FOUNDATION REPORTS
for
BRIDGES

July 2024

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

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1 INTRODUCTION

The intent of this document is to define the Department's standard of practice for preparation of the Structure Preliminary Geotechnical Report (SPGR), the Preliminary Foundation Report (PFR) and the Foundation Report (FR) for bridges.

1.1 Reporting for Project Delivery

Foundation investigation and reporting generally occurs at three stages of the project development process:

- A Structure Preliminary Geotechnical Report (SPGR) to support Advanced Planning Studies, performed during the Work Breakdown Structure activity 150.15 (K Phase).
- A Preliminary Foundation Report (PFR) to support Type Selection, performed during the Work Breakdown Structure activity 160.10 (0 Phase) or 240.70 (1 Phase).
- A Foundation Report (FR) to support the design and construction of the bridge, performed during the Work Breakdown Structure activity 240.80 (1 Phase).

A separate foundation report must be prepared for each bridge structure, with the following additional requirements:

- Left, center, and/or right bridges with the same bridge number should be combined into one report.
- Earth retaining systems connected to the bridge should be addressed in the foundation report.

Prepare reports to succinctly communicate information pertinent to the recommendations in accordance with the report preparation requirements. The following rules must be followed:

- Present specific information that is relevant to the recommendations.
- Reference or cite existing standards, specifications, or policy only when clarifying, modifying, or disallowing the standard, specification, or policies.
- Do not include unsubstantiated disclaimers.
- Provide titles and numbers for all figures and tables.
- Tables and figures must be included within the body of the report and located as near as possible to the place where they are first referenced.
- All depth references must have a corresponding elevation in parenthesis.

If Bridge Design requests seismic information only, use this reporting standard and include all applicable sections.

1.1.1 Reports Prepared by Caltrans Staff

Foundation Reports are written to the Bridge Designer, Specification Engineer, and Structure Construction, and are part of the contract.

For reports prepared by Geotechnical Services staff, Foundation Reports must be prepared using the reporting (MS Word) templates with the subject line of "Foundation Report for *Bridge Name*" or "Preliminary Foundation Report for *Bridge Name*" or "Structure Preliminary Geotechnical Report for *Bridge Name*". Do not include section numbers in the report. First-level section titles presented in this document (e.g., Geotechnical Conditions) must be included in the report. Second-level section titles (e.g., Geology, Surface Conditions) are optional.

Do not include the Log of Test Borings (LOTB) and/or As-built LOTB as part of the FR. The Engineering Graphics Unit will send Microstation LOTB files and scanned copies of the As-built LOTB sheets to the Bridge Designer for inclusion within the Contract Plans.

Sign, stamp, and distribute reports in accordance with the *Communications and Reporting* section of the *Offices of Geotechnical Design – Quality Management Plan*.

1.1.2 Reports Prepared by Consultants

Foundation Reports must include the following: cover sheet, table of contents, main contents per this document, and appendices. The cover of the report and any addenda/amendments to the report must include the following information: Caltrans District, County, Route, Post Mile, Bridge Number, Bridge Name, and Expenditure Authorization (EA) number.

The LOTB and/or As-built LOTB must be submitted as part of the FR. Refer to the *Caltrans Soil and Rock Logging, Classification, and Presentation Manual* for direction on the preparation of the LOTB and As-built LOTB.

2 STRUCTURE PRELIMINARY GEOTECHNICAL REPORT (SPGR)

The SPGR is required during the early stages of a project to assist Bridge Design in the preparation of an Advanced Planning Study and cost estimate for the District. Often the number, location, and type of bridge(s) are not completely known. As a result, recommendations may be general, and detailed field investigations are usually not warranted. Typical fieldwork consists of a site visit only. The SPGR provides an overview of the existing foundations, site geology, seismicity, and recommendations regarding suitable and unsuitable foundation types. If applicable, the SPGR should also discuss the anticipated field and laboratory work required to support the PFR and FR.

The following topics should be addressed in all Structure Preliminary Geotechnical Reports (SPGR).

2.1 Introduction

Summarize the purpose, scope, and types of work performed to obtain the information supporting the preliminary recommendations. Reference the request memo, preliminary plans by date so the reader knows on what plans the recommendations are based. Do not present an exhaustive list of tasks performed, a few sentences are sufficient.

Example

Pursuant to the request dated January 20, 2024, this Structure Preliminary Geotechnical Report has been prepared for the proposed widening of Dry Creek Bridge. This report is to summarizes the investigations performed and provides preliminary recommendations for Dry Creek Bridge. The recommendations presented in this report are based on the Advance Planning Study dated January 15, 2024, a review of existing literature including As-built plans, previous geotechnical reports, and BIRIS records, and a site visit.

2.2 Project Description

Describe the existing and/or proposed bridge(s), and pertinent project information relating to the planned improvements. Provide project vertical datum reference.

Example: New Bridge

The bridge site is in the city of San Diego on State Route 15 at PM R3.8 which crosses over Interstate 805 (I-805) at PM 15.1. At this site, the proposed bridge replacement is necessary to accommodate the underlying highway improvements, which include the widening of the existing I-805 to provide additional High-Occupancy Vehicle (HOV) lanes. Based on the General Plan, the proposed bridge is a 2-span, cast-in-place, prestressed concrete box girder bridge supported on pile foundations.

All elevations referenced within this report are based on the North American Vertical Datum of 1988 (NAVD 88), unless otherwise noted.

Example: Bridge Widening

The Sweetwater River left and right bridges are located on I-805 in Chula Vista, and are two of several bridges along I-805 which are in the process of being widened to accommodate construction of High Occupancy Vehicle (HOV) lanes in the median. “As-built” information indicates that the existing Sweetwater River left and right bridges consist of five-span, cast-in-place, pre-stressed concrete, box-girder structures, with end-diaphragm abutments that were constructed in 1968. The existing bridges are supported on driven Class 70C concrete piles at all support locations. The proposed work includes median widening between the left and right bridges and removal and replacement/widening of a portion of the deck of the right bridge. The center widening is proposed to consist of a six-span, cast-in-place, pre-stressed concrete, box-girder structure, with end-diaphragm abutments.

The 1968 As-built plans did not include a vertical datum reference. It is assumed that the elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD 29), however it is recommended that Bridge Design verify this assumption.

2.3 Exceptions to Policies and Procedures

List exceptions to Departmental policies and procedures relating to the SPGR. Approved *Request for Exception* forms must be included in the Appendix. Omit this section if there are no exceptions.

2.4 Geotechnical Investigation

Provide an overview of the geotechnical investigation(s) that support the preliminary foundation recommendations.

Example

The As-built LOTB show that a subsurface investigation, consisting of three mud rotary borings, was performed in 1969. Additionally, a site visit was performed on February 20, 2024 to review site access and creek conditions.

2.5 Geotechnical Conditions

Present only factual information in this section, not how it relates to design and construction. Discussion of the site geology, geological features, and subsurface conditions as they relate to the foundation design and construction must be placed in the *Foundation Recommendations* section.

2.5.1 Geology

Identify the pertinent geologic map and the prominent geologic unit(s) at the bridge site.

2.5.2 Surface Conditions

Describe site topography, surface water and drainage conditions, cuts and fills, rock exposures, geologic hazards such as landslides and rockfall, structures, and land use history that may affect the proposed bridge.

2.5.3 Subsurface Conditions

Provide a generalized description of the known subsurface conditions. The information included within this section may include:

- Types of soil/rock, depths to generalized layer breaks, and corresponding elevations

- Pertinent soil/rock conditions such as unsuitable materials (collapsible, expansive foundation materials)

Do not re-create an As-built LOTB in detail in this section. A generalized discussion or table is sufficient.

Example

The Geologic Map of Santa Ana 30' x 60' Quadrangle shows that the site is underlain by Quaternary alluvium.

The topography is relatively flat, and the site appears free of geologic hazards. Several partially exposed boulders were observed at the site. During the site visit the creek was flowing between Piers 2 and 3 with a water depth of approximately 2 feet.

Based on the 1966 As-built Log of Test Borings, the alluvial soil at the site can be separated into three general units. The upper unit consists of very loose to slightly compact silty sand with gravel that extends from the ground surface to a depth of about 15 feet (~ Elev. 950 feet). The middle unit consists of slightly compact to dense sand to a depth of approximately 35 feet (~ Elev. 930 feet). The lowermost unit consists of dense to very dense gravelly sand and sandy gravel with isolated zones of sandy silt and gravel. This unit extends to the maximum depth of the borings, which is approximately 60 feet below the ground surface (~ Elev. 905 feet).

2.6 Groundwater

Report groundwater elevation(s) and dates of measurements. Use of a table is recommended if there are numerous borings and/or measurements.

Table X: Summary of Groundwater Data

Location or Boring ID	Ground Surface Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)	Date Measured

Example: Groundwater Present

During the 1998 subsurface investigation, groundwater was encountered in both borings. Groundwater levels varied from elevation 945 feet (depth of 20 feet) in February to elevation 938 feet (depth of 27 feet) in August.

Example: Groundwater Not Present

During the 1998 subsurface investigation, groundwater was not encountered in either boring within the explored depth of 100 feet (~ Elev. 900 feet).

Example: Groundwater Information Not Available

Groundwater information was not available based upon the literature search performed.

Example: Groundwater Information Available Nearby

Groundwater measurements available from a DWR monitoring well, located 800 feet northwest of the proposed bridge, had groundwater elevations that varied between 930 feet and 920 feet from 2015 to present.

2.7 As-built Foundation Data

Include brief discussion of relevant As-built foundation data, such as:

- Existing foundation types and details (e.g., pile tip elevations)
- As-built geotechnical capacities or resistances.
- Construction reports or records such as pile driving logs, pile load test reports, construction difficulties, etc.

Use the tables in the examples below to present foundation data.

Omit this section if there is no As-built foundation data available.

Example: Driven Piles

Construction of the original bridge was completed in 1971 with all three supports supported on driven Alternative (Alt) "X" concrete piles. The 1971 As-built LOTB provided the data in Table 1.

