8 GEOTECHNICAL

8.1 General
The Design-Builder shall perform all Work necessary to meet the requirements of subsurface exploration, geotechnical analysis, design, and construction in accordance with the requirements of the Contract Documents.

8.2 Administrative Requirements
8.2.1 Standards
The Design-Builder shall perform the geotechnical work in accordance with the manuals and documents listed in Book 3. In the event of a conflict among the standards set forth in Book 3, the order of precedence shall be as set forth below, unless noted otherwise:

<table>
<thead>
<tr>
<th>Agency</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrans</td>
<td>California Amendments to the AASHTO LRFD Bridge Design Specifications</td>
</tr>
<tr>
<td>AASHTO</td>
<td>LRFD Bridge Design Specifications, 4th Edition</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Seismic Design Criteria</td>
</tr>
<tr>
<td>AASHTO</td>
<td>LRFD Bridge Design Specifications, 5th Edition</td>
</tr>
<tr>
<td>AASHTO</td>
<td>Guide Specifications for LRFD Seismic Bridge Design</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Bridge Memo to Designers</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Corrosion Guidelines</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Soil and Rock Logging, Classification, and Presentation Manual</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Guidelines for Preparing Geotechnical Design Reports</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Foundation Report Preparation for Bridges</td>
</tr>
<tr>
<td>Various</td>
<td>Special Provisions</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Standard Plans</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Standard Specifications*</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Bridge Construction Records and Procedures Manual, Volume 1</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Bridge Construction Records and Procedures Manual, Volume 2</td>
</tr>
<tr>
<td>Caltrans</td>
<td>California Test Methods (CTM)</td>
</tr>
<tr>
<td>AASHTO</td>
<td>Standard Specifications for Transportation Materials and Methods of Sampling and Testing</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society of Testing and Materials (ASTM) Standards</td>
</tr>
<tr>
<td>FHWA</td>
<td>Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications</td>
</tr>
<tr>
<td>AASHTO</td>
<td>Manual on Subsurface Investigations</td>
</tr>
<tr>
<td>AASHTO</td>
<td>Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations, R-8</td>
</tr>
<tr>
<td>FHWA</td>
<td>Subsurface Investigations – Geotechnical Site Characterization Reference Manual for NHI 132031</td>
</tr>
<tr>
<td>FHWA</td>
<td>Geotechnical Instrumentation</td>
</tr>
</tbody>
</table>
8.2.2 Software Requirements

The Design-Builder shall use gINT (version 8 or higher) or a compatible computer program to develop and maintain an electronic database of subsurface information and to produce 8.5-inch x 11-inch Boring Records.

8.2.3 Equipment Requirements

All field and laboratory equipment used for this Project, including Electronic Cone Penetrometers (CPTs), Pile Dynamic Analysis (PDA) and pile load cells shall be calibrated within the 12 months period prior to the use on the Project.

All instruments for measuring vibrations shall be capable of measuring, recording, and producing an electronic file and hardcopy printout of the frequency and peak particle velocity in three mutually perpendicular axes. Vector-sum instruments are not allowed. The instruments must also be capable of measuring and recording the frequency and displacement of each vibration event.

Standard Penetration Test (SPT) hammers must be tested for energy efficiency within 12 months prior to use on the Project, and with energy efficiency ratio reported in the boring logs and boring records.

8.2.4 Personnel Requirements

The Design-Builder shall provide a Project geotechnical team that includes at least one Professional Geotechnical Engineer (GE) and at least one Certified Engineering Geologist (CEG), both licensed in the State of California. The geotechnical team shall have experience in the exploration, analysis, design, and construction of the following Project related elements, at a minimum:

- Department LRFD methodology for bridge foundations, earth retaining systems, and other highway facilities
- Bridge structures and foundations of the magnitude and type that will be used
- Planning and conducting subsurface exploration for highway structures and other facilities
- Site-specific geologic, seismic, and geotechnical hazard evaluation
- Site characterization, including the development of design soil/rock profiles with relevant properties for the purpose of foundation type and size selection, analysis, design, and construction
- Analysis and design of structure foundations for static as well as dynamic (seismic) loading
- Soil-foundation-structure interaction (SFSI) analysis

The geotechnical team leader must be a Professional Geotechnical Engineer (GE) licensed in the State of California. The team leader must have a minimum of eight years of recent experience in the above matters relating to geotechnical subsurface exploration; geotechnical analysis; design; and construction of bridge foundations and retaining walls.

The Design Builder shall provide a designated Geotechnical Engineer of Record (GEOR) at all times during the duration of the Project. The GEOR must be registered with the State of California both as a Professional Civil Engineer (CE) and as a Geotechnical Engineer (GE).

The GEOR shall be in responsible charge for all geotechnical work, and perform or directly oversee all geotechnical Work, and sign or co-sign and stamp all geotechnical related design, analysis, Released For Construction Documents, Change Orders, As-Built Documents and other related documents. The team leader can be the GEOR but the GEOR must have a minimum of eight years of recent experience in the above matters relating to geotechnical subsurface exploration; geotechnical analysis; design; and construction of bridge foundations and retaining walls.

### 8.2.5 Certification Requirements

The Design-Builder shall perform all laboratory tests and testing equipment calibration at a Caltrans-certified facility for the geotechnical tests and equipment calibration required by this Section 8.

### 8.2.6 Definitions

The term “AASHTO LRFD Bridge Design Specifications, 4th Edition, with California Amendments” shall mean the requirements contained in the AASHTO LRFD Bridge Design Specifications, 4th Edition as amended by the Caltrans California Amendments to the AASHTO LRFD Bridge Design Specifications. If the Caltrans California Amendments to the AASHTO LRFD Bridge Design Specifications do not contain a modification or amendment to AASHTO LRFD Bridge Design Specifications, 4th Edition for a given section, then the Design-Builder shall meet the unmodified requirements in AASHTO LRFD Bridge Design Specifications, 4th Edition. Interims to the AASHTO LRFD Bridge Design Specifications, 4th Edition are included via the Caltrans California Amendments to the AASHTO LRFD Bridge Design Specifications.

### 8.3 Design Requirements

Soil boring information and test data for the Project are provided in Exhibits 2-8-A through 2-8-E and Exhibits 2-8-G through 2-8-I. The groundwater samples in Book 2, Section 4, Exhibit 2-4-B noted as “GW” are taken from the corresponding boring number noted as “SB” in Exhibit 2-8-E (e.g., groundwater sample GW-6 and soil sample SB-6 are both from boring No. 6). This boring information shall be considered part of the Contract Documents only to the extent that they are used to represent soil conditions at the time of drilling at the depths indicated within the respective borings drilled at the approximate locations shown. Presentation of this information in no way implies that subsurface conditions are the same at other locations and different times.

### 8.3.1 Supplemental Subsurface Investigations

The Design-Builder shall conduct supplemental subsurface investigations and geotechnical analyses and designs, as necessary, to supplement information provided by the Port in this Section 8 to meet minimum Project requirements and to substantiate the Design-Builder’s design and construction of the Project.
minimum, subsurface information used by the Design-Builder for the Project, regardless if provided by the Port or collected by the Design-Builder, shall be adequate to analyze the deformation or settlement and stability of the constructed facilities, and when necessary for adjacent structures or facilities, during both construction and service periods.

