melange. The landslide deposits consist of a mixture of fine-grained soils, deeply weathered rock, and scattered sandstone clasts which have been transported as a sliding mass with many internal slip surfaces. Boring records, inclinometer surveys, and cross-sectional analysis within the earthflow in the vicinity of the OMC suggest the basal failure surface/zones within borings RC-18-001/RC-18-002, RC-19-004, and RC-21-001 range from approximate depths of 49 and 118 feet. Inclinometer data collected at borehole RC-21-001 in February 2023 suggests an increased rate of movement relative to prior readings at the failure zone between approximately 90 to 96 feet. Inclinometer data from borehole RC-18-002 adjacent to the proposed OMC footprint indicates the earthflow thickness to be approximately 67 feet. The Melange below the slide debris consists of dark gray, pervasively sheared, soil-like argillite with scattered blocks of intact sandstone. Fill associated with former structures in the area may also be encountered.

It should be noted that the subsurface conditions described above are based on limited existing geotechnical data and will be verified using site-specific borings during the future design phase.

5 GROUNDWATER

The area-wide hydrogeology is dominated by groundwater flow along fractures in the bedrock, within the Melange and Broken Formations, and the overlying landslide deposits. The permeability of intact rock within these formations is very low, and most groundwater occurs and is transmitted within fractures of unknown interconnection. Where water-laden fractures intersect the bluff face, groundwater discharges as a spring or seep. Groundwater is also likely entering the ocean below the shoreline.

Groundwater flow along fractures in the project area can be interrupted and redirected, perched, or locally mounded behind subsurface barriers to flow such as clay-filled landslide-rupture zones.

VWP RC-18-001 was installed near the proposed OMC in the active earthflow. VWPs RC-19-004 and RC-21-001 were installed in the active earthflow about 800 feet south and northwest of the proposed OMC, respectively. Note that artesian conditions were encountered in VWP D-20-010, located approximately 1,200 feet northwest of the proposed OMC. The table below summarizes the groundwater data obtained from these VWPs. The data spans a timeframe between December 2018 and February 2023. No in-situ permeability testing has been performed within the earthflow in the vicinity of the proposed OMC.

Table 5-1. Groundwater Data from VWPs

Boring ID	Total Bore Depth (feet)	Surveyed Ground Surface Elevation (feet)	VWP Depth (feet)	VWP Elevation (feet)	Apparent Groundwater Depth Minimum (feet)	Apparent Groundwater Elevation Maximum (feet)	Date Measured
RC-18-001	85.3	345.1	69.8	275.3	5.5	339.6	12/4/2018 through 1/4/2022
RC-19-004	100.0	289.4	48.5	240.9	4.4	285.0	3/18/2020 through 2/15/2021
D-20-010	150.0	474.7	148.6	290.4	-8.3	447.3	12/8/2020 through 6/21/2023
			66.0	372.9	-10.1	449.0	
RC-21-001	150.0	408.4	149.0	259.4	23.7	384.7	1/16/2021 through 2/11/2023
			49.0	359.4	8.7	399.7	
			30.0	378.4	26.7	381.7	

6 AS-BUILT DATA

Existing underground structures in the vicinity of Alternative F consist of current roadway stability structures along U.S. 101. No live or abandoned underground utilities are believed to be present. SI casing and VWPs are located within and adjacent to the current roadway section near where Alternative F joins U.S. 101.

Plans and/or details for Caltrans repair structures along the existing highway alignment dated between 2015 and 2021 were provided by Caltrans but the structures are not in the vicinity of the proposed OMC. As-built plans for the repair structures completed in 2023 along the existing highway at PM 15.48 are available from Caltrans.

7 CORROSION EVALUATION

Four soil/rock samples and one groundwater sample were collected at various locations of the Project and were tested for corrosion as shown in the following table.

Table 7-1. Preliminary Corrosion Test Results

Boring ID	Sample Depth (feet)	Sample Description	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)	Corrosive
RC-20-014	71.2 to 71.5	Sandstone with iron oxide Broken Formation	1,050	7.55	35.5	57.8	No
RC-20-019	251.6 to 251.9	Argillite interbed in Sandstone of Broken Formation	5,360	6.32	5.1	1.7	No
RC-21-001	30.0 to 31.5	Argillite/Earthflow	2,170	7.59	2.5	79.1	No
RC-20-015	128.8 to 129.0	Argillite below Earthflow	2,200	7.56	2.6	126.8	No
P-20-012	-	Groundwater	-	7.58	25	110	No

According to the Caltrans Corrosion Guidelines (Caltrans, 2021a), soils are considered corrosive if the pH is 5.5 or less, or chloride content is 500 parts per million (ppm) or greater, or sulfate content is 1,500 ppm or greater. Also, as stated in the Caltrans Corrosion Guidelines, a minimum resistivity value for soil and/or water less than or equal to 1,500 ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion.

Based on the corrosion test results and Caltrans criteria, the soil samples tested were not found to be corrosive to bare metals and concrete. The corrosion potential is based on limited data and may not be representative of the conditions at the OMC. It should be noted that the OMC facility is not within 1,000 feet of the ocean; therefore, according to Caltrans Corrosion Guidelines (2021a), the site is not in a marine atmosphere zone.