Table 1: Summary of the 1971 As-built Data

Support Location	*Foundation Type*	*Design Load*	*Bottom of Pile Cap Elev. (feet)*	*Min. Penetration Elev. (feet)*	*Avg. Penetration Elev. (feet)*	*Max Penetration Elev. (feet)*
Abutment 1	*12" Driven Alt "X" Pile*	*45 ton*	*958.1*	*929.3*	*927.1*	*926.5*
Bent 2	*12" Driven Alt "X" Pile*	*45 ton*	*935.5*	*920.2*	*918.1*	*916.1*
Abutment 3	*12" Driven Alt "X" Pile*	*45 ton*	*953.6*	*928.1*	*926.5*	*925.3*

Example: Shallow Foundations

The existing Cenda Ditch Bridge consists of a two-span, cast-in-place, slab bridge that was constructed in 1963. Abutments 1 and 3 are end-diaphragm abutments and are supported on spread footings placed in approximately 20 feet of embankment fill material. Pier 2 is supported by seven columns on spread footings founded on rock. The As-built bottom of footing elevations and design loads for the bridge are shown below in Table 2.

Table 2: As-built Information

Location	As-built Bottom of Footing Elevation (feet)	As-built Allowable Footing Pressure (tsf)	As-built Design Footing Pressure (tsf)
Abutment 1	4499.1	2.0	2.0
Pier 2	4475.0	5.0	5.0
Abutment 3	4490.7	2.0	2.0

2.8 Scour Data

If the bridge spans a watercourse, report pertinent scour information including the potential for scour and the predicted magnitude of scour.

Omit this section if the bridge does not span a watercourse.

Example: Scour Data Available

The bridge site is underlain by alluvial soil, which is considered potentially scourable. The Structure Hydraulics & Hydrology Branch provided the following scour information in a Preliminary Hydraulics Report dated December 21, 2023 (Table 1).

Table 1: Scour Data

Support Location		Long Term Scour (Degradation and Contraction) Elevation (feet)	Short Term Scour (Local) Depth (feet)
Left Bridge	Abut 1	2285.6	3
	Abut 2	2285.1	3
Right Bridge	Abut 1	2291.9	3
	Abut 2	2291.6	3

Example: Scour Data Unavailable

The bridge spans a watercourse. BIRIS records do not identify any historic scour issues. The Structure Hydraulics & Hydrology Branch has not yet issued a Preliminary Hydraulics Report.

2.9 Corrosion Evaluation

Report and discuss pertinent site corrosion data.

Example: No information available

Historical corrosion data is not available. For preliminary design purposes the site should be considered non-corrosive based on the presence of predominantly cohesionless soil. Corrosion samples will be obtained during the design phase to evaluate the corrosion potential of the site.

Example: Non-Corrosive

Three soil samples and one water sample were collected for corrosion testing during the 2011 subsurface investigation. Corrosion test results for those samples are shown below in Table 1. Based on Caltrans' standards, the site is considered non-corrosive.

Example: Corrosive

During the 2011 subsurface investigation four soil samples were collected for corrosion testing. Corrosion test results for the samples collected from borings RC-11-001 and RC-11-002 are shown below in Table 1. Due to chloride content being greater than 500 ppm in two of the samples tested, the site is considered corrosive based on Caltrans' standards, and corrosion mitigation may be required depending on the type/depth of foundation selected.

Table 1: Soil Corrosion Test Summary

Boring ID	Elevation (feet)	Minimum Resistivity (Ohm-Cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)	Corrosive?
RC-11-001	15.8 to 14.3	1544	7.24	N/A	N/A	No
RC-11-001	-4.2 to -3.2	683	7.94	384	432	No
RC-11-002	-69.1 to -70.6	73	6.86	850	1500	Yes
RC-11-002	-104.1 to -105.6	78	7.71	1000	1600	Yes

Caltrans currently defines a corrosive environment as an area where the soil has either a chloride concentration of 500 ppm or greater, a sulfate concentration of 1500 ppm or greater, or has a pH of 5.5 or less. Except for MSE, soil and water are not tested for chlorides and sulfates if the minimum resistivity is greater than 1,500 ohm-cm.

2.10 Seismic Information

Report all information required in Section 2.10.1 in the SPGR. Referencing a seismic report that was delivered separately is not acceptable. Information required in Section 2.10.2 should be summarized while referencing the reader to the applicable report (e.g., Fault Rupture Report).

2.10.1 Ground Motion Hazard

Include the following information:

a. Ground Motion Parameters table
b. State how the estimated time-average shear wave velocity V_{S30} was determined (e.g., CPT, SPT correlations, or geophysics).
c. Ground Motion Data Sheet (see *Design Acceleration Response Spectrum-* module) in Appendix.

Table X: Ground Motion Parameters

Site Parameters			Design Ground Motion Parameters[1] (Return Period = 975 years)			Soil Profile Class
Latitude (degrees)	Longitude (degrees)	Shear-Wave Velocity[2] V_{S30}, (m/sec)	Horizontal Peak Ground Acceleration (g)	Deaggregated Mean Earthquake Moment Magnitude for PGA	Deaggregated Mean Site-to-Fault Distance for 1.0 Period Spectral Acceleration (km)	
XX.XXXXXX	XXX.XXXXXX	XXX.X	X.XX	X.XX	XX.XX	XX

1. Based on Caltrans web tool ARS Online (Version 3.xx)
2. Shear wave velocity determined by <edit as appropriate>

2.10.2 Other Seismic Hazards

The section must discuss potential for the following seismic hazards, as applicable at the site:

a. Surface fault rupture (see *Fault Rupture* module)
b. Liquefaction (see *Liquefaction Evaluation* module)
c. Seismically induced total and differential ground settlements
d. Lateral spreading (see *Lateral Spreading* module)
e. Seismic slope instability
f. Tsunami risk

Example

The bridge is not located within an Alquist-Priolo Earthquake Fault Zone or within 1000 feet of any unzoned Holocene fault. Therefore, the bridge is not considered susceptible to surface fault rupture hazards.

Groundwater was not encountered within the As-built borings drilled to depths ranging from 70 to 100 feet (~ Elev. 90 to 60 feet) from the existing ground surface. Dense and/or stiff soils were encountered in these borings below a depth of about 60 feet (~Elev. 100 feet) from the existing ground surface. Based on these groundwater and subsurface soil conditions, the project site is not susceptible to liquefaction or related seismic hazards, including seismic total or differential ground settlement, seismic downdrag and lateral spreading.

The project site and the adjacent areas are relatively flat. The existing abutment and approach embankment slopes consist of dense fill soil. Based on these soil conditions and the absence of soil liquefaction potential, the existing fill slopes at the site are not considered subject to instability during the design seismic ground motion event.

The site is located more than 0.5 miles from the nearest coastline and is situated above elevation 40 feet, therefore the risk for tsunami does not exist (per MTD 20-13).

2.11 Geotechnical Recommendations

Recommendations must include discussion of the appropriateness of shallow foundations, driven pile foundations, and CIDH concrete pile foundations. Recommendations must be presented in the order of preference with the recommended foundation type(s) presented first; followed by feasible, but not preferred, alternatives; followed by foundation types not recommended. If applicable, include commentary relating to foundation types proposed by the Bridge Designer (MTD 3-1, Table 3-2).

Example

The following is a discussion of the foundation system alternatives. This discussion is based upon an understanding of the regional geology and the observations of the subsurface conditions from the 1990 field investigation and construction of the existing bridge in 1992.

- *Driven Displacement Piles: Driven displacement piles such as Standard Plan precast prestressed concrete piles or closed end pipe piles are recommended for support of the new bridge.*
- *Driven Non-Displacement Piles: Driven non-displacement open-ended pipe piles or H-piles are feasible for foundation support, however installed pile lengths are expected to be variable and difficult to predict in these subsurface conditions, particularly for the H-pile alternative. Driven displacement piles are preferable to driven H-piles.*
- *Cast-in-Steel-Shell (CISS) Concrete Piles: CISS piles are feasible for foundation support, however installed pile lengths are expected to be variable and difficult to predict.*
- *Large Diameter Drilled Shafts (CIDH Concrete Piles): Large diameter drilled shafts, those with diameters greater than 24 inches, are feasible but not recommended for support. Saturated granular foundation soils exist at this location. Caving and flowing soils are expected, and slurry displacement construction methods would be required.*
- *Small Diameter Drilled Shafts (CIDH Concrete Piles): Small diameter drilled shafts, those with diameters of 24 inches and less, are not recommended for support. Saturated granular foundation soils exist at this location. Caving and flowing soils are expected, and slurry displacement construction methods would be required.*
- *Spread Footings: The foundation conditions are not suitable for spread footings because of the presence of loose material in the upper 15 feet.*

2.12 Additional Field Work and Laboratory Testing

Describe the anticipated scope and types of fieldwork and testing that may be required to complete the geotechnical investigation. Discuss the potential need for entry permits, task orders, groundwater monitoring, access road construction, lane closures, etc.

Example

The available site information will not provide adequate data to complete the design recommendations for Dry Creek Bridge. Therefore, a field investigation consisting of borings, seismic CPT, and laboratory testing will be performed to characterize the site.

The District Project Manager must initiate the process of obtaining drilling clearances (e.g., environmental permits, right of entry, categorical exemptions, etc.) so that drilling, preliminary design, and the Preliminary Foundation Report can be completed prior to the end of PA&ED. For field investigation details, the District Project Manager may contact the Office of Geotechnical Design X.

Any questions regarding the above recommendations should be directed to the attention of NAME and PHONE.

2.13 Report Distribution

The SPGR must be addressed to the Bridge Designer and copies provided to:

- District Project Manager
- Project Liaison Engineer
- District Materials Engineer
- District Environmental Planning (optional)

2.14 Appendix

Reports must include the following:

- Appendix I: Ground Motion Data Sheet

Consultants must submit the following individually (i.e., not attached to the report) for all Structure Preliminary Geotechnical Reports:

1. As-built Log of Test Borings (if available)
2. Comment Matrix with consultant responses (if available)

3 PRELIMINARY FOUNDATION REPORT (PFR) and FOUNDATION REPORT (FR)

The PFR is prepared after completion of the SPGR and Advanced Planning Study, and prior to the Structure Type Selection. The number, location, types of foundations, and preliminary loads will be provided in a request by Bridge Design, with expectation the site investigation be completed prior to delivery of the PFR. As the foundation type selection will rely on the PFR it is required that all liquefiable zones be identified and confirmed via field and laboratory data. The lateral and vertical extent of the liquefaction must be reported in the PFR.