8.3.1.1 General Requirements

Foundation subsurface investigations refer to exploratory geotechnical soil borings and field tests, including Standard Penetration Tests (SPTs), Cone Penetration Tests (CPTs), ground penetrating radar, other in-situ soil testing methods, and laboratory soil tests conducted to support the analysis, design, and construction of the foundations of the Project structures such as bridges, earth retaining walls, buildings, sign posts, and large culverts, and to prevent damage to existing adjacent structures, Utilities, and other facilities or properties. If the Design-Builder chooses or needs to supplement the subsurface information provided by the Port, the Design-Builder shall select the locations and methods of foundation subsurface investigations on the basis of field observations including topography, access limitations, review of the subsurface information provided, proposed structure support locations, anticipated subsurface conditions, seismic hazard evaluation, types, sizes and/or lengths of foundation elements and their design methodology and construction considerations, and the criteria specified in Table 8-1.

The Design-Builder shall perform sufficient land surveying work to identify the location of the soil borings within 1 foot horizontally and 0.1 foot vertically.

The Design-Builder shall prepare a Geotechnical Task Execution Plan for the Project. The Geotechnical Task Execution Plan shall identify the required geotechnical scope of work the Design-Builder plans to complete for the design and construction of the Project. This report shall include evaluation of the need, locations, and types of additional subsurface investigation(s) and discuss the requirements of the Contract Documents as they apply to the specific situation.

The Geotechnical Task Execution Plan shall discuss, at a minimum, the following aspects:

- A study of existing and preliminary plans and temporary staging plans
- An on-Site inspection and documentation of the access limitations, if any, and the presence of structures and others facilities to remain adjacent to the proposed construction locations, and the anticipated effects of construction, if any, on the adjacent structures, and the method of analysis and evaluation with soil parameter requirements
- A review of available existing subsurface investigation information applicable to the Project
- A review of the potential geologic, seismic, and geotechnical hazards, and the data needed by the Design-Builder for their evaluation
- A review of the design performance and stability requirements for the LRFD Service, Strength, and Extreme Event Limit States for the Project structures
- A review of the applicable design performance and stability requirements for other elements of the Project, including roadways, embankments, and slopes
- An assessment of the potential foundation loads, locations, types, sizes, depths of embedment, method of analysis and design, and construction methods and considerations
- An assessment of the geotechnical data needed to perform foundations analysis and design, to evaluate construction issues, and to design and implement mitigation measures, if necessary
- Anticipated soil-foundation-structure interaction analysis and data needs
- Others potential Site, structure, or improvement-specific geotechnical elements, design and construction issues and the geotechnical data needed for their analysis, evaluation, and design and implementation of mitigation measures when necessary
- Planning the field investigation and laboratory testing program
• Obtaining soil and/or rock samples and performing field tests, when appropriate
• Methods of measuring and recording groundwater levels
• Methods of preparing field and final boring logs to document all subsurface investigation and soil testing information

This Geotechnical Task Execution Plan shall also include:
• A diagram showing the various field exploration and laboratory testing sub-tasks and their schedule
• A diagram showing planned exploration locations and methods
• Planned geotechnical evaluation, analysis and design methodologies, tasks and their schedule
• Planned instrumentation and monitoring programs, if any
• A list of geotechnical sub-task completion milestones and meetings the Design-Builder will require that are associated with each milestone

The Design-Builder shall review, at a minimum, the above information to ascertain alignment, site topography, locations of bridge abutments and bents, profiles of proposed bridges, footing elevations, approach embankments, locations of retaining walls, locations of Utilities in the vicinity of the proposed investigations, and general locations of structures relative to existing roads and waterways.

The Design-Builder shall conduct an on-Site inspection that includes a geotechnical engineering reconnaissance of soil and geologic conditions existing at the Site. The Design-Builder shall review the contemplated effect of the proposed construction on the Site. The Design-Builder shall record notes on performance of existing embankments in the immediate vicinity, differential settlement, foundation failures, active landslides, bedrock exposure, limits of questionable foundation areas, stability of adjacent earth or manmade masses, and possible damage to existing structures and facilities. The possible locations of supplemental investigations should be documented during the field reconnaissance study. The Design-Builder shall review all background information prior to selecting the final locations, types, and extent of field and laboratory explorations.

The Design-Builder shall schedule a meeting within ten Days of the initial submittal of the Geotechnical Execution Plan to present the geotechnical concept, the geotechnical needs of the Project, the draft Geotechnical Execution Plan, and the meeting schedule.

Once comments to the initial Geotechnical Task Execution Plan and comments from the meeting have been addressed, the Design-Builder shall resubmit the Geotechnical Task Execution Plan.

8.3.1.2 Project-Specific Foundation Subsurface Investigation Requirements

Supplemental Borings by the Design-Builder

The Design-Builder shall selectively locate supplemental foundation borings on the basis of field observations, design considerations, and the criteria specified in Table 8-1. Location of borings shall be as Site conditions, including but not limited to, topography, existing developments both above and below ground, soil subsurface conditions, and design factors dictate; however, to be considered representative for the subsurface conditions of a structure foundation, the number of supplemental borings required in Table 8-1 shall be located within the footprint of the pile cap or foundation.

If a supplemental boring cannot be located within the pile cap or foundation footprint, it shall be located no further than 30 feet horizontally from the nearest proposed edge of the structure pile cap or foundation limit. Any boring located outside the pile cap or foundation limits specified are subject to the Port’s review and Acceptance as representative to the subsurface conditions of the foundation proposed by the Design-Builder. The Design-Builder shall prepare justification for not being able to obtain a boring within the footprint of the pile cap or foundation limit in the Geotechnical Task Execution Plan. Justification shall include discussion on subsurface conditions encountered in the existing borings, the proposed foundation locations and types, at a minimum.
A sufficient number of soil samples shall be collected by the Design-Builder and tested to adequately characterize and evaluate the relevant engineering properties of the subsurface soil units extending at least 2B or 20 feet, whichever is greater, below the lowest pile cap or pile tip elevation. The variable “B” shall be taken as the width (or diameter) of the pile cap, foundation or foundation group(s) when acting as a unit or with overlapping stress zones.

Borings Provided by the Port

The Design-Builder may use Port-provided exploration borings as long as they are within 30 feet horizontally from the nearest proposed edge of the pile cap or foundation limit for which they will be used.

General

The combination of Port-provided exploration borings and Design-Builder supplemental borings shall meet the minimum requirements specified herein and the minimum criteria in Table 8-1. CPT sounding holes may be used to supplement, but not to substitute, a boring needed to meet the requirements specified herein.

For single deep foundations supports (driven or cast-in-drilled-hole), if any, one exploratory boring shall be located within 30 feet from the center of the deep foundation (driven or cast-in-drilled-hole).

For the purposes of deciding if a provided boring is within the distance limits stated above, the Design-Builder shall use the station and offset location provided for each boring, if available.