Section 90-1.02H Concrete in Corrosive Environments of the Caltrans Standard Specifications provides specification language for corrosion resistant concrete mix designs that address corrosive conditions.

8 SEISMIC INFORMATION

8.1 Ground Motion Hazard

The project site is susceptible to strong earthquake-induced ground motions during the design life of the proposed improvements. Since the OMC includes human occupancy structures, it should be designed in accordance with California Building Code (CBC, 2019) and the CBC seismic design criteria. In addition, the OMC is part of the Caltrans infrastructure and critical for operation of the tunnel, therefore some elements of the OMC may be designed in accordance with Caltrans seismic design criteria.

The seismic design criteria for the site in accordance with Caltrans and CBC criteria is provided in this section.

Caltrans Seismic Design Criteria

Following the procedures described in Caltrans Seismic Design Criteria Version 2.0 (SDC 2.0) (2019a) and October 2019 Interim Revisions to SDC 2.0 (2019b), the preliminary Acceleration Response Spectrum (ARS) curve for a 975-year Return Period was determined using the Caltrans ARS Online V3.0.2 (2021b) and utilizing the small-strain shear wave velocity for the upper 100 feet (V_{S30}) of the project site. The preliminary value of V_{S30} was estimated from the soil data of existing Boring RC-18-001 (approximately 150 feet north of the site), and the standard penetration test (SPT) correlations provided in the Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (Caltrans, 2012). The 2021 correlations described in Attachment 2 of Caltrans Geotechnical Manual – Design Acceleration Response Spectrum module (Caltrans, 2021c) were not adopted, because it was determined that they are not representative of the site conditions. In order to determine whether 2021 correlations are suitable for the site, the estimated shear wave velocity from these correlations were compared with available seismic refraction survey results near the same locations, as shown in the PGR (Caltrans, 2023b). The 2021 correlations tend to yield a lower V_{S30} value than direct shear wave velocity measurements from seismic refraction lines, while the 2012 correlations provide reasonably close results. Therefore, the 2012 correlations have been adopted for this site.

Preliminary site seismic parameters are listed in the following table.

Table 8-1. Preliminary Site Seismic Parameters

Structure	Tunnel Operations and Maintenance Center Building
Reference Boring(1)	RC-18-001
Site Geospatial Coordinates (latitude, longitude)(2)	41.616°, -124.107°
V_{S30} (m/s)	305

Notes:

(1) Based on Preliminary Geotechnical Data Report (Final) (Caltrans, 2022).
(2) Estimated from Google Maps and the current Geometric Approval Drawings.

Based on the Caltrans ARS Online V3.0.2 (2021b), the preliminary values of Peak Ground Acceleration (PGA), the deaggregated mean earthquake moment magnitude (M) for PGA, and the mean site-to-source distance (R) for 1.0 second period spectral acceleration are 0.87g, M8.64, and 20.0 km, respectively. The Ground Motion Data Sheets, presenting the preliminary ARS data, plots, and other relevant information are included in Appendix A.

According to the Caltrans Geotechnical Manual – Landslides module (Caltrans, 2020) and Caltrans Geotechnical Manual – Embankments module (Caltrans, 2014), a horizontal seismic coefficient (k_h) for seismic slope stability analysis may be equal to one-third of the PGA at the site. Therefore, a preliminary k_h value of 0.29 is recommended to estimate the seismic lateral earth pressure for the site proposed retaining walls.

California Building Code

The seismic design provisions of the California Building Code (2019) will be followed for buildings. Based on the soil data of the existing Boring RC-18-001, a site class type D was adopted to determine site coefficients.

The USGS Web Services tool (2021) and ASCE 7-16 standard were used to determine the short and long period spectral accelerations in accordance with the CBC/ASCE7-16 procedures. Preliminary ground motion parameters are shown in the following table.

Table 8-2. Preliminary Ground Motion Parameters

<table>
<tr><th colspan="2">Site Coordinates</th><th colspan="2">Site Classification/ Risk Category</th><th colspan="2">Site Coefficients</th><th colspan="2">Risk–Targeted MCE_R ARS Parameters</th><th colspan="2">Design Spectral Acceleration Parameters</th></tr>
<tr><td rowspan="2">Lat.</td><td rowspan="2">41.616°</td><td rowspan="2">Site Class</td><td rowspan="2">D</td><td rowspan="2">F_a</td><td rowspan="2">1.0</td><td>S_s</td><td>1.995 g</td><td>S_{MS}</td><td>1.995 g</td></tr>
<tr><td>S_1</td><td>0.938 g</td><td>S_{M1} [1]</td><td>1.595 g</td></tr>
<tr><td rowspan="2">Lon.</td><td rowspan="2">-124.107°</td><td rowspan="2">Risk Category</td><td rowspan="2">IV</td><td rowspan="2">F_v</td><td rowspan="2">1.7[1]</td><td rowspan="2">T_L</td><td rowspan="2">16 s</td><td>S_{DS}</td><td>1.33 g</td></tr>
<tr><td>S_{D1} [1]</td><td>1.063 g</td></tr>
<tr><td colspan="10">Note:
(1) See requirements for site-specific ground motions in Section 11.4.8 of ASCE 7-16.</td></tr>
</table>

8.2 Other Seismic Hazards

The proposed OMC facility is not located within 1,000 feet of any active faults as delineated by the Alquist-Priolo Earthquake Fault Zone (APEFZ) (CGS, 2007) or Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) model (USGS, 2013). Therefore, per Caltrans MTD 20-10 (2013) and Caltrans Geotechnical Manual – Fault Rupture module (2017), the site is not considered susceptible to surface fault rupture hazards, and no Surface Fault Rupture Displacement Hazard Analysis (SFRDHA) is needed.