The FR is prepared after completion of the PFR and presents the foundation recommendations and specifications that will be used to prepare the PS&E. The number, location, types of foundations, and all limit state loads will be provided in a request by Bridge Design. The FR becomes part of the contract documents via its inclusion in the Information Handout per Standard Special Provision 2-1.06B, “Supplemental Project Information.”

The following topics must be addressed in the Preliminary Foundation Report and Foundation Report.

3.1 Introduction

Summarize the scope and types of work performed to obtain the information supporting the foundation recommendations.

Foundation Report only: Include a statement that the current report supersedes all previous reports (referenced by title and date).

Example: Preliminary Foundation Report

Pursuant to the request dated March 17, 2024, this Preliminary Foundation Report has been prepared for the proposed widening of Dry Creek Bridge. The recommendations presented in this report are based on the draft general plan dated February 20, 2024, a subsurface investigation consisting of borings at the abutments, and preliminary loads and scour information provided by Bridge Design.

Example: Foundation Report

Pursuant to the request dated March 17, 2024, this Foundation Report has been prepared for the proposed widening of Dry Creek Bridge. The recommendations presented in this report are based on the general and foundation plans dated February 20, 2024, a subsurface investigation, and loads and scour information provided by Bridge Design.

This Foundation Report supersedes the Preliminary Foundation Report for (Bridge Name) dated (Date) and the Structure Preliminary Geotechnical Report for (Bridge Name) dated (Date).

3.2 Project Description

Describe the existing and/or proposed bridge(s), and pertinent project information relating to the planned foundation improvements. Provide project vertical datum reference.

<u>Example</u>

The bridge site is in the city of San Diego on State Route 15 at PM R3.8, which crosses over Interstate 805 (I-805) at PM 15.1. At this site, the proposed bridge replacement is necessary to accommodate the underlying highway improvements, which include the widening of the existing I-805 to provide additional High-Occupancy Vehicle (HOV) lanes. All elevations referenced within this report are based on the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted. To convert an elevation at this site from National Geodetic Vertical Datum of 1929 (NGVD29) to NAVD88, add 2.3 feet to the NGVD29 elevation.

Based on the General Plan, the proposed bridge is a 2-span, cast-in-place, prestressed concrete box girder structure supported on pile foundations.

3.3 Exceptions to Policies and Procedures

Discuss exceptions to Departmental policies and procedures relating to the PFR/FR. Approved *Request for Exception* forms must be included in the Appendix.

Omit this section if there are no exceptions.

3.4 Geotechnical Investigation

Provide an overview of the geotechnical investigation(s) performed to support the geotechnical recommendations including the number of boreholes/CPT soundings with maximum depth(s), corresponding elevation(s), and the types of field and/or downhole testing (e.g., in-situ, geophysical).

<u>Example</u>

The geotechnical investigation included a review of the as-built borings from the 1966 investigation and drilling three borings in March 2024. The 1966 foundation investigation consisted of one 3-inch mud rotary boring and eight 1-inch driven soil tube borings. In March 2024, three mud rotary borings were drilled to a maximum depth of 80 feet (~ Elev. 230 feet) using a CS2000 drill rig. The Standard Penetration Test (SPT) was performed at regular intervals to evaluate the engineering properties of the earth materials. The type(s) and location(s) of field testing are shown on the LOTB sheets.

3.5 Laboratory Testing Program

Provide an overview of the laboratory testing program, if performed, to support the geotechnical recommendations. Briefly explain what the tests were used for (e.g., soil classification, settlement, strength parameters).

Example

During the March 2024 field investigation, soil samples were collected from borings RC-24-001 and RC-24-002 for soil classification and corrosion evaluation (Particle Size Analysis, Plasticity Index, Corrosion Testing). A summary of the test results is provided in the Appendix, and the test sample locations are shown on the Log of Test Borings.

3.6 Geotechnical Conditions

Present only factual information in this section, not how it relates to design and construction. Discussion of the site geology, geological features, and subsurface conditions as they relate to the foundation design and construction must be placed in the *Foundation Recommendations, Notes for Specifications,* and/or *Notes for Construction* sections.

3.6.1 Geology

Identify the pertinent geologic map and the prominent geologic unit(s) at the bridge site.

3.6.2 Surface Conditions

Describe site topography, surface water and drainage conditions, cuts and fills, geologic hazards such as landslides and rockfall, structures, and land use history that may affect the proposed structure(s).

3.6.3 Subsurface Conditions

Provide a generalized description of the subsurface conditions. The information included within this section may include:

- Types of soil/rock, depths to generalized layer breaks, and corresponding elevations
- Pertinent soil/rock conditions such as unsuitable materials (collapsible, expansive foundation materials)

Do not re-create the LOTB(s) in detail in this section. A generalized discussion or table is sufficient.

Example

The Geologic Map of Santa Ana 30' x 60' Quadrangle shows that the site is underlain by Quaternary alluvium. The topography is relatively flat, and no geologic hazards have been identified.

Based on the 2024 site investigation, the alluvial soil at the site can generally be separated into three units. The upper unit consists of very loose to medium dense silty sand with gravel that extends from the ground surface to a depth of about 15 feet (~ Elev. 950 feet). The middle unit consists of dense sand to a depth of approximately 35 feet (~ Elev. 930 feet). The lowermost unit consists of dense to very dense gravelly sand and sandy gravel with isolated zones of sandy silt and gravel. This unit extends to the maximum explored depth of the borings, which is approximately 60 feet below the ground surface (~ Elev. 905 feet).

3.7 Groundwater

Report groundwater elevation(s) and dates of measurements. Use of the following table is recommended if there are numerous borings and/or measurements. Discuss surface water conditions that might influence the design or construction of the foundations. State the groundwater elevation(s) (e.g., liquefaction, pile design) used for analyses and design.

Table X: Summary of Groundwater Data

Location or Boring ID	Ground Surface Elevation (feet)	Depth to Groundwater (feet)	Groundwater Elevation (feet)	Date Measured

Example

As-built LOTB's from the April 1968 subsurface investigation indicate that groundwater was encountered in several borings at that time and ranged from elevation 19.0 feet to elevation 21.2 feet (NAVD88 datum). During the 2024 subsurface investigation groundwater was measured in Boring RC-24-001 at elevation 15.3 feet, and in Boring RC-24-002 at elevation 13.9 feet. During the 2024 subsurface investigation, groundwater was measured in boring RC-24-003 at elevation 17.1 feet, which corresponded to the level of the water in the riverbed at that time. The groundwater elevation used for design was 21 feet.

3.8 As-built Foundation Data

Include brief discussion of relevant As-built foundation data, such as:

- Existing foundation types and details.
- As-built geotechnical capacities or resistances.
- Construction reports/records such as pile driving logs, load test reports, etc.

Use the tables in the examples below to present foundation data. Omit this section if there is no As-built foundation data available.

Example: Driven Piles

Construction of the original bridge was completed in 1971 with all three supports supported on driven Alternative (Alt) "X" concrete piles with design loads of 45 tons. The 1971 As-built LOTB provided pile driving information, which included the minimum, average, and maximum penetration elevations for the piles. The bottom of pile cap elevations listed were obtained from the As-built foundation plan. Table 1 presents a summary of the 1971 As-built Data.

Table 1: Summary of the 1971 As-built Data

Support Location	Foundation Type	Design Load (ton)	Bottom of Pile Cap Elev. (feet)	Min. Penetration Elev. (feet)	Avg. Penetration Elev. (feet)	Max Penetration Elev. (feet)
Abutment 1	12" Driven Alt "X" Pile	45	958.1	929.3	927.1	926.5
Bent 2	12" Driven Alt "X" Pile	45	935.5	920.2	918.1	916.1
Abutment 3	12" Driven Alt "X" Pile	45	953.6	928.1	926.5	925.3

Example: Shallow Foundations

The existing Cenda Ditch Bridge consists of a two-span, cast-in-place, slab bridge that was constructed in 1963. Abutments 1 and 3 are end-diaphragm abutments and are supported on spread footings placed in approximately 20 feet of embankment fill material. Pier 2 is supported on seven columns, each with a spread footing founded on rock. The As-built bottom of footing elevations and footing pressures for the bridge are shown below in Table 2.

Table 2: As-built Information

Location	As-built Bottom of Footing Elevation (feet)	As-built Allowable Footing Pressure (tsf)	As-built Design Footing Pressure (tsf)
Abutment 1	4499.1	2.0	2.0
Pier 2	4475.0	5.0	5.0
Abutment 3	4490.7	2.0	2.0

3.9 Scour Data

If the bridge spans a watercourse, use the table in the example to present scour data from the Hydraulics Report.

If the field investigation reveals geologic information that contradicts the hydraulics report, discuss the findings and provide pertinent information to the hydraulics report author so that the scour recommendations can be re-evaluated.

Omit this section if the bridge does not span a watercourse.

Example: Scour Data Unavailable (PFR only)

The bridge spans a watercourse. BIRIS records do not identify historic scour issues. The Structure Hydraulics & Hydrology Branch has not yet provided a Hydraulics Report to this Office.

Example: Scour Data Available

The bridge site is underlain by alluvial soil, which are considered potentially scourable. The Structure Hydraulics & Hydrology Branch provided the following scour information in a report dated December 15, 2023 (Table 1).

Table 1: Scour Data

Support Location		*Long Term Scour (Degradation and Contraction) Elevation (feet)*	*Short Term Scour (Local) Depth (feet)*
Left Bridge	*Abut 1*	*2285.6*	*3*
	Abut 2	*2285.1*	*3*
Right Bridge	*Abut 1*	*2291.9*	*3*
	Abut 2	*2291.6*	*3*

3.10 Corrosion Evaluation

Include and update the corrosion data from the SPGR based on new findings and field investigations. If corrosion testing was not completed during the foundation investigation, provide justification for the corrosion recommendations.

Example: Non-Corrosive

Three soil samples and one water sample were collected for corrosion testing during the 2024 subsurface investigation. Corrosion test results for those samples are shown below in Table 1. Based on Caltrans standards, the site is non-corrosive.