<table>
<thead>
<tr>
<th>Pile Cap and Foundation Support Type</th>
<th>Minimum Number of Borings per Pile Cap or Foundation</th>
<th>Boring Locations</th>
<th>Minimum Boring Depth</th>
<th>Required Boring Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Span Bridge tower pile caps</td>
<td>Five</td>
<td>Exterior corners and the center of the pile cap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge pile caps with longest plan dimension &gt; 100 feet</td>
<td>Two</td>
<td>Exterior of pile cap at the center of shortest plan dimension of the pile cap</td>
<td>As required per standards (3)</td>
<td>Rotary Wash</td>
</tr>
<tr>
<td>Bridge pile caps on shallow foundation (3)</td>
<td>One</td>
<td>Center of pile cap or deep foundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge pile cap on deep foundation (3)</td>
<td>One</td>
<td>Space approximately 100-200 ft. Space at or near 1/3 points if wall length &lt; 200 ft. At or near mid-point for wall length &lt;100 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retaining wall with deep foundation</td>
<td>Wall length in feet divided by 200. At least one per wall for wall length &lt;100 feet. Two if 100 ft &lt; wall length &lt; 200 ft</td>
<td>Space approximately 100-200 ft. Space at or near 1/3 points if wall length &lt; 200 ft. At or near mid-point for wall length &lt;100 ft.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retaining wall with shallow foundation</td>
<td>Variable</td>
<td>Take borings on 200-ft grid pattern.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embankment fill with fill heights &gt; 5 ft.</td>
<td>Culvert length in ft divided by 100. Two if length &lt; 100 ft.</td>
<td>Under roadway or as needed to define subsurface condition.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culverts greater than 30 inch span or diameter</td>
<td>Culvert length in ft divided by 100. Two if length &lt; 100 ft.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8.3.1.3 Project-Specific Roadway Subsurface Investigation Requirements

The Design-Build shall obtain a sufficient number of borings, with sufficient depths, to determine the following:

- R-value of the subsurface material within 5 feet of the bottom of any pavement structure
- Foundation soil deformation and strength parameter for both static and seismic design
- Soil liquefaction and related hazards
- Settlement of embankments and retaining walls
- Static and seismic stability of embankments and retaining walls
- To enable the preparation of the soils related reports

For a pavement section placed directly on existing ground, in a cut section, or when fill heights are less than 5 feet, the Design-Build shall take borings to a minimum depth of 5 feet below the bottom of the proposed pavement surface or 5 feet below the existing ground surface, whichever is lower, and determine the California R-Value. Borings shall be taken in a sufficient number to determine the soil profile, parameters, and type to show the required California R-Value will be achieved under all pavement surfaces. At a minimum, borings shall be taken every 200 feet along the proposed alignment. On divided highways, the borings on the two roadways can be staggered, resulting in 200-400 foot spacing along each alignment.

In fill under the pavement influence area determined by 1:1 slopes from the edges of pavement surfaces, the Design-Build shall use fill material having a minimum California R-Value of 15.

Where soils are encountered that are considered unsuitable for roadway embankment construction, the Design-Build shall follow the requirements of the Standards.

8.3.2 Geotechnical Subsurface Exploration

8.3.2.1 Drilling

The Design-Build shall perform drilling, sampling, and field testing in accordance with ASTM and other applicable Standards.

8.3.2.2 Cone Penetration Test

The Design-Build shall perform Cone Penetration Tests (CPT) in accordance with ASTM D5778. Data to be collected includes raw and corrected tip resistance, side friction, and excess pore water pressure. This data must be collected electronically and presented in graphical format that includes adequate interpretation of the types, conditions and relevant engineering characteristics of the encountered subsurface materials.

8.3.2.3 Borehole Site Cleanup

The Design-Build shall backfill boreholes, after drilling or CPT sounding, in accordance with the applicable State and local agency requirements. Unless required otherwise by the controlling agency, holes shall be backfilled with a cement bentonite grout mix or bentonite hole-plug in a manner that prevents subsequent settlement hazardous to persons, animals, or equipment. If a borehole penetrates pavement, the Design-Build shall restore the pavement to a condition equal to or better than that existing before the boring, using pavement materials that match the existing materials. Upon completion of the field...
in investigation, the Design-Builder shall remove all surplus material, temporary structures, and debris on land and water resulting from the field investigation. The Design-Builder shall leave the premises in a neat, orderly condition. The Design-Builder shall restore any areas disturbed during boring operation in the kind and character existing before the Work was started.

8.3.2.4 Geotechnical Laboratory Test
The Design-Builder shall perform tests in accordance with the applicable California Test Methods (CTM), AASHTO, and American Society for Testing and Materials (ASTM) Standards.

8.3.2.5 Sample Retention and Transfer
The Design-Builder shall store all samples until after Final Acceptance per the Standards after required tests and analyses are completed. The Port shall be given access to these samples at any time to these samples.

8.3.3 Geotechnical Instrumentation Plan
8.3.3.1 Geotechnical Instrumentation Plan
The Design-Builder shall develop, implement, and maintain a Geotechnical Instrumentation Plan. All geotechnical instruments shall be installed and monitored by the Design-Builder. Any instruments damaged during construction and requiring removal and/or recalibration shall be replaced and/or recalibrated by the Design-Builder.

For each recommended instrument type, the Design-Builder shall show locations, installation procedures and requirements, zones of influence, critical or limiting readings, frequency of readings, threshold settlement or other movement criteria, and procedures to modify construction methods should threshold criteria be exceeded.

The Design-Builder shall install geotechnical instrumentation where necessary to monitor such parameters as the following to protect structures, tunnels, Utilities, and other features within the zone of influence of construction:

- Vibrations from construction activities
- Real-time settlement and tilt monitoring of structures
- Settlement and settlement rates of embankments, walls, structures, tunnels, Utilities, and other features within the zone of influence of construction
- Lateral movement or heave of soil
- Stability of walls and slopes
- Pore water pressures
- Groundwater levels
- Integrity and movement of excavated faces and supported structures, if any

8.3.4 Vibration Monitoring and Control Requirements
Wherever vibration-producing activities could affect a structure, building, or Utility, the Design-Builder shall prepare a Vibration Monitoring and Control Plan that address the potential impacts to nearby receptors due to construction or demolition activities associated with this Project. The term “receptor” includes buildings, structures, Utilities, dikes, and sensitive operations/processes for which construction impacts or operations above recommended limits may be detrimental. The plan shall include ground and air-blast vibration threshold limits.

Approval of the plan will be based on appropriateness only, and does not guarantee that damage will not be caused by construction activities, nor does it relieve the Design-Builder from responsibility should damage occur. The plan shall address how the Design-Builder intends to complete vibration-related activities and meet the following minimum requirements:
1. Develop a list of all anticipated vibration producing activities and where they are expected to occur.
2. Develop a list of all potentially impacted receptors from these activities.
3. Provide a vibration susceptibility analysis for each identified receptor, and establish a vibration control limit to preclude damage, including threshold damage, to each of the identified receptors. Threshold damage is defined in this Contract as the loosening of paint, small plaster cracks at joints between construction elements, or the lengthening of old plaster cracks.
4. Provide a plan for notifying the public of potential vibration impacts, responsible project personnel, receptors requiring precondition surveys, and vibration monitoring activities.
5. Monitor construction related vibrations at the nearest and most critical receptor(s), and notify appropriate project personnel immediately if established vibration limits are exceeded.
6. The instrumentation locations, monitoring procedures, and a description of the monitoring devices and/or manufacturers’ brochures shall be included in the submitted plan.
7. The Design-Builder shall assess any sensitive community or business operations that may be affected by vibrations.
8. Provide recommendations for vibration-limiting methods to meet the established maximum safe vibration levels. Methods may include: pile driving pre-boring, drilled shafts, micropiles, spread footings, or other alternate foundation types as needed to meet vibration limitations.