Preliminary liquefaction potential analysis was performed, using the procedures outlined by Youd et al. (2001), and the blow counts and measured groundwater depths of existing Boring RC-18-001, extracted from the Summary of Phase 1 Geotechnical Investigation (Caltrans, 2018), and Preliminary Geotechnical Data Report (Final) (Caltrans, 2022). Due to the presence of fine-grained or dense materials below groundwater table, no liquefiable layers are identified. Therefore, the project site is not susceptible to liquefaction or related seismic hazards, including seismic total or differential ground settlement, and lateral spreading. However, according to the empirical method proposed by Tokimatsu and Seed (1987), dry sand settlement of about 4 inches may result from the top 7 feet subsurface materials during a design seismic event.

The project site is located within the earthflow complex; therefore, the site has potential for earthquake-induced slope instability. The structures will be designed for ground movement in order to minimize collapse potential and improve life safety as much as possible.

According to Caltrans MTD 20-13 (2010), the tsunami hazard is significantly reduced at locations beyond one-half mile of the coast or at elevations greater than 40 feet above mean sea level. The proposed building site is located about 0.27 miles from the nearest coastline. However, because the project site is situated at elevation above +350 feet (much higher than +40 feet), the risk for tsunami-related damage does not exist, per Caltrans MTD 2013. However, potential impact of tsunami on the global stability of the site will be evaluated.

9 PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

The OMC site would include a building, parking spaces, outdoor storage, and maintenance equipment. The building would be an approximately 12-foot-tall, 18,000-square-foot, single-story structure. It would contain equipment and other facilities related to tunnel maintenance, operations, and emergency response. It is anticipated the building roof would be planted (i.e., a "green" roof) to blend into the surrounding terrain.

Construction of the OMC would involve cutting into the hillside and regrading a portion of the existing highway to create an access road to the facility. It is anticipated that porous pavement would be used to filter stormwater. BMPs appropriate to site conditions and regulatory requirements will be used.

The building foundation loads are anticipated to be relatively low. Based on available information from VWPs, the preliminary assumption for the groundwater level depth is between 5 and 27 feet below the ground surface. There is no liquefaction potential, and the site is located within the earthflow complex. The proposed foundation system will be designed to maintain integrity of the supporting structure under a ground movement scenario, in order to prevent total collapse and maintain life safety.

According to the soil data from the existing Boring RC-18-001, the proposed foundations will be placed on gravelly silt, silty sand with gravel, or gravelly lean clay (colluvium).

Based on these considerations, appropriate foundation system alternatives are discussed in the following sections. It should be noted that these recommendations are based on limited soil data and may be modified and revised once additional soil data becomes available.

Due to deep-seated nature of the landslides at the site, a deep foundation system may not be the best alternative for this site. Rigid shallow foundations could provide better performance during ground movement and allow the structures to float over earthflow with less damage. The recommended foundation types for structure support are as follows:

- Post-tensioned Slabs: Stiff post-tensioned slabs can be used to support the proposed building structures. The slab will provide adequate stiffness to allow the supporting buildings to move as a monolithic structure with the earthflow.
- Stiff Reinforced Mat Foundations: A thick reinforced mat foundation or a mat foundation with rigid grade beams is another feasible foundation type for the buildings.

Per Chapter 18 - Soils and Foundations of the 2019 CBC, minimum footing embedment depth is 12 inches. A presumptive allowable vertical foundation pressure of 1.5 ksf and allowable lateral bearing pressure of 100 psf/ft can be used for preliminary design of spread footings. Allowable coefficient of friction for lateral sliding resistance is 0.25. These values can be increased by one-third when used with the alternative basic load combinations of Section 1605.3.2 of CBC 2019 that include wind or earthquake loads.

Preliminary maximum total settlement is estimated to be 2 inches, and the differential settlement can be assumed to be 50 percent of the total settlement. A modulus of subgrade reaction of 100 psi may be used for preliminary design of slabs. This value will be adjusted for the size of the loaded area.

Due to the limited soil data, presence of expansive soils beneath the footings cannot be ruled out. If further investigation indicates that expansive soils are present, the slabs will be designed for appropriate uplift pressure due to soil expansion.

Because of the expected settlement, differential settlement and horizontal movement at the subject site, flexible joints are recommended in all conduits for the OMC buildings and equipment.

Cut slopes up to 2H:1V gradient can be used for site grading. Slopes will be properly benched, and appropriate drainage and erosion control measures will be provided to prevent erosion and sloughing. The recommendations of Section 1808.7 of CBC 2019 regarding footing setback from descending slopes and clearance from ascending slopes will be followed for building structures.

Due to the existing ground slope, site grading and retaining walls will be utilized to achieve flat building pads for the structures. The proposed OMC site is almost entirely cuts into the slope on the north side of U.S. 101 highway. Retaining walls would be located around the OMC building and yard to retain the cut slopes and provide a grade break that allows the OMC facilities to be placed below the existing ground surface.