<u>Example: Corrosive</u>

During the 2024 subsurface investigation, four soil samples were collected for corrosion testing. Corrosion test results for the samples collected from borings RC-24-001 and RC-24-002 are shown below in Table 1. Due to the chloride content being greater than 500 ppm in two of the samples tested, the site is corrosive based on Caltrans standards, and corrosion mitigation is required.

Table 1: Soil Corrosion Test Summary

Boring ID	Elevation (feet)	Minimum Resistivity (Ohm-Cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)	Corrosive?
RC-24-001	15.8 to 14.3	1544	7.24	N/A	N/A	No
RC-24-001	-4.2 to -3.2	683	7.94	384	432	No
RC-24-002	-69.1 to -70.6	73	6.86	850	1500	Yes
RC-24-002	-104.1 to -105.6	78	7.71	1000	1600	Yes

Caltrans currently defines a corrosive environment as an area where the soil has either a chloride concentration of 500 ppm or greater, a sulfate concentration of 1500 ppm or greater, or has a pH of 5.5 or less. Except for MSE, soil and water are not tested for chlorides and sulfates if the minimum resistivity is greater than 1,100 ohm-cm.

3.11 Seismic Information

Update the seismic information required for the SPGR based on new findings and/or investigations. Summarize analyses and evaluations performed, and recommendations relating to seismic design.

3.11.1 Ground Motion Hazard

Include the following information:

a. Ground Motion Parameters table
b. State how the estimated time-average shear wave velocity V_{S30} was determined (e.g., CPT, SPT correlations, or geophysics).
c. Ground Motion Data Sheet (see *Design Acceleration Response Spectrum-* module) in Appendix
d. In cases where the Soil Profile Class varies between bridge supports (deep foundations only), include the *Soil Profile Class* table and leave the Soil Profile Class column in the Ground Motion Parameters table blank.

Table X. Ground Motion Parameters

Site Parameters			Design Ground Motion Parameters[1] (Return Period = 975 years)			Soil Profile Class
Latitude (degrees)	Longitude (degrees)	Shear-Wave Velocity[2] V_{S30}, (m/sec)	Horizontal Peak Ground Acceleration (g)	Deaggregated Mean Earthquake Moment Magnitude for PGA	Deaggregated Mean Site-to-Fault Distance for 1.0 Second Spectral Acceleration (km)	
XXX.XXXX	XXX.XXXX	XXX.X	X.XX	X.XX	XX.XX	XX

1. Based on Caltrans web tool ARS Online (Version 3.xx)
2. Shear wave velocity determined by SPT correlations

Table X. Soil Profile Class

Bridge Support	Pile Diameter (inches)	Pile's Zone of Influence in Lateral Loading				Soil Profile Class
		Soil Type(s)	Top Elev.(1) EL_{top} (ft)	Thickness (2) L_{upper} (ft)	Bottom Elev.(3) EL_{bottom} (ft)	

1 EL_{top}.: Lower of the pile cut-off and the lowest finish grade elevations at the support
2 L_{upper}: Thickness of the pile's zone of influence in lateral loading based on Section 6.2.3 of SDC v2.0
3 $EL_{bottom} = (EL_{top} - L_{upper})$.

3.11.2 Other Seismic Hazards

The section must address the following seismic hazards:

a. Surface fault rupture (see *Fault Rupture* module)
b. Liquefaction (see *Liquefaction Evaluation* module)
c. Effects of Liquefaction, including
    i. Seismically-induced ground surface settlements at each support location
    ii. Downdrag at each support location with pile foundations (see *Downdrag* module)
    iii. Lateral spreading (see *Lateral Spreading* module)
d. Seismic slope stability
e. Tsunami risk

<u>*Example: No Hazards*</u>

The site has been determined not to have potential for surface fault rupture, liquefaction, seismic-induced slope failure, or tsunami.

<u>*Example: No Surface Fault Rupture*</u>

The bridge is not located within an Alquist-Priolo Earthquake Fault Zone or within 1000 feet of any unzoned Holocene fault. Therefore, the bridge is not considered susceptible to surface fault rupture hazards.

<u>*Example: Surface Fault Rupture*</u>

The bridge is located within the active Hayward fault zone (north section). The Hayward fault lies within the bridge footprint, probably at Abutment 3, oriented approximately perpendicular to the bridge. Per the attached Fault Rupture Report dated March 10, 2024, the bridge could experience up to 7.9 feet of lateral offset, *perpendicular to and anywhere within the bridge footprint. Up to 0.79 feet of vertical offset can be expected to occur with the horizontal offset.*

Example: Liquefaction

Due to the presence of loose to medium dense alluvial material and shallow groundwater beneath the site, the potential for soil liquefaction is present at the site. Liquefiable zone elevations at the abutment and pier locations are summarized in Table 1.

Table 1: Liquefaction Potential at Old River Bridge

Support	Liquefaction Elevation (feet)	Estimated Seismic-induced Settlement (inches)
Abutment 1	Elev. 20 to 15 Elev. 0 to -10	3
Pier 2	Elev. 10 to -5	4
Abutment 3	Elev. 20 to 10	3

Example: Liquefaction with Downdrag

Liquefaction-induced settlement of the ground surface and pile downdrag are anticipated and summarized in Table 1. Implications of liquefaction on the pile tip elevations will be addressed in the Geotechnical Recommendations section.

Table 1: Liquefaction Potential at Old River Bridge

Support	Liquefaction Elevation (feet)	Estimated Seismic-induced Settlement (inches)	Downdrag Zone Bottom Elevation (feet)	Estimated Downdrag Load (kips/pile)
Abutment 1	Elev. 20 to 15 Elev. 0 to -10	3	-5	150
Pier 2	Elev. 10 to -5	4	-3	50
Abutment 3	Elev. 20 to 10	3	12	100

Note: Downdrag loads calculated for 24-inch CIDH concrete piles at the Abutments and 60-inch CISS at Pier 2.

Example: Lateral Spreading

Due to the presence of liquefiable soils at shallow depths and relatively high design horizontal peak ground acceleration, a lateral spreading hazard assessment was performed at each abutment by ignoring all lateral resistance contributions from the foundation piles. The assessment indicated a lateral spreading hazard potential at both abutments.

Additional lateral spreading analyses were performed for each abutment. The pile restraining force versus displacement plots (MTD 20-15 Figure 5, Curve 3) developed for the two abutments are shown in Figures X and Y.

Due to the discontinuity of the liquefiable layers, lateral spreading potential does not exist at Pier 2.

Example: Seismic Slope Stability

Seismic slope stability analyses were performed to evaluate the overall stability at the proposed abutment slopes. The pseudo static analysis was performed with a horizontal seismic coefficient (k_h) equal to 0.15g.

Two-dimensional slope stability analyses were performed. The analyses found the value of factor of safety at the proposed abutment slopes to be approximately 1.25 (resistance factor = 0.8), which meets the accepted minimums for stable abutment slopes (per AASHTO-CA-BDS).

Example: No Tsunami Risk

The site is located about 0.25 miles from the nearest coastline. However, the ground surface elevation at the bridge location ranges from 100 to 120 feet above mean sea level. The site is not located within the tsunami inundation zone shown in California Official Tsunami Inundation Map for the X County (Interactive Map accessed on mm/dd/year).

Based on the above information and per MTD 20-13, a tsunami hazard does not exist at the site.

Example: Tsunami Risk

The site is located about 0.25 miles from the nearest coastline and the ground surface elevation at the bridge location ranges from 10 to 50 feet above mean sea level. The site is located within the tsunami inundation zone shown in California Official Tsunami Inundation Map for the X County (Interactive Map accessed on mm/dd/year).

Based on the above information and per MTD 20-13, a tsunami hazard exists at the site.

3.12 Geotechnical Recommendations

Provide complete and concise recommendations for bridge foundations by addressing the topics in the applicable portions (i.e., Shallow Foundations, Driven Pile Foundations, and/or CIDH Concrete Pile Foundations) of this section. Include recommendations for earth retaining structures connected to the bridge.

Present and/or discuss the following:

1. Identify all structures addressed in this section
2. Discuss any considerations (e.g., environmental, right-of-way, permitting, CMGC, ABC) that influenced the foundation type selection.

Example

The following recommendations are for the proposed Dry Creek Bridge (Br. No. 54-1200) and associated wing walls.

3.12.1 Shallow Foundations

Provide complete and concise recommendations by addressing the topics in the applicable portions of this section. Discuss any considerations which influence foundation type selection, analysis, and design (e.g., scour, groundwater, ground improvement).

Present the following in the Preliminary Foundation Report:

1. A description of the material on which the footing is to be placed
2. A description of the ground line conditions (e.g., flat, sloped)
3. Foundation Data table (MTD 4-1, Attachment 4, Table 1)
4. Preliminary Foundation Data Tables
   a. End Supports (Abutments) table (after MTD 4-1 Attachment 2, Table 1)
   b. Intermediate Supports (Bents and Piers) table (after MTD 4-1 Attachment 2, Table 2)

If applicable, present the following additional items in the Preliminary Foundation Report:

5. If spread footings are to be constructed below groundwater level, identify the type of excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).
6. If unsuitable native soil underlies the proposed footing, specify removal and replacement with structure backfill.

<u>*Example: Shallow Foundations (PFR)*</u>

At Abutments 1 and 2 support locations, spread footings are recommended. The foundation recommendations were designed in accordance with the AASHTO Bridge Design Specification with CA Amendments. The subsurface information gathered for the site indicate that the abutment footings will be founded on dense sand. The spread footings are in proximity to a descending slope and were designed as "footing on a slope." The following Foundation Geotechnical Data Tables provide preliminary recommendations for all support locations.