The Design-Builder shall include the following in their list of receptors:
- Bridge pile caps, including the existing Gerald Desmond Bridge (Bridge No. 53C-0065)
- Utilities, including the 42-inch Conoco Phillips petroleum line near Ocean Boulevard “A” Line Station 274+25
- Wells and associated Utilities
- Storage tanks
- Dikes, including elements that make up the dike system
- Buildings
- Newly constructed elements

### 8.3.4.1 Vibration Susceptibility Analysis

The Design-Builder shall assess the condition of all identified receptors, including any sensitive operations that may be affected by vibrations. The Design-Builder shall establish maximum vibration levels that will prevent damage to structures or undue disturbance to operations. These maximum vibration levels shall be used as vibration limits for the Project. The Design-Builder is referred to the current standard of AASHTO Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations, R-8 for guidance. Unless different vibration monitoring criteria is provided by Utility Owners, the Design-Builder shall set maximum vibration levels for each receptor and the maximum vibration levels shall not be less stringent than those set forth in the AASHTO Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations, R-8, Figure 1, and the levels included in Table 8-2 below. The vibration criteria shall be expressed in peak particle velocity in inches per second (ips) and frequency in Hertz (Hz). The Design-Builder shall determine the maximum vibration levels and other relevant criteria in close coordination with the Owner of a receptor.

<table>
<thead>
<tr>
<th>Structure and Condition</th>
<th>Maximum Peak Particle Velocity (inches/second)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transient Sources</td>
</tr>
<tr>
<td></td>
<td>Continuous/Frequent Intermittent Sources</td>
</tr>
</tbody>
</table>

Table 8-2: Guideline Vibration Damage Potential Threshold
8.3.4.2 Notification

The Design-Builder shall provide the following information to the Port via the Design-Builders Public Information Liaison (PIL) potentially affected by ground vibrations which could include contact a household, building occupant, institutional and property owner and operator, Utility Owner, or business establishment. The Design-Builder shall provide this information to the Port a minimum of 12 Days prior to any activities producing vibrations. The Port will request receipt of notification from the receptor owners and provide to the Design-Builder. The Design-Builder shall not begin any pile-driving, or any other Work, that produces perceptible ground vibration until such time they have been informed by the Port that the Port has received the receptor owners receipt of notification.

The Design-Builder shall supply the Port the following, at a minimum, for each receptor:

- Description and schedule of the proposed construction
- Explanation of the potential for producing vibrations
- Steps the Design-Builder will take to avoid potential damage from those vibrations, and the maximum vibration levels
- Name and telephone number of a contact person to respond to any questions or concerns
- An overall list of structure, building, and Utility locations and the buildings’ occupants, institutional and property owners and operators, Utility Owners and businesses with whom the Port will be required to make contact to notify them of the potential for construction-induced vibrations.

8.3.4.3 Inspection and Documentation

Prior to construction, the Design-Builder shall inspect and video-record the existing condition of all structures and property surrounding structures deemed receptors. This includes video-recording both the inside and outside of existing structures. The Design-Builder shall coordinate the date and time of the inspections with the Port, the owner (or their representative) of the receptor, and the structure or property owner at least 10 Days in advance.

The Design-Builder shall provide all materials, labor, and equipment necessary for performing a video inspection. The Design-Builder shall use high-quality, color, DVD-format equipment that allows both audio and video information to be recorded. DVD recordings shall not be edited. Control pan and zoom rates shall ensure playback clarity and provide lighting for the camera if necessary. Audio commentary shall be
provided as necessary during filming to document existing conditions. Special consideration shall be given to any existing structural defects, including measurement of any crack lengths and widths.

The Design-Builder shall complete a Post-Construction DVD inspection after all construction affecting a receptor is complete. This Post-Construction DVD inspection shall be completed following the same procedure as for the Pre-Construction DVD inspection.

8.3.4.4 Vibration Monitoring Personnel Requirements

The Design-Builder shall provide personnel with the following qualifications to conduct the vibration monitoring requirements.

1. Submitting of execution, instrumentation and monitoring plans and daily Construction Vibration Reports, overseeing installation of the vibration monitoring equipment and interpretation of vibration monitoring data shall be performed by personnel with the following qualifications:
   - Professional Engineer licensed in the State of California.
   - Minimum of five years experience in the vibration consulting field.
   - Successful completion of at least five projects that involved monitoring vibrations and evaluating effects of vibrations on structures.

2. Installation and monitoring of the vibration monitoring equipment, and collection of the vibration monitoring data shall be performed by personnel with the following qualifications.
   - At least two years of experience in the operation of the proposed monitoring equipment and interpretation of data produced by such equipment.
   - Experience installing, operating, monitoring, and interpreting vibration monitoring equipment and data on at least three projects that involved monitoring vibrations and evaluating the effects on structures.

The qualifications shall be included in the Vibration Monitoring and Control Plan.

8.3.4.5 Design-Builder Responsibility

The Design-Builder shall conduct all Work to prevent damage and undue annoyance to adjacent buildings, structures, Utilities, and operations. The Design-Builder shall provide appropriate protection measures when necessary to prevent damage and undue annoyance.

The Design-Builder shall have complete responsibility for monitoring and controlling vibrations, prevention of consequent settlement and/or damage to any structure, residences and their property, and repair of any damage whatsoever resulting from operations.

8.3.5 Field Determination of Pile Geotechnical Nominal Resistance in Axial Compression

Geotechnical nominal resistance in axial compression of each pile installed on the Project shall be verified in the field and the Design-Builder shall prepare a Verification of Pile Nominal Resistance in Axial Compression report.

For driven piles, dynamic measurements with signal matching analysis calibrated to match the results of pile load tests specified herein for each Control Zone shall be used to verify field geotechnical nominal resistance in compression for piles installed in the corresponding Control Zone. Pile driving acceptance criteria shall be established prior to installing any production pile. Alternatively, proof load testing of production piles to a load of at least 1.5 times the Service Limit State design load in conjunction with the permissible pile settlement under service load may be used as the pile acceptance criteria.

CIDH load test piles shall be instrumented along the length to establish load transfer (t-z) curves for each soil layer and (q-z) curve for the bearing layer(s). CIDH pile acceptance criteria or tip elevation for production piles shall be established based on static resistance prediction adjusted to match the load test results. CIDH acceptance criteria shall be established prior to installing any production pile. Alternatively, proof load
testing of production piles to a load of at least 1.5 times the Service Limit State design load in conjunction with the permissible pile settlement under service load may be used as the pile acceptance criteria.

Pre-production driven test piles shall be loaded to the amount and/or pile settlement necessary to establish the pile geotechnical nominal resistance in axial compression as per Standards. CIDH test piles shall be loaded until the side resistances are fully mobilized along the entire pile length and a pile tip settlement of at least 5% times the pile diameter occurs.

Test piles shall be designed structurally so that no overstressing occurs during the load tests.

A Control Zone is a zone that has similar subsurface profile and engineering properties. This Project has two control zones which are identified as follows:

- Control Zone 1 contains the Project area west of the Back Channel.
- Control Zone 2 contains the Project area east of the Back Channel.

For driven pile diameters less than or equal to 36 inches, the Design-Builder shall perform one Pile Dynamic Analysis (PDA) Test for each Control Zone to verify pile nominal resistance for each production pile size and type selected by the Design-Builder for the Project. The Design-Builder shall determine acceptance criteria for each production pile size and type for each Control Zone by using the PDA test result and the signal matching analysis.

For driven pile diameters greater than 36 inches, including cast in steel shell (CISS) piles, the Design-Builder shall perform one PDA test and one static axial pile load test for each control zone to verify pile nominal resistance for each production pile size and type selected by the Design-Builder for the Project. The Design-Builder shall determine acceptance criteria for each production pile size and type selected for each Control Zone in accordance with the provisions in Sections 10.7.3.8 and 10.7.3.10 of the California Amendments to the AASHTO LRFD Bridge Design Specifications for compression and tension, respectively.