The site retaining walls are proposed to be constructed of reinforced concrete with heights up to 20 feet. Based on these assumptions, concrete cantilever walls similar to Caltrans standard walls can be used. However, it should be noted that site PGA is larger than 0.6g, and lateral earth pressures could be higher due to active earthflow at the site. Therefore, special design walls are likely to be needed for perimeter walls.

The exact dimension/configuration of the walls have not yet been developed. The OMC building construction is not intended to stabilize the deep landsliding (100+ ft deep). Wall design should be evaluated in more detail once there is more information on wall heights/configurations and better subsurface data.

Other wall types that can be considered include cantilever nongravity walls and anchored walls. Cantilever nongravity walls usually have deep embedment depths and are likely to perform poorly in an active earthflow situation. Anchored walls typically have shallower embedment depth, however, impact of active earthflow on anchor loads will be evaluated before considering these wall types. Mechanically stabilized earth (MSE) retaining walls can be considered for fill sections.

10 ADDITIONAL FIELD WORK AND LABORATORY TESTING

The proposed OMC site is approximately 350 feet long and 240 feet wide and includes about 800 feet of retaining walls. To supplement the existing subsurface data, we recommend drilling a total of eight (8) mud rotary/rock core borings. Four borings will be drilled within the footprint of the maintenance facility and office building in the north of the site, and one boring will be drilled in the area designated for the auxiliary structures in the south of the site. In addition, three borings will be drilled behind the retaining wall layout lines, on the west, north, and east of the site.

The proposed boring depth should extend at least 20 feet or three times the width of the footing (whichever greater) below the proposed shallow foundation base, with a minimum depth of 40 feet. Borings would include in-situ permeability testing and installation of instrumentation to monitor groundwater levels and landslide displacement.

Samples recovered during the field investigation will be transported to the laboratory for testing. All of the soil samples will be visually classified and moisture content/density tests will be performed. Additional samples will be selected for sieve analysis, No. 200 wash, corrosion, and direct shear and unconfined compression tests. Other laboratory tests such as Point Load Strength Index tests may be required, depending upon the nature of the soils and bedrock encountered during the investigation.