Table X: Foundation Data

Support Location	Finished Grade Elevation (feet)	Bottom of Footing Elevation (feet)	Footing Dimensions (feet)		Permissible Settlement under Service Load (inches)
			B	L	
Abutment 1					
Bent 2					
Abutment 3					

Table X: Preliminary Foundation Data for Abutments

End Supports (Abutments)

Support Location:
Foundation Material (Soil or Rock)[1]:
Friction Angle or Undrained Shear Strength for Sliding:
Permissible Settlement (in):
Resistance Factor (Strength) – φ_b:
Resistance Factor (Seismic) – φ_b:

	Total Number of B' =			
No	Effective Footing Width	Gross Nominal Bearing Resistance	Permissible Net Contact Stress (Settlement)	Factored Gross Nominal Bearing Resistance (Strength)
	B' (feet)	q_n (ksf)	q_{pn} (ksf)	q_R (ksf)
1				
2				
3				
4				
5				

1. Select “Soil” or “Rock” depending on design methodology used.
2. Based on L’ =_____ ft.

Table X: Preliminary Foundation Data for Bents and Piers

Intermediate Supports (Bents and Piers)

Support Location:
Foundation Material (Soil or Rock)[1]:
Friction Angle or Undrained Shear Strength for Sliding:
Permissible Settlement (in):
Resistance Factor (Strength) – φ_b:
Resistance Factor (Seismic) –φ_b:

Total Number of unique *L′/B′* Ratios[2]	
Total Number of *B*′s per *L′/B′* Ratios[3]	

No	Effective Footing Width	Effective Footing Size Ratio	Gross Nominal Bearing Resistance	Permissible Net Contact Stress (Settlement)	Factored Gross Nominal Bearing Resistance (Strength)
	B' (ft)	L' / B'	qn (ksf)	qpn (ksf)	q_R (ksf)
1					
2					
3					
4					
5					
1					
2					
3					
4					
5					
1					
2					
3					
4					
5					
1					
2					
3					
4					
5					
1					
2					
3					
4					
5					

1. Select “soil” or “rock” depending on design methodology used.
2. Indicates total number of curves used to show variations of q_n, q_{pn}, and q_R vs. B'.
3. Indicates total number of points on each curve to show variations of q_n, q_{pn}, and q_R vs. B'.

Present the following in the Foundation Report:

1. A description of the material on which the footing is to be placed.
2. A description of the ground line conditions (e.g., flat, sloped)
3. Information from the Bridge Designer
    a. Foundation Data table (MTD 4-1, Attachment 4, Table 1)
    b. Summary of Controlling Loads table (MTD 4-1, Attachment 5, Table 1)
4. Foundation Design Recommendations for Spread Footing table (MTD 4-1, Attachment 5, Table 2).
5. Spread Footing Data Table (MTD 4-1, Attachment 5, Table 3).
6. Calculated resistance factor for overall/global stability and local slope stability of the foundation (Service Limit State and Extreme Event Limit State).

If applicable, present the following additional items in the Foundation Report:

7. If spread footings are to be constructed below groundwater level, identify the type of excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).

    Example

    Show Type D excavation on the plans at Piers 2 and 3.

8. For Type A excavations present the seal course thickness (see *Seal Course* module).

    Example

    Show Type A excavation on the plans at Piers 2 and 3 with a seal course thickness of 3 feet.

9. If unsuitable native soil underlies the proposed footing, specify removal and replacement with structure backfill.

Example: Shallow Foundations (FR)

At Abutments 1 and 2 support locations, spread footings are recommended. The foundation recommendations are based on the information provided by Bridge Design in the following tables and were designed in accordance with the AASHTO Bridge Design Specification with CA Amendments. The subsurface information gathered for the site indicate that the abutment footings will be founded on dense sand. The spread footings are in proximity to a 1.5:1 descending slope and were designed as "footing on a slope." The following Foundation Design Recommendations table and Spread Footing Data Table provide final recommendations for Abutments 1 and 2.

Table X: Foundation Data

Support Location	Finished Grade Elevation (feet)	Bottom of Footing Elevation (feet)	Footing Dimensions (feet)		Permissible Settlement under Service Load (inches)
			B	L	
Abutment 1					
Bent 2					
Abutment 3					

Table X: Summary of Controlling Loads

Support Location	L (feet)	B (feet)	Controlling Loads						
			M_X (kip-ft)	M_Y (kip-ft)	V_X (kips)	V_Y (kips)	P_{total} (kips)	P_{perm} (kips)	*Load Combination*
Abutment 1				N/A	N/A				
Bent 2									
Abutment 3				N/A	N/A				

Table X: Foundation Design Recommendations for Spread Footing

Support Location	Footing Size (feet)		Bottom of Footing Elevation (feet)	Minimum Footing Embedment Depth (feet)	Total Permissible Support Settlement (inches)	Service Limit State	Strength Limit State (φ_b=)	Extreme Event Limit State (φ_b=1.0)
	B	L				Permissible Net Contact Stress (ksf)	Factored Gross Nominal Bearing Resistance (ksf)	Factored Gross Nominal Bearing Resistance (ksf)
Abutment 1						(B' =)	(B' =)	N/A
Bent 2						(B' =)	(B' =)	(B' =)
Abutment 3						(B' =)	(B' =)	N/A

For each contact stress and bearing resistance in the table, include the associated effective footing width (B') in parentheses. See *Shallow Foundations* module for example.

Table X: Spread Footing Data Table

Support Location	Service Permissible Net Contact Stress (Settlement) (ksf)	Strength/Construction Factored Gross Nominal Bearing Resistance (φ_b=) (ksf)	Extreme Event Factored Gross Nominal Bearing Resistance (φ_b=1.0) (ksf)
Abutment 1			N/A
Bent 2			
Abutment 3			N/A

Example: Shallow Foundations (FR)

Groundwater will be encountered during construction of the footings at the proposed abutments, therefore show Structure Excavation Type A on the plans with a seal course thickness of 3 feet.

The subsurface information gathered for the site indicate that the Abutment 1 footing will be founded in sedimentary rock formation. At Abutment 2, unsuitable native soils underlie the proposed footings. It is recommended that the native materials be removed to a depth of 5 feet (Elev. 15 feet) below the bottom of footing and be replaced with Structure Backfill or seal course to the bottom of footing elevation. The bottom of sub-excavation elevations for the abutments are listed in Table 1. The limits of the sub-excavation and replacement shown on the plans must conform to the limits specified in Standard Specification 19-5.03B for compaction of embankments under retaining wall footings without pile foundations.

Table 1: Bottom of Sub-Excavation Elevation

Support Location	*Bottom of Sub-Excavation Elevation (feet)*
Abutment 2	*15*

Global stability was analyzed at Abutment 2. The calculated resistance factors for global stability were found to satisfy current requirements for both the Service-I Limit State (static), as well as the Extreme Event Limit State (pseudo-static). Table 2 summarizes the global stability analysis results. Abutment 1 was not analyzed because it is founded on sedimentary rock formation.

Table 2: Global Stability Analysis Summary (Abutment 2)

Service Limit State	*Calculated Factor of Safety*	*Calculated Resistance Factor*	*2017 AASHTO LRFD Resistance Factor Requirement*
Service-I Limit State (Static)	*1.5*	*0.65*	*≤0.65*
Extreme Event Limit State (Pseudo-Static)	*1.11*	*0.89*	*≤0.90*

3.12.2 Deep Foundations

3.12.2.1 Driven Pile Foundations

Provide complete and concise recommendations by addressing the topics in the applicable portions of this section. Discuss any considerations which influence the analysis and design (e.g., scour, liquefaction, lateral spreading, groundwater).

Present the following in the <u>Preliminary Foundation Report</u>:

1. Information provided by Bridge Designer
    a. Preliminary Foundation Design Data Sheet (MTD 3-1, Attachment 1, Table 3-2)
2. Preliminary Foundation Design Recommendations table, that includes the following modifications:
    a. Report the resistance factors (in column header) using the appropriate notations, e.g., ϕ_{qs} and ϕ_{qp} = 0.7 for side resistance and tip resistance, see AASHTO-CA-BDS-8 (10.3 and Table 10.5.5.2.3-1).
    b. Round the Required Nominal Resistance up to the nearest 10 kips.

If applicable, present the following in the <u>Preliminary Foundation Report</u>:

3. When requested by Bridge Design, provide the soil parameters for lateral analyses for both non-liquefied and liquefied conditions. In some cases, complete lateral analyses may also be requested. Present the data in the Appendix.
4. If the Required Nominal Resistance does not equal the Required Nominal Driving Resistance (e.g., scour susceptible layer, liquefiable layer), explain why.
5. If a Standard Plan pile or steel H-pile requires modification (e.g., increased wall thickness, adding driving tips or lugs), provide recommendations so that the modifications will be shown on the project plans.

    <u>Example</u>

    Install lugs on all steel "H" piles prior to driving. It is recommended that the pile detail sheets or abutment detail sheets show the lugs as illustrated in the Bridge Construction Records and Procedures Manual, Bridge Construction Memo 130-5.0, except that the lugs be located 10 feet from the pile tip.

6. When a pile cap excavation is anticipated to extend below the groundwater surface elevation, discuss with the Bridge Designer and identify the “type” of structure excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).

   Example

   Show Type D excavation on the plans at Piers 2 and 3.

7 For Type A excavations present the seal course thickness (see *Seal Course* module).

   Example

   Show Type A excavation on the plans at Piers 2 and 3 with a seal course thickness of 3 feet.

Example: Driven Pile Foundations (PFR/FR)

Driven pile foundations are recommended at all support locations to address the liquefiable layer located in the upper 15 feet. The foundation recommendations were designed in accordance with the AASHTO Bridge Design Specification with CA Amendments. The following tables provide (preliminary) recommendations for all support locations.

Table X: Preliminary Foundation Design Data Sheet

Support Location	Foundation Type(s) Considered	Estimate of Maximum Factored Compression Loads (Strength Limit State) (kips)
Abutment 1		
Pier 2		
Abutment 3		

Table X: Preliminary Foundation Design Recommendations

Support Location	Pile Type	Cutoff Elevation (feet)	Required Nominal Resistance (Strength Limit State) (kips)		Preliminary Tip Elevation (feet)
			Compression (φ_{qs}=0.7) (φ_{qp}=0.7)	Tension (φ_{qs}=0.7)	
Abutment 1					
Pier 2					
Abutment 3					

Add note if applicable:

- Cutoff elevations not provided by Bridge Design and are estimated by Geotechnical Services

Present the following in the Foundation Report:

1. Information provided by Bridge Design
    a. Foundation Design Data Sheet (MTD 3-1, Attachment 1, Table 3-4)
    b. Foundation Factored Design Loads (MTD 3-1, Attachment 1, Table 3-5)
2. Foundation Design Recommendations table (after MTD 3-1, Attachment 1, Table 3-6), that includes the following modifications:
    a. Report the resistance factors (in column header) using the appropriate notations, e.g., ϕ_{qs} and ϕ_{qp} = 0.7 for side resistance and tip resistance, see AASHTO-CA-BDS-8 (10.3 and Table 10.5.5.2.3-1).
    b. Round the Required Nominal Resistance (Strength and Extreme Limit State) to the nearest 10 kips.
3. Pile Data Table (MTD 3-1, Attachment 1, Table 3-7)
4. The Required Nominal Driving Resistance is the side resistance of all penetrated soil, including scourable layers, downdrag, and liquefiable layers, plus the tip resistance. Show this value in the Foundation Design Recommendations table and the Pile Data Table.