For drilled pile diameters greater than 36 inches, including cast in drilled hole (CIDH) piles, the Design-Builder shall perform one static axial pile load test for each control zone to verify pile nominal resistance for each production pile size and type selected by the Design-Builder for the Project. The Design-Builder shall determine acceptance criteria for each production pile size and type selected for each control zone in accordance with the provisions in Sections 10.7.3.8 and 10.7.3.10 of the California Amendments to the AASHTO LRFD Bridge Design Specifications for compression and tension, respectively.

Pile load test shall be conducted on the pile with the lowest pile tip elevation for each pile size, pile type, and Control Zone. Statnamic testing will not be allowed.

Test pile installation techniques, including hammer type, cushion, energy setting for driven pile, drilling method, and use of casing for drilled pile, must reflect the method to be used for the production pile. Similarly, methods used to install production pile must match the methods used to install test piles.

Test piles shall be sacrificial and shall not be used as production piles. After completion of a pile load test and the test pile is no longer needed, it shall be cut off 2 feet below final grade.

The Design-Builder shall prepare a Pile Geotechnical Nominal Resistance Test Implementation Report containing test procedures, instrumentation plan including measurements along the piles, test pile locations, pile sizes, and types being tested and equipment used.

The Design-Builder shall prepare a Pile Geotechnical Nominal Resistance Test Results Report containing test results per pile size and type tested, production piling driving system, and production piling acceptance criteria.

### 8.3.6 Seismic Ground Motions

The ARS design curves and spectrum-compatible earthquake time histories have been developed for two-level seismic design criteria of the project. The Safety Evaluation Earthquake (SEE) was developed for a 1,000 year return period and the Functional Evaluation Earthquake (FEE) was developed for a 100 year
return period. The ground motion criteria and seismic design data are provided in Exhibit 2-8-F (Ground Motion Data). The Design-Build shall use the project-specific ground motion data in Exhibit 2-8-F for the seismic designs of the bridge structures. Revision to the seismic design criteria will not be permitted.

8.3.7 Foundation Design

The Design-Build shall provide foundations in accordance with the following, applicable design criteria provided elsewhere in the Contract Documents and the Standards.

For foundations, walls and embankments, the Design-Build shall provide estimates of expected magnitude and rate of settlement and lateral movement, and reference to a construction monitoring plan developed to evaluate accuracy of the settlement and lateral movement performance estimates. Remediation methods shall be provided if estimated or measured settlement and lateral movement exceeds the allowable, permissible or limiting settlement and lateral movement.

Design-Build shall provide, install, and monitor geotechnical instrumentation to measure total settlement (short term + long term) of bridges or walls with shallow foundations and other fills beginning prior to any placement of embankment or wall fill and continuing until 90 percent of the total calculated settlement is measured. Settlement plates (flat plates with shielded pipe extensions) may be used for measuring settlement in areas Approved by the Port.

The Design-Build shall include the loading from Service, Strength, and Extreme conditions including Seismic in the design of foundations. Loading from railroads shall also be included in the design of foundations.

8.3.7.1 Bridge Foundation Design

The Design-Build shall provide bridge foundations per applicable Department requirements and Sections 3.10 and 10.5.4 of the AASHTO LRFD Bridge Design Specifications, 4th Edition, with California Amendments.

The Design-Build shall limit the total settlement (short term + long term) at each bridge foundation support due to LRFD Service 1 Load Combination to 1 inch or less for continuous structures and 2 inches or less for simple spans.

The Design-Build shall determine settlement at each foundation of each structure and account for the differential settlement per the following:

- When the differential settlement between two adjacent foundation supports of the same structure due to the LRFD Service 1 Load Combination is limited to 0.5 inches or less, effects of settlement does not need to be considered in the structure design or analysis.
- If the differential foundation settlement due to the LRFD Service 1 Load Combination between two adjacent supports of the same structure exceeds 0.5 inches, the Design-Build shall include the force effects due to settlement in the design of the superstructure, and the load factors, SE, shall be taken as 0.5 and 0.0.
- If the Design-Build performs nonlinear structural response analysis, utilizing appropriate non-linear soil springs, then the force effect due to support differential settlement shall be automatically included in the analysis of the structure. In that case, settlement load factors, SE, shall be taken as 1.0 and 0.0.

The Design-Build shall perform foundation designs for Strength and Extreme Event using the resistance factors provided in the California Amendments to the AASHTO LRFD Bridge Design Specifications.

8.3.7.2 Retaining Wall Design

The Design-Build shall provide retaining wall foundations per applicable Standards. For items not addressed in the Standards, the Design-Build shall follow Section 5.0 of the Caltrans Bridge Design Specifications, 2000.
Differential settlement of cast-in-place concrete walls due to the LRFD Service 1 Load Combination shall not exceed 0.5 inches along 100 feet of wall and total settlement (short term + long term) at any location shall be limited to 1.0 inch or less.

Differential settlement of MSE walls after facing installation due to the LRFD Service 1 Load Combination shall be limited to 1.0 inch or less along 10 feet of wall and total settlement after facing installation at any location shall be limited to 2.0 inches.

In addition, the total as well as differential settlement between any two adjacent points shall be limited as necessary to protect supported existing or new structures, if any.

For walls supported by shallow foundations and MSE walls on dense cohesion-less soils and stiff/hard clay, the location of the resultant LRFD Service Limit I Load Combination shall be within the middle third of the foundation base. For Strength or Extreme Event (Seismic) design, the resultant force location need not be a consideration provided all applicable stability requirements including those for bearing resistances under the most severe eccentric conditions are met.

The total lateral displacement, including that due to rotation caused by eccentric loading when founded on weak soils, at the top of retaining walls shall be limited to 1.0 inch.

The total lateral displacement of retaining walls due to service loads shall be limited to the following, or less when necessary, to protect supported structures and/or to prevent unacceptable movement of supported structures:

1. 0.25 inches at top of pile cap for pile-supported walls
2. Allowable horizontal deflection at the top of the wall shall not exceed 0.5 percent of the wall height.

Seismic stability of retaining walls shall be evaluated using pseudo-static or numerical approaches such as finite element analysis methods. If pseudo-static analysis is used, stability analysis shall be based on horizontal acceleration coefficients equal to 1/3 of the design Peak Ground Acceleration (PGA). The minimum factor of safety for seismic bearing, and sliding stability shall be 1.5 and 1.1, respectively. All stability and eccentricity requirements specified in the Standards for both static and seismic design shall be met.

8.3.8 Roadway Analysis and Design

8.3.8.1 Roadway Design Criteria

Differential settlement across approach slabs shall not exceed 0.50 inches in 25 feet. The Design-Builder shall implement ground improvement techniques to the approach embankment subgrade, if necessary, to meet this requirement.

8.3.8.2 Subgrade Excavations

The Design-Builder shall address unsuitable material and/or expansive type soils that may exist below the grading plane or elsewhere on the Project if materials do not meet the requirements of the Standards or, for materials under roadways, have a California R-Value less than 15.

The Design-Builder’s methods of addressing unsuitable material and/or expansive type soils must be Accepted by the Port in the Materials Design Recommendation or the applicable Released For Construction Documents prior to completing the Work. If an unknown soil condition is discovered, the Design-Builder shall propose a resolution and obtain Port Acceptance prior to moving forward with Work at the specific area to address the unknown soil condition.