11 REFERENCES

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PLATES

PLOTTED: 15 Nov 2023, 8:59pm, DFahmey

CAD FILE: C:\Users\DFahmey\Downloads\20208000\ LAYOUT: 1a

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

CONSULTANT DESIGN MANAGER	CALTRANS DESIGN OVERSIGHT APPROVAL	REGISTRATION No.	LICENSE Exp DATE	DATE SIGNED

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON

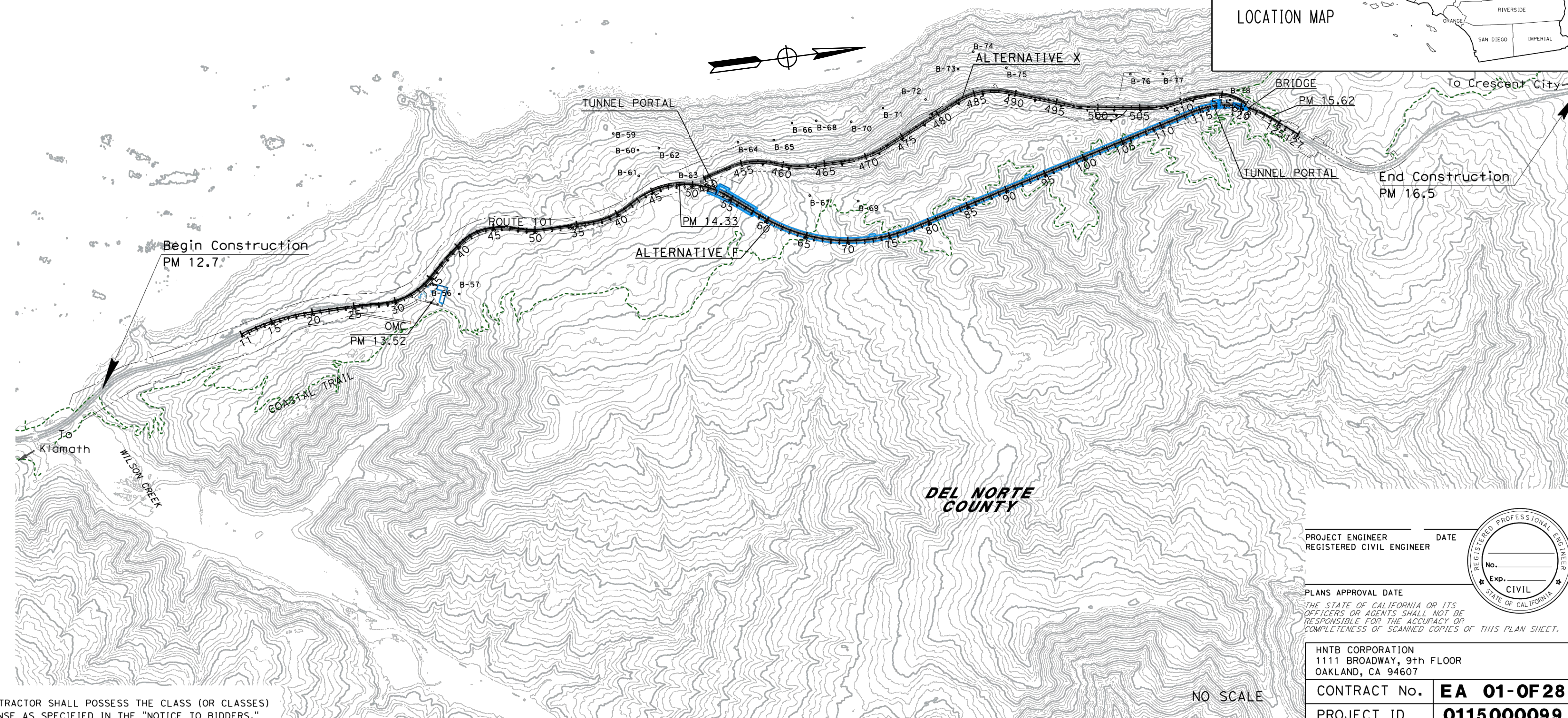
STATE HIGHWAY

IN DEL NORTE COUNTY
NEAR CRESCENT CITY
FROM WILSON CREEK BRIDGE TO
DAMNATION CREEK TRAILHEAD

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2018

GEOMETRIC APPROVAL DRAWINGS

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		



THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

PROJECT ENGINEER DATE
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
CIVIL
STATE OF CALIFORNIA

PLANS APPROVAL DATE

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HNTB CORPORATION
1111 BROADWAY, 9th FLOOR
OAKLAND, CA 94607

CONTRACT No.	EA 01-0F280
PROJECT ID	0115000099

DATE PLOTTED => 2023-10-19
TIME PLOTTED => 8:41:42 AM
LAST REVISION 00-00-00

BORDER LAST REVISED 10/4/2013 | CALTRANS WEB SITE IS: HTTP://WWW.DOT.CA.GOV/ | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => bwong DGN FILE => 0115000099ab001.dgn | UNIT 0000 | PROJECT NUMBER & PHASE 00000000000

REFERENCE:
"STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION, PROJECT PLANS FOR CONSTRUCTION ON STATE HIGHWAY IN DEL NORTE COUNTY NEAR CRESCENT CITY FROM WILSON CREEK BRIDGE TO DAMNATION CREEK TRAILHEAD, GEOMETRIC APPROVAL DRAWINGS," CONTRACT NO. EA 01-0F280, PROJECT ID 0115000099, DATED 10/26/2023.

LAST CHANCE GRADE PERMANENT RESTORATION PROJECT STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL NOVEMBER 2023	GEOMETRIC APPROVAL DRAWINGS Cover Sheet	PLATE 1a

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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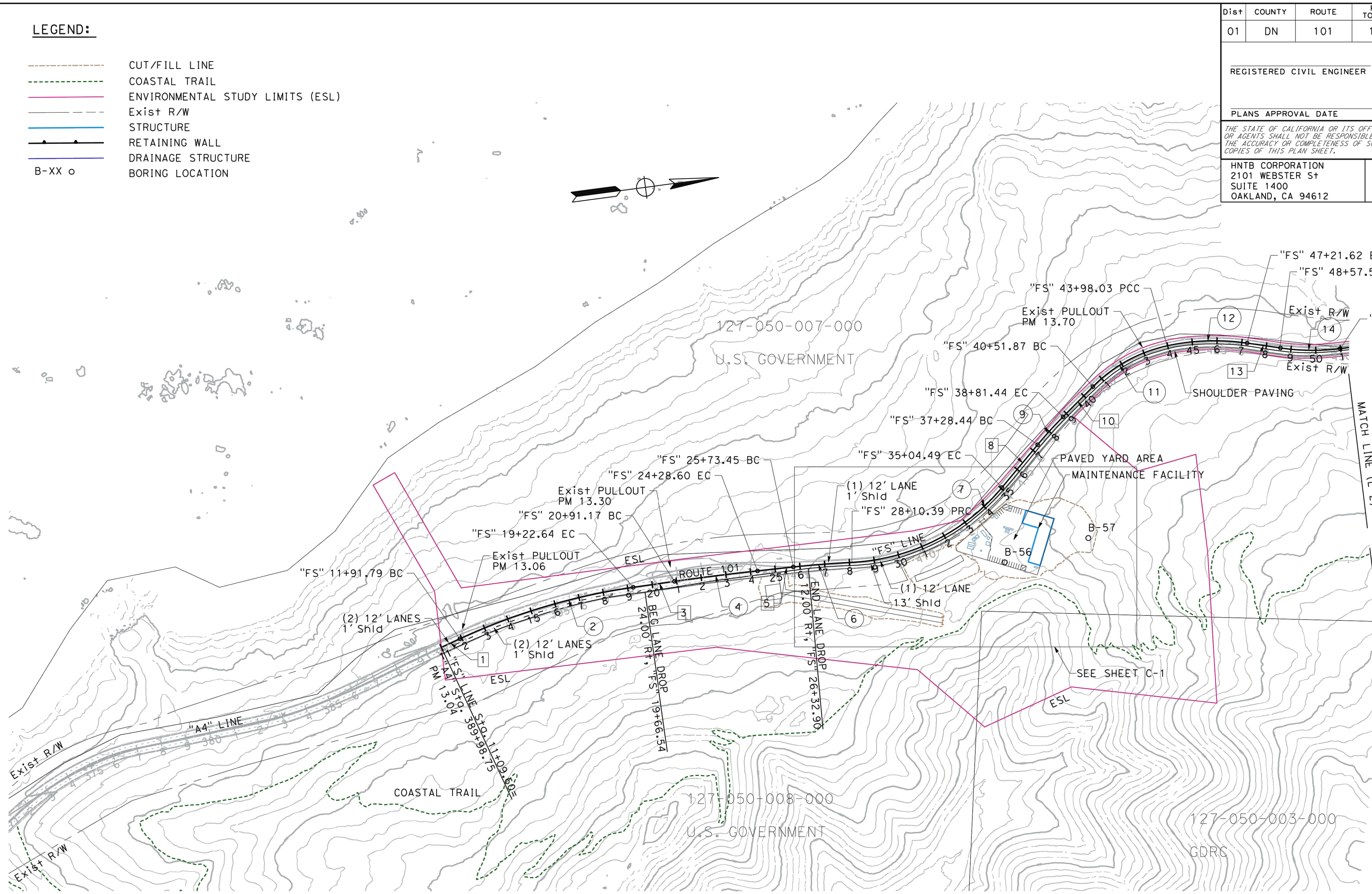
OAKLAND, CA 94612