If applicable, present the following in the Foundation Report:

5. When requested by Bridge Design, provide the soil parameters for lateral analyses for both non-liquefied and liquefied conditions. In some cases, complete lateral analyses may also be requested. Present the data in the Appendix.
6. If the Required Nominal Resistance does not equal the Required Nominal Driving Resistance (e.g., scour susceptible layer, liquefiable layer), explain why.
7. For projects where a pile drivability study has been performed during the design phase (for pipe piles and steel shells), provide the minimum pile wall thickness determined by the pile drivability study in the Foundation Design Recommendation and Pile Data tables.
8. If a Standard Plan pile or steel H-pile requires modification (e.g., increased wall thickness, adding driving tips or lugs), provide recommendations so that the modifications will be shown on the project plans.

    Example

    Install lugs on all steel "H" piles prior to driving. It is recommended that the pile detail sheets or abutment detail sheets show the lugs as illustrated in the Bridge Construction Records and Procedures Manual, Bridge Construction Memo 130-5.0, except that the lugs be located 10 feet from the pile tip.

    Example

    Show Modified Class 200, Alternative "W" steel pipe pile details on the project plans. The modified pipe pile must be shown with a flat circular steel plate or *conical steel tip with a minimum thickness of ¾ inch welded to the pile tip, similar to the Alternative "V" pile tip detail shown in the Standard Plans.*

9. If the design calculations account for liquefaction, discuss how the effect of liquefaction was incorporated in the pile foundation recommendations.

10. If the design calculations account for seismic downdrag then add the following:

    "The design loads and design tip elevations were adjusted to account for seismic downdrag. The additional seismic downdrag loads calculated by Geotechnical Services were provided to Bridge Design, and appropriate load factors were applied by Bridge Design and incorporated into the Foundation Factored Design Loads (MTD 3-1, Attachment 1, Table 3-5) provided by Bridge Design to this Office."

11. If the design calculations account for static downdrag, discuss how the effect of static downdrag was incorporated in the pile foundation recommendations.

12. When a pile cap excavation is anticipated to extend below the groundwater surface elevation, the Geoprofessional must discuss with the Bridge Designer and identify the "type" of structure excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).

    Example

    Show Type D excavation on the plans at Piers 2 and 3.

13. For Type A excavations present the seal course thickness (see Seal Course module).

    Example

    Show Type A excavation on the plans at Piers 2 and 3 with a seal course thickness of 3 feet.

14. State how the nominal resistance was developed for CISS piles.

    Example

    The geotechnical resistance of the CISS piles was developed using external side resistance and tip resistance based upon a combination of the end area of the steel shell and the internal side resistance of the portion of the soil plug that will be left in place.

15. For CISS piles, state the top of soil plug elevation and the seal course thickness (if applicable) required for the tip resistance design of CISS piles.

    Example

    At Abutment 4, a soil plug is utilized to develop internal side resistance in the lower portion of the CISS pile for tip resistance design. The top of the soil plug elevation must be at elevation 252 feet. A seal course thickness of 5 *feet is required to counteract the hydrostatic forces of the groundwater and to allow for the pile reinforcement and concrete to be poured in the dry.*

Table X: Foundation Design Data Sheet

Support Location	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inches)	Number of Piles per Support
				B	L		
Abut 1							
Pier 2							
Abut 3							

Table X: Foundation Factored Design Loads

Support Location	Service-I Limit State (kips)		Strength/Construction Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load per Support	Permanent Load per Support	Compression		Tension		Compression		Tension	
			Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1							N/A	N/A	N/A	N/A
Pier 2										
Abut 3							N/A	N/A	N/A	N/A

Table X: Foundation Design Recommendations

Support Location	Pile Type	Cut-Off Elevation (feet)	Service-I Limit State Load per Support (kips)		Total Permissible Support Settlement (inches)	Required Nominal Resistance (kips)				Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Required Nominal Driving Resistance (kips)
						Strength Limit		Extreme Event				
			Total	Perm.		Comp. (φ_{qs}=0.7) (φ_{qp}=0.7)	Tension (φ_{qs}=0.7)	Comp. (φ_{qs}=1) (φ_{qp}=1)	Tension (φ_{qs} =1)			
Abut 1	Class 140 Alt "V"							N/A	N/A	(a-I) (c)		
Pier 2	CISS 24 x 0.5									(a-I) (b-I) (a-II) (b-II) (c)		
Abut 3	Class 140 Alt "V"							N/A	N/A	(a-I) (c)		

Present the following notes under the Foundation Design Recommendations table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by (a-I) Compression (Strength), (b-I) Tension (Strength), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement

If the design tip elevation for settlement is not calculated because the pile tip is in rock, add the following note:

- Design Tip Elevations for Settlement were not calculated because the pile is tipped in rock.

If applicable:

- The specified tip elevations shall not be raised above the design tip elevations for Tension, Settlement and Lateral Load.
- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevation and are therefore the Specified Tip Elevations. The Required Nominal Driving Resistances are based on the lateral design tip elevations.

Table X: Pile Data Table

Support Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Required Nominal Driving Resistance (kips)
		Compression	Tension			
Abutment 1	Class 140 Alt. “V”			(a) (c)		
Pier 2	CISS 24 x 0.5			(a) (b) (c)		
Abutment 3	Class 140 Alt. “V”			(a) (c)		

Present the following Notes under the Pile Data Table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by (a) Compression, (b) Tension, (c) Settlement

If the design tip elevations for settlement are not calculated because the pile tips are in rock, add the following note:

- Design Tip Elevations for Settlement not calculated because the piles are tipped in rock.

If applicable, add the following note:

- The specified tip elevations shall not be raised above the design tip elevations for Tension, Settlement and Lateral Load.
- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations and are therefore the Specified Tip Elevations. The Required Nominal Driving Resistances are based on the lateral design tip elevations.

3.12.2.2 CIDH Concrete Pile Foundations

Provide complete and concise recommendations by addressing the topics in the applicable portions of this section. Discuss any considerations which influence analysis and design (e.g., scour, liquefaction, lateral spreading, groundwater, usage of permanent casings or shells). Discuss how the pile was designed (e.g., side and tip resistance, locations where geotechnical resistance was ignored, downdrag zones).

Present the following in the Preliminary Foundation Report:

1. Information provided by Bridge Design
    a. Preliminary Foundation Design Data Sheet (MTD 3-1, Attachment 1, Table 3-2)
2. Preliminary Foundation Design Recommendations table, that includes the following modifications:
    a. Report the resistance factors (in column header) using the appropriate notations, e.g., ϕ_{qs} = 0.7 and ϕ_{qp} = 0.5 for side resistance and tip resistance, see AASHTO-CA-BDS-8 (10.3 and Table 10.5.5.2.4-1).
    b. Round the Required Nominal Resistance up to the nearest 10 kips.

If applicable, present and/or discuss the following in the Preliminary Foundation Report:

3. When requested by Bridge Design, provide the soil parameters for lateral analyses for both non-liquefied and liquefied conditions. In some cases, complete lateral analyses may also be requested. Present the data in the Appendix.

4. When a pile cap excavation is anticipated to extend below the groundwater surface elevation, the Geoprofessional must discuss with the Bridge Designer and identify the “type” of structure excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).

    Example

    Show Type D excavation on the plans at Piers 2 and 3.

5. For Type A excavations present the seal course thickness (see Seal Course module).

    Example

    Show Type A excavation on the plans at Piers 2 and 3 with a seal course thickness of 3 feet.

<u>Example: CIDH Concrete Piles (PFR/FR)</u>

CIDH concrete pile foundations are recommended at all support locations. The foundation recommendations were designed in accordance with the AASHTO Bridge Design Specification with CA Amendments. The following tables provide (preliminary) recommendations for all support locations.

Table X: Preliminary Foundation Design Data Sheet

Support Location	Foundation Type(s) Considered	Estimate of Maximum Factored Compression Loads (Strength Limit State) (kips)
Abutment 1		
Pier 2		
Abutment 3		

Table X: Preliminary Foundation Design Recommendations

Support Location	Pile Type	Cutoff Elevation (feet)	Required Nominal Resistance (Strength Limit State) (kips)		Preliminary Tip Elevation (feet)
			Compression (φ_{qs}=0.7) (φ_{qp}=0.5)	Tension (φ_{qs}=0.7)	
Abutment 1					
Pier 2					
Abutment 3					

Add note if applicable:

- Cutoff elevations not provided by Bridge Design and are estimated by Geotechnical Services

Present the following in the Foundation Report:

1. Information provided by Bridge Design
   a. Foundation Design Data Sheet (MTD 3-1, Attachment 1, Table 3-4)
   b. Foundation Factored Design Loads (MTD 3-1, Attachment 1, Table 3-5)
2. Foundation Design Recommendations table (MTD 3-1, Attachment 1, Tables 3-6 or Tables 3-8), with the following modifications:
   a. Report the resistance factors (in column header) using the appropriate notations, e.g., ϕ_{qs} = XX for side resistance, ϕ_{qp} = YY for tip resistance, see AASHTO-CA-BDS-8 (10.3 and Table 10.5.5.2.4-1).
   b. Round the Required Nominal Resistance (Strength and Extreme Limit State) and Factored Design Loads (Service Limit State) to the nearest 10 kips.
   c. If a CIDH concrete pile is supporting a single column, identify whether the pile is a Type I or Type II shaft in the “Pile Type” column.
   d. If a Permanent Steel Casing is used, add column “Permanent Steel Casing Specified Tip Elevation (feet)”.
   e. If a Permanent Casing is used, add column “Permanent Casing Specified Tip Elevation (feet)”.
   f. If a Driven Steel Shell is used:
      i. add column “Driven Shell Specified Tip Elevation (feet)”.
      ii. add column “Required Nominal Driving Resistance (kips)”.
   g. If a Rock Socket (see table A) is used:
      i. Add column “Top of Rock Socket Elevation (feet)”.
      ii. Add footnote: “The Bottom of Rock Socket Elevation is equal to the Specified Tip Elevation.”
3. Pile Data Table (MTD 3-1, Attachment 1, Tables 3-7 or 3-9), with the following modifications:
   a. Round the Nominal Resistance up to the nearest 10 kips.
   b. If a CIDH concrete pile is supporting a single column, identify whether the pile is a Type I or Type II shaft in the “Pile Type” column.
   c. If a Permanent Steel Casing is used, add column “Permanent Steel Casing Specified Tip Elevation (feet)”.
   d. If a Permanent Casing is used, add column “Permanent Casing Specified Tip Elevation (feet)”.
   e. If a Driven Steel Shell is used:
      i. add column “Driven Steel Shell Specified Tip Elevation (feet)”.

ii. add column "Required Nominal Driving Resistance (kips)".

f. If a Rock Socket is used:

i. Add column "Top of Rock Socket Elevation (feet)".

ii. Add footnote: "The Bottom of Rock Socket Elevation is equal to the Specified Tip Elevation.".