The Design-Builder shall not address unsuitable material and/or expansive type soils by changing the permanent pavement section(s) required elsewhere in the Contract Documents or by relying on stabilizing the moisture content by minimizing the access of water through surface and subsurface drainage and the use of a waterproof membrane (i.e., geomembrane, asphalt saturated fabric, or rubberized asphalt membrane).
8.3.9  **Excavations and Embankments**

8.3.9.1  **General**

Minimum limits for deep excavations to remove organic deposits shall be in accordance with the standards. Blasting and/or use of explosives will not be allowed on the Project.

8.3.9.2  **Lightweight Fills**

The Design-Builder may use lightweight aggregate or lightweight cellular concrete to reduce loads on soils and reduce settlement.

Lightweight fills that can deteriorate from ultraviolet (UV) rays or petroleum products are not allowed for use in the Project.

The Design-Builder shall provide lightweight fills that are not affected by uplift forces from buoyancy when water level reaches the Mean Higher High Water elevation (MHHW). The Design-Builder shall also consider tidal action and local flooding events in providing lightweight fills.

Unless specified otherwise herein or in the standards, light-weight aggregate and cellular concrete shall be designed, constructed and tested in accordance with the applicable ACI and ASTM guidelines and test methods.

The in-place dry density of these materials shall be within the range of 30 to 60 pcf.

The minimum 28-Day compressive strength of light weight cellular concrete shall be 120 psi, minimum.

The lightweight concrete mix design and construction shall be performed by personnel experienced in performing this type of work for at least five recent projects. Lightweight aggregate materials shall be designed to prevent migration of fines from adjacent earth materials.

The Design-Builder shall prepare a Lightweight Fill Report that contains, at a minimum, the following:

- The proposed Project specific applications and locations with a detailed description of their purposes and justifications for use in place of regular soil or concrete materials
- Design requirements and analysis results for the elements to be constructed
- Constituent materials and the mix design requirements including the permissible maximum and minimum range of the in-place dry density and, when applicable, compressibility, compressive strength, permeability and nominal bearing resistance
- Mixing and placement procedure
- Quality Controls and Quality Assurance requirements and execution plans
- Manufacturer's requirements and certifications

8.3.9.3  **Embankment Settlement**

Engineering analysis shall show that total settlement at any point on constructed embankment will not exceed 2 inches. Differential settlement between two points 100 feet apart shall be limited to 0.5 inches or less.

The Design-Builder shall provide, install, and monitor geotechnical instrumentation to measure total settlement of constructed embankments and other fills beginning prior to any placement of embankment and continuing until 90 percent of the total calculated settlement is measured. Settlement plates (flat plates with shielded pipe extensions) may be used for measuring settlement in areas Approved by the Port.

Seismic stability of embankments shall be evaluated using pseudo-static or numerical approaches such as finite element analysis methods. If pseudo-static analysis is used, stability analysis shall be based on horizontal acceleration coefficients equal to 1/3 of the design Peak Ground Acceleration (PGA). The minimum factor of safety for seismic bearing, and sliding stability shall be 1.5 and 1.1, respectively. All
stability and eccentricity requirements specified in the Standards for both static and seismic design shall be met.

8.3.10 Geotechnical Reports

For each earth retaining, bridge structure or sign foundation, the Design-Builder shall prepare Preliminary Foundation Reports (PFR), Foundation Reports (FR) and As-Built Foundation Reports (As-Built FR). Each structure number shall have a separate report. The FR shall be prepared during design, include all final recommendations to be implemented, and provide the necessary information per the standards and as needed to construct the foundation. The As-Built FR shall contain any amendments to the FR during construction. One As-Built FR shall be provided for each bridge or wall structure number and shall contain the FRs used in the design and construction of the associated bridge or wall number.

For nonstructural or roadway Project elements requiring geotechnical reports, the Design-Builder shall provide a Geotechnical Design Report (GDR) and an As-Built GDR before Final Acceptance. The GDR shall be prepared during design, include all final recommendations to be implemented, and provide the necessary information per the standards and as needed to construct the feature. The As-Built GDR shall contain any amendments made to the GDR during construction. One As-Built GDR shall be provided for the Project and shall contain the GDRs used in design and construction of the Project.

Preliminary Seismic Reports (PSRs) can be prepared separately or included in the PFR or GDR. Seismic Reports (SRs) can be prepared separately or included in the FR or GDR. An As-Built Seismic Report (As-Built SR) shall contain any amendments to the SR during construction and shall be contained in the As-Built FR for each bridge or wall structure number.

Reports prior to As-Built FR, As-Built GDR, or As-Built SR may be revised or updated during the design process to reflect what is required to be constructed or was constructed, while As-Built FR, As-Built GDR shall be considered as-designed and constructed As-Built Documents.

Addenda, and revisions to a FR, GDR or SR shall be signed and sealed by the Geotechnical Engineer licensed in the State of California who completed the reports.

The reports must include geotechnical subsurface information, geotechnical laboratory test results, analyses, design, recommendations for design and construction, and associated documents in accordance with Caltrans Guidelines for Preparing Geotechnical Design Reports and Caltrans Foundation Report Preparation for Bridges. Incorporate existing information, including information provided by the Port, in the reports as applicable.

Typically, the completion of geotechnical reports is an iterative process between the geotechnical group and the structural group until the final recommended approach to the element is decided. All reviews and iterations between members of the Design-Builder team shall be completed and what is submitted to the Port shall be the result of this coordination and be the agreed to result of coordination between design disciplines and the Design-Builder.

8.3.10.1 Geotechnical Subsurface Information

The Design-Builder shall provide geotechnical subsurface information and boring records to the Port that is in compliance with the Department database format.

The Design-Builder shall submit subsurface information obtained by the Design-Builder to the Port in the applicable report as noted above. The subsurface information shall be recorded and reported in accordance with the following:

- Caltrans Soil and Rock Logging, Classification, and Presentation Manual
- Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS) Schemas and Data Dictionaries.

Subsurface information must be submitted along with applicable reports. The subsurface information that must be submitted includes:
- Boring and Sampling
  - Field log of each bore hole performed
  - Final Borehole Log or Borehole Record of each borehole performed
  - Digital photo logs of rock core samples with associated rock core information shown on each digital photo
  - Test report of energy efficiency ratio of Standard Penetration Test (SPT) hammer for each hammer used to perform SPT tests.
- CPT Sounding
  - An electronic copy of the CPT raw data and hardcopy CPT logs for each CPT performed
  - Calibration report of CPT cone
- Geotechnical In-Situ Instrumentation
  - Results of geotechnical in-situ instrumentation tests performed
- Geophysical Test
  - Results of geophysical tests performed
- Laboratory Test
  - Results of laboratory tests performed
- Survey data of bore hole, CPT, in-situ instrumentation, and geophysical test locations, including elevation, strata information, northing and easting, converted latitude and longitude, and station and offset.

The Design-Builder shall prepare Log of Test Borings (LOTBs) in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual.

The Design-Builder shall submit LOTB in the PFR to support the type selection process. These LOTBs shall contain the borings provided by the Port or existing borings, at a minimum. Previous investigations or tests completed in metric units shall be converted to English units.

The Design-Builder shall submit LOTB in the FR with the final design package associated with the Released For Construction Documents. These LOTBs shall contain new borings obtained by the Design-Builder, the borings provided by the Port and existing borings. Previous investigations or tests completed in metric units shall be converted to English units. The Design-Builder shall submit all the LOTBs with the Released For Construction Documents and with As-Built Documents. Each submittal shall be made in Microstation and PDF formats.