LINE DATA

No.	LENGTH	DIRECTION
1	82.19	N 24°54'50" W
3	168.53	N 8°09'51" W
5	144.85	N 6°13'51" W
8	224.38	N 50°10'51" W
10	170.43	N 45°19'29" W
13	135.91	N 8°19'55" E

CURVE DATA

No.	R	Δ	T	L
2	2500.00	16°44'59"	368.05	730.85
4	10000.00	1°56'00"	168.73	337.42
6	4000.00	3°23'38"	118.51	236.95
7	840.00	47°20'38"	368.24	694.10
9	1800.00	4°51'22"	76.33	152.56
11	600.00	33°03'22"	178.05	346.16
12	900.00	20°36'02"	163.56	323.59
14	900.00	15°21'54"	121.41	241.35

LAYOUT

ALTERNATIVE F

SCALE: 1" = 200'

L-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY | CHECKED BY

REVISED BY | DATE REVISED

LAST REVISION 00-00-00 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

BORDER LAST REVISED 7/2/2010

USERNAME => $USER
DGN FILE => $REQUEST

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

PLOTTED: 15 Nov 2023, 8:59pm, DFahmey

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LAST CHANCE GRADE PERMANENT RESTORATION PROJECT
STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL
NOVEMBER 2023

GEOMETRIC APPROVAL DRAWINGS
Sheet L-1

PLATE
1b

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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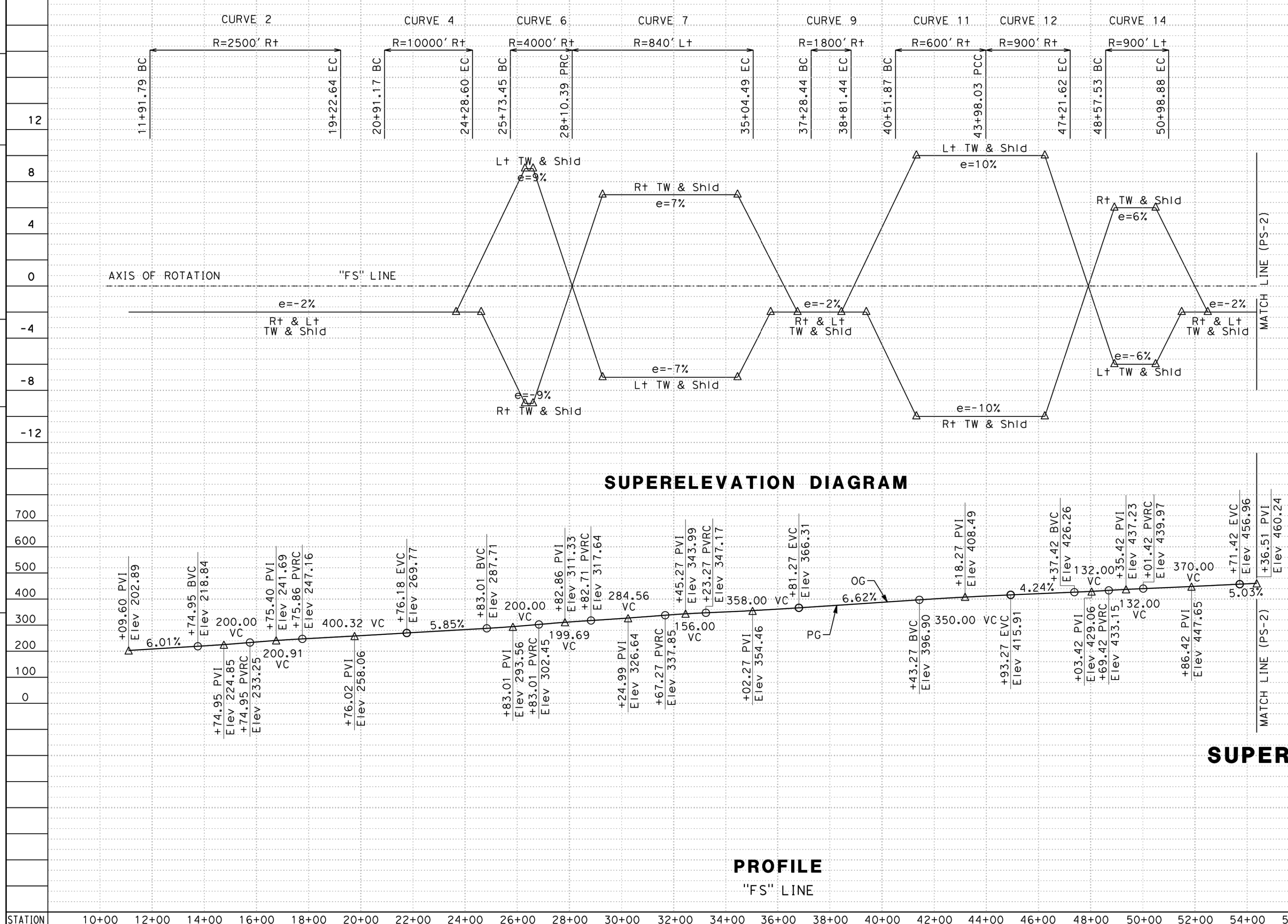