If applicable, present and/or discuss the following in the Foundation Report:

4. When requested by Bridge Design, provide the soil parameters for lateral analyses for both non-liquefied and liquefied conditions. In some cases, complete lateral analyses may also be requested. Present the data in the Appendix

5. If the design calculations account for liquefaction, discuss the how the effects of liquefaction were incorporated in the pile foundation recommendations

6. If the design calculations account for seismic downdrag then add the following:

"The design loads and design tip elevations were adjusted to account for seismic downdrag. The additional seismic downdrag loads calculated by Geotechnical Services were provided to Bridge Design, and appropriate load factors were applied by Bridge Design and incorporated into the Foundation Factored Design Loads (MTD 3-1, Attachment 1, Table 3-5) provided by Bridge Design to this Office."

7. If the design calculations account for static downdrag, discuss the how the effect of static downdrag was incorporated in the pile foundation recommendations.

8. If a Driven Steel Shell is recommended, state that the geotechnical side resistance is used in pile design. State the minimum pile wall thickness for the driven steel shell.

Example

The geotechnical side resistance of the driven steel shell is used in the design of the pile. A minimum pile wall thickness of 0.5 inches is required per the drivability study.

9. If a Permanent Casing is recommended, state that it must be a corrugated metal pipe and that it is not used for geotechnical capacity.

Example

The permanent casing must be specified as a CMP. It is not used for geotechnical capacity.

10. If a Permanent Steel Casing is recommended, state that it is not used for geotechnical capacity.

    Example

    The permanent steel casing is not used for geotechnical capacity.

11. When a pile cap excavation is anticipated to extend below the groundwater surface elevation, the Geoprofessional must discuss with the Bridge Designer and identify the "type" of structure excavation (Type A or Type D) required at all applicable support locations (See Bridge Design Aids, Section 11 - Estimating).

    Example

    Show Type D excavation on the plans at Piers 2 and 3.

12. For Type A excavations present the seal course thickness (see Seal Course module).

    Example

    Show Type A excavation on the plans at Piers 2 and 3 with a seal course thickness of 3 feet.

Use the applicable Foundation Design Recommendations table and Pile Data Table listed below and presented on the following pages.

- CIDH Concrete Pile in Soil (no Casing/Shell)
- CIDH Concrete Pile in Soil (Permanent Casing)
- CIDH Concrete Pile in Rock Socket (no Permanent Casing)
- CIDH Concrete Pile in Rock Socket (Permanent Casing)

CIDH Concrete Pile in Soil (no Casing/Shell)

Table X: Foundation Design Recommendations

Support Location	Pile Type	Cut Off Elevation (feet)	Service-I Limit State Load per Support (kips)		Total Permissible Support Settlement (inches)	Required Nominal Resistance (kips)				Design Tip Elevation (feet)	Specified Tip Elevation. (feet)
						Strength/Construction		Extreme Event			
			Total	Permanent		Compression (ϕ_{qs}=0.7) (ϕ_{qp}=0.5)	Tension (ϕ_{qs}=0.7)	Compression (ϕ_{qs}=1.0) (ϕ_{qp}=1.0)	Tension (ϕ_{qs}=1.0)		
Bent 2	60" CIDH Concrete Piles									(a-I) (a-II) (c)	
Bent 3	60" CIDH Concrete Piles									(a-I) (a-II) (c)	

Present the following notes under the Foundation Design Recommendations table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by (a-I) Compression (Strength), (b-I) Tension (Strength), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations, and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Soil (no Casing/Shell)

Table X: Pile Data Table

Support Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Bent 2	60" CIDH Concrete Piles			(a) (c)	
Bent 3	60" CIDH Concrete Piles			(a) (c)	

Present the following notes under the Pile Data Table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by: (a) Compression, (c) Settlement.
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If applicable:

- The lateral design tip elevation provided by Bridge Design is lowest design tip elevation, and is therefore the Specified Tip Elevation.

CIDH Concrete Pile in Soil (Permanent Casing)

Table X: Foundation Design Recommendations

Support Location	Pile Type	Cut Off Elevation (feet)	Service-I Limit State Load per Support (kips)		Total Permissible Support Settlement (inches)	Required Nominal Resistance (kips)				Permanent Casing Specified Tip Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation (feet)
						Strength/Construction		Extreme Event				
			Total	Permanent		Compression (ϕ_{qs}=0.7) (ϕ_{qp}=0.5)	Tension (ϕ_{qs}=0.7)	Compression (ϕ_{qs}=1.0) (ϕ_{qp}=1.0)	Tension (ϕ_{qs}=1.0)			
Bent 2	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)										(a-I) (a-II) (c)	
Bent 3	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)										(a-I) (a-II) (c)	

Present the following notes under the Foundation Design Recommendations table. Edit to include only those load cases provided in the table:

- Permanent Casing must be a CMP
- Design tip elevations are controlled by (a-I) Compression (Strength), (b-I) Tension (Strength), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations, and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Soil (Permanent Casing)

Table X: Pile Data Table

Support Location	Pile Type	Nominal Resistance (kips)		Permanent Casing Specified Tip Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation (feet)
		Compression	Tension			
Bent 2	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)				(a) (c)	
Bent 3	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)				(a) (c)	

Present the following notes under the Pile Data Table. Edit to include only those load cases provided in the table:

- Permanent Casing must be a CMP
- Design tip elevations are controlled by: (a) Compression, (c) Settlement.
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations, and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Rock Socket (no Permanent Casing)

Table X: Foundation Design Recommendations

Support Location	Pile Type	Cut Off Elevation (feet)	Service-I Limit State Load per Support (kips)		Total Permissible Support Settlement (inches)	Required Nominal Resistance (kips)				Top of Rock Socket Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation. (feet)
						Strength/Construction		Extreme Event				
			Total	Permanent		Compression (ϕ_{qs}=0.7) (ϕ_{qp}=0.5)	Tension (ϕ_{qs}=0.7)	Compression (ϕ_{qs}=1.0)	Tension (ϕ_{qs}=1.0)			
Bent 2	60” CIDH Concrete Piles										(a-I) (a-II) (b-I) (b-II) (c)	
Bent 3	60” CIDH Concrete Piles										(a-I) (a-II) (b-I) (b-II) (c)	

Present the following notes under the Foundation Design Recommendations table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by (a-I) Compression (Strength), (b-I) Tension (Strength), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement
- Bottom of Rock Socket Elevation = Specified Tip Elevation
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If the design tip elevation for settlement is not calculated because the pile tip is in rock, add the following note:

- Design Tip Elevations for Settlement not calculated because the piles are tipped in rock.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations, and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Rock Socket (no Permanent Casing)

Table X: Pile Data Table

Support Location	Pile Type	Nominal Resistance (kips)		Top of Rock Socket Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation (feet)
		Compression	Tension			
Bent 2	60" CIDH Concrete Piles				(a) (b) (c)	
Bent 3	60" CIDH Concrete Piles				(a) (b) (c)	

Present the following notes under the Pile Data Table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by: (a) Compression, (b) Tension, (c) Settlement.
- Bottom of Rock Socket Elevation = Specified Tip Elevation
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If the design tip elevations for settlement are not calculated because the pile tips are in rock, add the following note:

- Design Tip Elevations for Settlement not calculated because the piles are tipped in rock.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Rock Socket (Permanent Casing)

Table X: Foundation Design Recommendations

Support Location	Pile Type	Cut Off Elevation (feet)	Service-I Limit State Load per Support (kips)		Total Permissible Support Settlement (inches)	Required Nominal Resistance (kips)				Top of Rock Socket Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Permanent Casing Specified Tip Elevation (feet)
						Strength/Construction		Extreme Event					
			Total	Permanent		Compression (ϕ_{qs}=0.7) (ϕ_{qp}=0.5)	Tension (ϕ_{qs}=0.7)	Compression (ϕ_{qs}=1.0) (ϕ_{qp}=1.0)	Tension (ϕ_{qs}=1.0)				
Bent 2	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)										(a-I) (a-II) (b-I) (b-II)		
Bent 3	60" CIDH Concrete Piles with Permanent Casing (Type II Shaft)										(a-I) (a-II) (b-I) (b-II)		

Present the following notes under the Foundation Design Recommendations table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by (a-I) Compression (Strength), (b-I) Tension (Strength), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement
- Below the steel casing tip elevations, the CIDH concrete pile diameter is 48"
- Bottom of Rock Socket Elevation = Specified Tip Elevation
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If the design tip elevations for settlement are not calculated because the pile tips are in rock, add the following note:

- Design Tip Elevations for Settlement not calculated because the piles are tipped in rock.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations and are therefore the Specified Tip Elevations.