The Design-Builder shall submit the Borings Records with the Released For Construction Documents and with As-Built Documents. Each Borings Record submittal shall be made in gINT (version 8 or higher) format for borings completed prior to the year 2009, and all should be provided in PDF format.

8.3.10.2 Geotechnical Analysis and Design

Reports shall include the following geotechnical analysis and design topics, at a minimum:
- Evaluate and interpret geotechnical subsurface information.
- Derive engineering properties of subsurface materials for geotechnical analysis and design.
- Evaluate geological and seismic hazards, including fault rupture hazards and design ground motion.
- Evaluate secondary seismic effects on the Project elements from soil liquefaction potential. Soil liquefaction potential for structures shall extend to the deeper of the following two depths:
  - At least 20 feet below the as-built pile tip elevation of the existing structures
  - At least 10 feet below the bottom of the lowest potentially liquefiable soil layer
- Evaluate effects on the Project elements from tsunami effects from a 1000 year return period.
- Evaluate potential effects on the Project elements associated with soil liquefaction, including loss of soil strength and stiffness, ground motion modifications, ground deformation, lateral spreading, slope instability, overall or global stability of foundations, loss of foundation capacity, imposed downdrag on deep foundations, and resulting foundation settlement, kinematic lateral loads on foundations due to soil movements, and seismically induced lateral earth pressure on earth retaining structures. Provide design recommendations, including remedial measures. The Design-Builder shall meet the requirements of AASHTO LRFD Bridge Design Specifications, 5th Edition, Section 10.5.4.2.
  - For roadways, liquefaction shall be evaluated to a depth of at least:
    - 50 feet below the existing ground surface
    - 50 feet below the bottom of the roadway subgrade
    - 2H feet below the bottom of embankments and earth structures or cuts of height H (feet).
  - Liquefaction for roadway structure elements including retaining walls, shall be evaluated to a depth of at least:
    - 50 feet below existing ground surface
    - 4B feet below the bottom of shallow foundations of width or diameter B (feet)
    - 4B feet below the tip elevation of individual deep foundations of width or diameter B (feet)
    - 2B feet below the bottom of pile groups of width or diameter B (feet)
  - The Design-Builder shall use the depths above as required that result in the deepest evaluation of liquefaction for the area being investigated.
- Perform static and pseudo-static slope stability analysis, and provide design and construction recommendations. Perform deformation analyses where factor of safety for pseudo-static analyses is less than the value specified in the Standards.
- Perform a fault rupture study, if appropriate.
- Provide earthquake ground motion parameters
- Provide characterizations of foundation stiffness
- Evaluate potential settlements due to applied loads, and provide mitigation measures.
- Evaluate potential for ground heave or lateral movement, if applicable, and provide mitigation measures.
- Perform bearing capacity analyses for proposed structures and embankment fills.
- Analyze axial and lateral capacities of bridge foundations.
- Evaluate lateral stability of bridge abutments and earth retaining structures for both static and dynamic loads. The evaluation must also include future stability of bridge abutments and earth retaining structures if the immediate site conditions are changed due to work on a Utility that is in place at the time of Final Acceptance.
- Establish construction requirements for cut slopes, excavations, dewatering, foundations for roadway embankments and structures, including bridges, retaining walls, drainage structures and protection of dike, Utilities and other structures.
- Provide soil corrosivity recommendations.
- Determine subgrade characteristics, California R-Values for pavement design, and corrective measures to meet design criteria.
- Provide recommendations for shoring and false work foundations during construction.
- Provide recommendation for construction observation and testing.

The Design-Builder shall submit applicable analysis and design calculations with each report as appendices for review. The person who performed the calculation must sign each calculation package.
8.3.11 Materials Design Recommendation

The Design-Builder shall prepare a Materials Design Recommendation that addresses all work anticipated below the grading plane as defined in Topic 62 of the Caltrans Highway Design Manual and includes such items as grading, subgrade excavations, removals, and liquefaction mitigation measures. The Design-Builder shall present how it will address anticipated Project features to be encountered, including muck excavations, subgrade excavations, embankment construction (including the need for special materials, controlled rate of fill, etc.), need for perforated pipe or dewatering, shrinkage factors, turf establishment, detention ponds, infiltration zones, and base and surfacing design.

In addition, the Design-Builder shall address temporary and permanent dewatering and the potential impacts of dewatering on nearby structures, wells, springs, and Utilities.

The Design-Builder shall not address recommendations included in the Geotechnical Design Reports and Foundation Reports in the Materials Design Recommendation. Instead, the Materials Design Recommendation must include how the Design-Builder will meet the recommendations and requirements of the Geotechnical Design Reports and Foundation Reports.

The Materials Design Recommendation must include, at a minimum:

- Construction processes with lines of communication, if necessary
- Materials specifications, sources, storage, and conveyance
- Process to identify and resolve inadequate soils
- Processes that will be used to avoid material contamination
- How the Design-Builder will address areas under roadways with an California R-Value less than 15

8.3.12 Borrow Material

Borrow materials for roadway embankment, if any, shall consist of natural soils free of organic matter, oversized particles (>3.0 inch in smallest dimension) or clay particles. Borrow materials shall be well graded and predominantly cohesionless in nature with less than 10% non-plastic, non-corrosive and non-expansive fines. Borrow soil shall meet the following requirements:

- Sand Equivalent <20
- Plasticity Index (PI) of the fines <4
- Percent fines <10 %
- Percent gravel <15 %

All imported materials for structure backfill or foundation subgrade, pavement subbase and base materials, and infill for reinforced-earth structures shall meet the requirements of the applicable Department or AASHTO standard. All borrow or imported materials shall be tested for compliance to the Project requirements and Approved by the Port prior to transporting to the Project Site.

8.3.13 Loading

The Design-Builder shall design foundations, roadways, embankments and other applicable elements of the Project for the following loading scenarios:

- A design finished grade elevation of 18.0, regardless if the existing ground is in fact at this elevation or not.
- A 1000 psf uniform live load pressure placed on the design finished grade as required to maximize the force effects on Project elements including footings, embankments, and walls.
8.4 Construction Requirements

8.4.1 Piling
Pile-tip grouting to mobilize drilled-shaft tip resistance is allowed with cast-in-drilled-hole (CIDH) piles if the Design-Builder provides a CIDH Tip Resistance Testing Protocol to the Port for review. The Design-Builder shall also demonstrate that the CIDH pile tip has effectively been mobilized by grouting and that load bearing is achievable. Testing, interpretation of results and report writing shall be completed by an AASHTO or Department approved independent testing firm. Testing results shall be compiled in a CIDH Tip Resistance Testing Results and be submitted to the Port.

8.4.2 Soil Nail Wall Requirements
The Design-Builder shall follow Caltrans Standard Special Provisions for soil nail walls and the following:

- Identify wall zones on the RFC Documents with one design pullout resistance number assigned for each wall zone.
- Perform proof tests on sacrificial proof test nails. The number of sacrificial proof test nails must be at least 10 percent of the total number of designed soil nails.
- Show the locations of 80 percent of the proof test nails on the RFC Documents. The locations of remaining 20 percent of proof test nails must be determined during construction by the Design-Builder and the location is subject to review of the Port.