PROFILE AND SUPERELEVATION DIAGRAM

ALTERNATIVE F

SCALE: Horiz 1" = 200'
Vert 1" = 200'

PS-1

BORDER LAST REVISED 7/2/2010

USERNAME => $USER
DGN FILE => $REQUEST

RELATIVE BORDER SCALE IS IN INCHES

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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LAST CHANCE GRADE PERMANENT RESTORATION PROJECT
STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL
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GEOMETRIC APPROVAL DRAWINGS
Sheet PS-1

PLATE
1c

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LEGEND:

- CUT/FILL LINE
- COASTAL TRAIL
- ENVIRONMENTAL STUDY LIMITS (ESL)
- Exist R/W
- STRUCTURE
- RETAINING WALL
- B-XX o BORING LOCATION
- PROPOSED CONTOURS
- DRAINAGE STRUCTURE
- V-DITCH / DIRECTION OF FLOW

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
01	DN	101	12.7/16.5		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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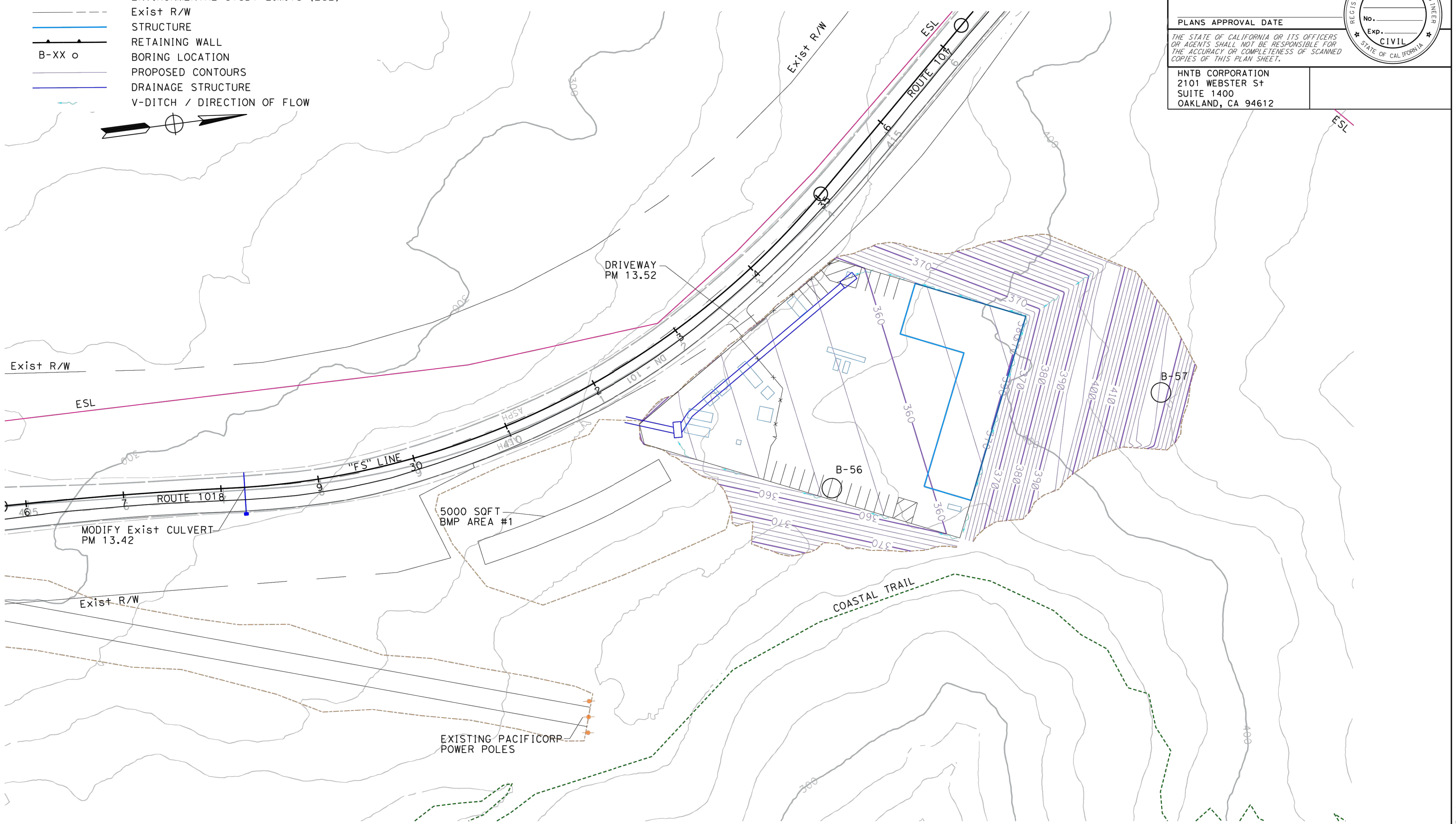