8.4.3 Vibration Monitoring
The Design-Builder shall install all necessary vibration monitoring equipment per the Approved Vibration Monitoring and Control Plan, monitor vibrations during vibration-inducing operations, and interpret vibration monitoring data during all construction operations. The following items must be met:

1. Provide daily a Construction Vibration Report to the Port when vibration-inducing operations identified in the Approved Vibration Monitoring and Control Plan are taking place. The following shall be included:
   - The source of the vibration readings
   - A plot of the 10 highest readings (occurrences) on a graph of particle velocity (in/sec) vs. frequency (Hz), with the envelopes from Fig 1, AASHTO Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations, R-8, and envelopes derived from levels included in Table 8-2 all on the same graph

2. If the Approved vibration threshold limits are exceeded, the Design-Builder shall immediately stop the activity that produced vibration(s) exceeding the Approved vibration threshold and immediately submit a Construction Vibration Report to the Port that includes:
   - The source of the vibration readings
   - A plot of the 10 highest readings (occurrences) on a graph of particle velocity (in/sec) vs. frequency (Hz), with the envelopes from Fig 1, AASHTO Standard Recommended Practice for Evaluation of Transportation-Related Earthborne Vibrations, R-8, and envelopes derived from levels included in Table 8-2 all on the same graph.
   - Explanation of the conditions of the violation and the steps that the Design-Builder will take to reduce the vibrations to below the vibration threshold limit. The Design-Builder is responsible for using methods and/or different equipment to stay within the vibration tolerances at no additional cost to the Port.

8.4.4 Movement-Related Monitoring
For each instrument type, location, and critical or limiting readings provided in the Approved Geotechnical Instrumentation Plan, the Design-Builder shall provide actual instrument readings and verification that the actual readings meet the acceptance criteria in a Construction Movement Monitoring Report, as readings become available, including monitoring done during and after construction.
The Design-Builders shall replace or recalibrate instruments damaged during construction within five Days.

8.4.5 Potential Damage to the Dike

The dike east of the Back Channel and north of “A” Line (Ocean Boulevard) that surrounds the Long Beach Generating Station is critical to the operation of facilities and well being of the public and must be protected from damage or reduced level of flood protection at all times. The Design-Builders shall prepare a Dike Repair Plan that evaluates different scenarios of potential adverse impacts to the dike and how the adverse impacts will be addressed, including changes in under-seepage, changes in through-seepage, increased potential for soil erosion, reduction in stability, increased settlement or lateral movement, small volume breaches and large volume breaches. The report shall include the following, at a minimum, for each potential event:

- Parameter or item with threshold limit that will require implementation of dike repair if limit is exceeded
- 24-hour-per-Day contact information for the person charged with monitoring and repairing the dike if a breach were to occur
- Communication requirements including a communication plan with lines of communication, contact information, roles, and responsibilities if a breach were to occur
- A mitigation plan outlining what will be immediately deployed, enlisted, or installed to decrease the impact of a potential breach in the dike
- Schedule of how the repair will be completed, starting from the time the damage or breach is identified and ending with the final repair to the dike
- Specific resources needed to determine a timely and appropriate repair, such as personnel, material, equipment, exploration, and testing required to appropriately and efficiently respond to a breach in the dike. Each resource shall have a timeline and be noted in the schedule

In the event damage to the dike does occur, this Dike Repair Plan may be used as the guiding document to all parties involved, including the Port and the Department, to address the damage in the most efficient and effective way possible. If damage to the dike results or could result in lack of stability of the dike, emergency services shall be contacted immediately.

8.4.6 Recycled Material

Recycled materials are not allowed as structural backfills in permanent retaining walls. Recycled material may be used in the construction of roadway embankments or foundations with Port Approval. To obtain Approval, the Design-Builders must submit a Recycled Material Use Request containing the following, at a minimum:

- Material name, supplier, description, and properties to define what will be used
- The advantages and disadvantages of using the material
- Documentation such as testing reports, laboratory studies, research results, demonstration projects that show the proposed material will serve its intended function for the design life of the element and its surrounding environment
- Manufacturer-recommended installation and/or construction procedures along with construction tolerances
- Location or element in which the material will be installed, along with limits on a Project-wide basis
- Description of the equipment required
- Inspection training, techniques, or processes required. If training is required, this shall be coordinated by the Design-Builder with the Port

If requested by the Port, the Design-Builders shall construct a test panel at no additional cost to the Project.

The Design-Builders shall have a representative of the proposed recycled material manufacturer on site during initial construction and installation until such time the Design-Builder demonstrates proficiency. The Design
Builder must submit to the Port a Manufacturer Representative Release requesting to release the product representative.

### 8.5 Deliverables

Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hardcopy format. Acceptable electronic formats include Microsoft Word, Microsoft Excel, or Adobe Acrobat (.PDF) files, unless otherwise indicated. At a minimum, the Design-Builders shall submit the following to the Port:

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>For Acceptance or Approval</th>
<th>Number of Copies</th>
<th>Submittal Schedule</th>
<th>Reference Section</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Hardcopy</strong></td>
<td><strong>Electronic</strong></td>
<td></td>
</tr>
<tr>
<td>Geotechnical Task Execution Plan</td>
<td>Approval</td>
<td>2</td>
<td>1 (PDF)</td>
<td>Approval two weeks prior to commencing with any subsurface investigations</td>
</tr>
<tr>
<td>Geotechnical Instrumentation Plan</td>
<td>Approval (in writing)</td>
<td>2</td>
<td>1 (PDF)</td>
<td>Geotechnical instrumentation shall be installed prior to the start of construction</td>
</tr>
<tr>
<td>Vibration Monitoring and Control Plan</td>
<td>Approval</td>
<td>2</td>
<td>1 (PDF)</td>
<td>Vibration monitors shall be installed prior to the start of construction</td>
</tr>
<tr>
<td>Pre-Construction DVD</td>
<td>Approval</td>
<td>N/A</td>
<td>1 (PDF)</td>
<td>Two weeks prior to the start of construction</td>
</tr>
<tr>
<td>Post-Construction DVD</td>
<td>Approval</td>
<td>N/A</td>
<td>1 (PDF)</td>
<td>After construction</td>
</tr>
<tr>
<td>Verification of Pile Nominal Resistance in Axial Compression</td>
<td>Acceptance</td>
<td>2</td>
<td>1 (PDF)</td>
<td>Prior to construction of a pile cap.</td>
</tr>
<tr>
<td>Pile Geotechnical Nominal Resistance Test Implementation Report</td>
<td>Approval</td>
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<td>1 (PDF)</td>
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EXHIBIT 2-8-A
Boring Location Alignments

This exhibit is provided as an electronic file.

The alignment information provided in this exhibit shall be considered part of the Contract only for the sole purpose of locating the borings provided in Exhibit 2-8-B.
EXHIBIT 2-8-B

Boring and Cone Penetration Logs 2005

This exhibit is provided as an electronic file.
EXHIBIT 2-8-C
Cone Penetration Data 2005
This exhibit is provided as an electronic file.
EXHIBIT 2-8-D
Seismic Wave Velocity Data 2005
This exhibit is provided as an electronic file.
EXHIBIT 2-8-E

Phase II Log of Test Borings

This exhibit is provided as an electronic file.
EXHIBIT 2-8-F

Ground Motion Data

This exhibit is provided as an electronic file.
EXHIBIT 2-8-G

Boring and Cone Penetration Logs 2011

This exhibit is provided as an electronic file.
EXHIBIT 2-8-H

Cone Penetration Data 2011

This exhibit is provided as an electronic file.
EXHIBIT 2-8-I
Seismic Wave Velocity Data 2011
This exhibit is provided as an electronic file.