CONSTRUCTION DETAIL

ALTERNATIVE F

SCALE: 1" = 50'

C-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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TIME PLOTTED => $TIME
LAST REVISION 00-00-00

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REFERENCE:
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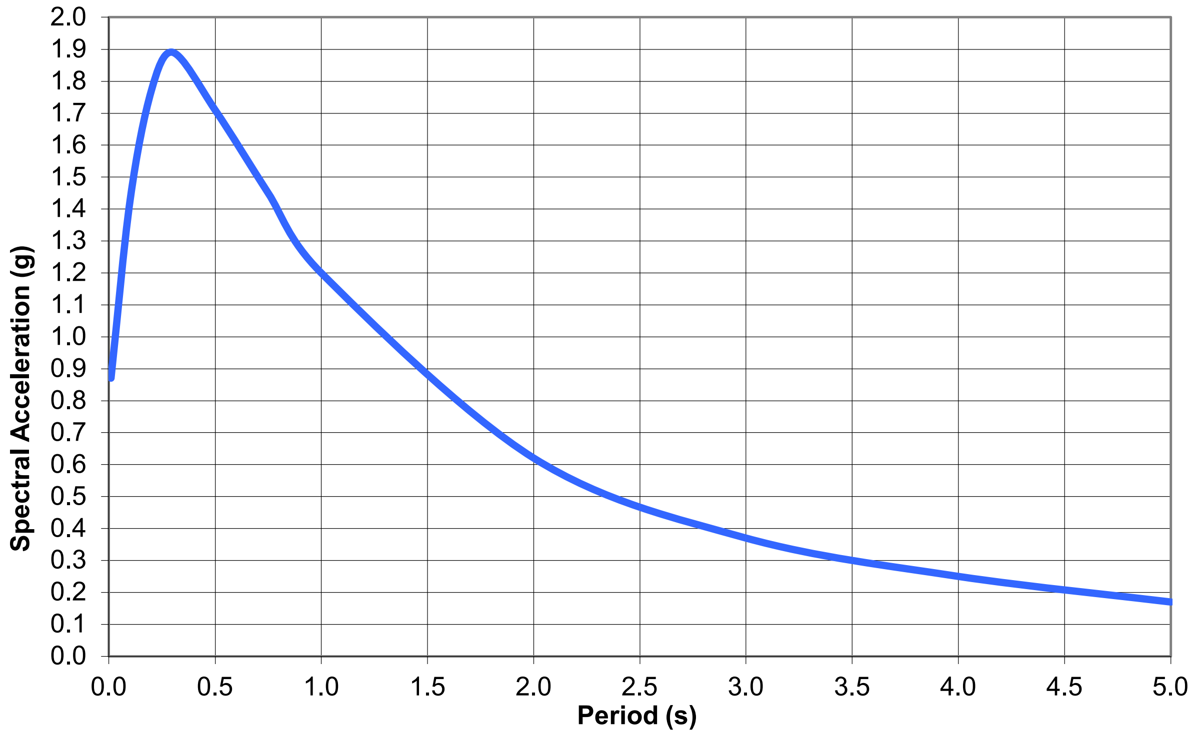
LAST CHANCE GRADE PERMANENT RESTORATION PROJECT
STRUCTURE PRELIMINARY GEOTECHNICAL REPORT - FINAL
NOVEMBER 2023

GEOMETRIC APPROVAL DRAWINGS
Sheet C-1

PLATE
1d

APPENDICES

APPENDIX A Preliminary Design Acceleration Response Spectra



Preliminary ARS Curve (5% Damping)

Caltrans ARS (V3.0.2) (Vs30 = 305m/s = 1,001ft/s)

Return Period = 975 Years

Latitude: 41.6160 Longitude:-124.1070

Peak Ground Acceleration (PGA) = 0.870g

Mean earthquake moment magnitude (M) for PGA = 8.64

Mean Site-to-Source Distance (R) for S1 = 20.0km = 12.4ml

Spectral Coordinates:

Period (sec)	**Acc.** (g)
0.01	0.870
0.10	1.430
0.20	1.770
0.30	1.890
0.50	1.710
0.75	1.450
1.00	1.200
2.00	0.620
3.00	0.370
4.00	0.250
5.00	0.170

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Project Number : 20-103 | Date: Nov, 2023

Last Chance Grade Permanent Restoration Project
Alternative F Tunnel Operations and Maintenance Center

Preliminary ARS Curve

Figure --