CIDH Concrete Pile in Rock Socket (Permanent Casing)

Table X: Pile Data Table

Support Location	Pile Type	Nominal Resistance (kips)		Top of Rock Socket Elevation (feet)	Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Permanent Casing Specified Tip Elevation (feet)
		Compression	Tension				
Bent 2	60” CIDH Concrete Piles with Permanent Casing (Type II Shaft)				(a) (b) (c)		
Bent 3	60” CIDH Concrete Piles with Permanent Casing (Type II Shaft)				(a) (b) (c)		

Present the following notes under the Pile Data Table. Edit to include only those load cases provided in the table:

- Design tip elevations are controlled by: (a) Compression, (b) Tension, (c) Settlement.
- Below the steel casing tip elevations, the CIDH concrete pile diameter is 48”
- Bottom of Rock Socket Elevation = Specified Tip Elevation
- The specified tip elevation shall not be raised above the lowest design tip elevation.

If the design tip elevations for settlement are not calculated because the pile tips are in rock, add the following note:

- Design Tip Elevations for Settlement not calculated because the piles are tipped in rock.

If applicable:

- The lateral design tip elevations provided by Bridge Design are the lowest design tip elevations and are therefore the Specified Tip Elevations.

3.12.3 Dynamic Monitoring and Pile Load Testing

Identify support locations for dynamic monitoring. The control zones are identified in the Notes for Specifications.

Example: Dynamic Monitoring (Preliminary Foundation Report)

At Piers 2, 4 and 6, dynamic monitoring is to be performed on the first CISS pile installed and will determine the pile acceptance criteria (SS 49-1.01D(4)). The control zones will be identified in the Foundation Report.

Example: Dynamic Monitoring (Foundation Report)

At Piers 2, 4 and 6, dynamic monitoring is to be performed on the first CISS pile installed and will determine the pile acceptance criteria (SS 49-1.01D(4)). The control zones are identified in the Notes for Specifications section of this report.

In consultation with Foundation Testing and Instrumentation staff, present and/or discuss the following for Pile Load Tests:

1) Control zones and associated support locations for the pile load tests.
2) Location, type and specified tip elevation of the load test pile and anchor piles in the Pile Load Test data table.
3) Type of load test
    a. Compressive (ASTM D 1143)
    b. Tensile (ASTM D 3689)
4) Purpose of test (select one)
    a. Proof test at Nominal Resistance
    b. Load to failure (provide estimate of maximum test load)
5) Identify piles to be dynamically monitored (Per the Standard Specifications, the load test pile and at least one anchor pile).
6) Restrike schedule if pile setup is anticipated.

Example: Driven CISS Piles – Pile Load Test (Preliminary Foundation Report)

Pile load tests in compression must be conducted on a non-production 48-inch CISS pile between Bent 4 of the left and right bridges. Pile Load Test details will be provided in the Foundation Report.

Example: Driven CISS Piles – Pile Load Test (Foundation Report)

Pile load tests in compression must be conducted on a non-production 48-inch CISS pile between Bent 4 of the left and right bridges, installed as required in the Pile Load Test Data table (Table 1). The control zone for the pile load test at Bent 4 will be Bents 2, 3, and 4 of the left and right bridges. During pile installation, the load test pile and one anchor pile will be dynamically monitored.

The compression test must be performed in two stages. For Stage 1 Pile Load Test, load the test pile to the nominal axial geotechnical resistance after driving the test pile to the tip elevation and before removal of the soil plug. For Stage 2 Pile Load

Test, load the test pile to the "failure load" after removal of the soil plug, placement a 5-foot-thick seal course, and placement of concrete in the test pile. The estimated maximum test load is 2700 kips.

Table 1: Pile Load Test Data

Support Location	*Pile Type*	*Ground Elevation (feet)*	*Cut-Off Elevation (feet)*	*Specified Top of Soil Plug Elevation (feet)*	*Specified Tip Elevation (feet)*	*Required Nominal Driving Resistance (kips)*
Bent 4	*CISS 48 x 1.0 (Load Test Pile)*	*98*	*108*	*40*	*30*	*2350*
	CISS 24 x 0.5 (Anchor Piles)	*98*	*101*	*N/A*	*40*	*800*

3.12.4 Approach Fills

This section may be omitted if the approach fill (fill within 150 feet of the bridge abutment) does not require special considerations for soft or otherwise unsuitable soil.

Present approach fill recommendations in this section. Reporting requirements for embankment construction on soft soil are presented in the *Embankment* module and the *Ground Improvement* module of the Geotechnical Manual.

In cases where settlement-related recommendations are presented, the Geoprofessional must collaborate with the author of the Geotechnical Design Report to assure that the recommendations are compatible. Issues to discuss may include:

- Anticipated settlement magnitude
- Rate of construction
- Prefabricated vertical drain locations, spacings, and lengths (see *Ground Modification* module)
- Use of geosynthetics for separation and/or reinforcement (see *Geosynthetics* module and *Geosynthetic Reinforced Embankment* module)

3.13 Notes for Specifications

Omit this section for the Preliminary Foundation Report.

This section provides recommendations to the Specifications Engineer for inclusion and editing of Standard Special Provisions and NSSPs. Refer to the *Geotechnical Notes for Specifications* module for guidance on how to prepare this report section.

3.14 Notes for Construction

Omit this section for the Preliminary Foundation Report.

Notes for Construction are written to State construction personnel and contractors. Specific geologic conditions that are relevant to construction inspection should be cited in this section to ensure that both the intent of the geotechnical design is met and construction is successful. Include the following Notes if applicable.

3.14.1 Notes for Construction (Shallow Foundations)

1) Include the following instructions (edited for the project site conditions) to address potential disturbance of native material below the specified bottom of footing elevation(s).

   Example: Footing on Soil

   At all support locations, the spread footings are to be founded on the native alluvium. The structural concrete is to be placed neat against the undisturbed native alluvium at the bottom of the footing excavation. Should the bottom of the footing excavation be disturbed, then the disturbed material must be removed and replaced at 95% relative compaction.

   Example: Footing on Rock

   At all support locations, the spread footings are to be founded on the weathered rock. The structural concrete is to be placed neat against the trimmed walls and undisturbed rock at the bottom of the footing excavation. Should the bottom of the footing excavation be disturbed, then the disturbed material must be removed and replaced to the bottom of footing elevation with concrete.

2) Include the following instructions to request footing inspections by the Geoprofessional.

   Example

   All support footing excavations are to be inspected and approved by the Office of Geotechnical Design X, Branch Y. The inspections will be made after the excavation has been completed to the bottom of footing elevations and prior to placing concrete or rebar in the excavations. It is requested that the Structures Representative provide the Office of Geotechnical Design X, Branch Y a one-week notification to perform the inspections.

   (Note: If sub-excavation and replacement are required, modify the above example to require the inspection to be performed when the contractor completes the sub-excavation and prior to replacement.)

3.14.2 Notes for Construction (Driven Piles)

1) Provide limits for vibratory installation

   Example:

   Usage of the vibratory method for pile installation may be used to a pile tip elevation of XX feet.

3.14.3 Notes for Construction (CIDH Concrete Piles)

Report how the geotechnical resistance is derived, whether from side resistance and/or tip resistance. Present the highest “Top” elevation and lowest “Bottom” elevation for soil that contribute to pile side resistance in the “CIDH Concrete Pile Side Resistance Zone Elevations” table.

Example: CIDH Geotechnical Resistance in Soil

The calculated “Nominal Resistance” of the CIDH concrete piles was based on side resistance only. Tip resistance was not used. The zones used to calculate the side resistance of the CIDH concrete piles are shown in Table 1.

Table 1: CIDH Concrete Pile Side Resistance Zone Elevations

Support Location	*Top of Side Resistance Zone Elevation (feet)*	*Bottom of Side Resistance Zone Elevation (feet)*	*Specified Tip Elevation (feet)*
Pier 2	*165.4*	*151.4*	*145.0*
Pier 3	*165.4*	*153.4*	*147.0*
Pier 4	*168.5*	*156.0*	*150.0*

Example: CIDH Geotechnical Resistance in Rock Socket

The calculated “Nominal Resistance” of the CIDH concrete piles was based on side resistance only. Tip resistance was not used. The zones used to calculate the side resistance of the CIDH concrete piles are shown in Table 2.

If the actual top of rock elevation varies by more than X feet from the elevation presented in Table 2, the Office of Geotechnical Design Y must be contacted for further instruction.

Table 2: CIDH Concrete Pile Side Resistance Zones

Support Location	*Top of Rock Elevation (feet)*	*Top of Side Resistance Zone Elevation (feet)*	*Bottom of Side Resistance Zone Elevation (feet)*	*Specified Tip Elevation (feet)*
Pier 2	*67.5*	*65.5*	*50.5*	*48.5*
Pier 3	*67.5*	*65.5*	*52.5*	*50.5*
Pier 4	*70.5*	*68.5*	*55.0*	*53.0*

3.15 Report Distribution

Reports must be addressed to the Bridge Designer and copies provided to:

- District Project Manager
- Project Liaison Engineer (PFR only)
- District Environmental Planning (optional, PFR only)
- Structure Office Engineer (FR only)
- District Materials Engineer

3.16 Appendices

Report appendices provide detailed information supporting foundation type selection, analyses, and recommendations. Reports prepared by Geotechnical Services staff must include the following if produced during the investigation (in the order presented, numerated as Appendix I, Appendix II, …):

- Ground Motion Data Sheet
- Laboratory Test Data (including Corrosion Test Report) – Organized by test type. In addition to the raw laboratory test results, organize and provide summary tables and graphs developed for the interpretation of laboratory test results.
- Field-generated Geologic Map and Cross-Sections: Do not include copies of published maps.
- Geophysical Test Reports
- Fault Rupture Report
- Pile Drivability Study
- Approved "Request for Exception" forms

Optional:

- Photos relevant to the investigation findings, design recommendations, and construction. Photos that illustrate content presented in the text should be embedded in the report if feasible.

Reports prepared by consultants must include the following if produced during the investigation (in the order presented, numerated as Appendix I, Appendix II, …).

- Ground Motion Data Sheet
- Laboratory Test Data (including corrosion) – Organized by test type. Summarize and provide summary tables and graphs developed for the interpretation of laboratory test results.
- Field-generated Geologic Map and Cross-Sections: Do not include copies of published maps.
- Geotechnical Design Parameters for p-y Curves
- Geophysical Test Reports
- Fault Rupture Report
- Pile Drivability Study
- Data acquired from field testing such as Pressuremeter, Dilatometer, in-situ Vane Shear Tests, slope inclinometer.
- Approved "Request for Exception" forms
- OPTIONAL: Photos relevant to the investigation findings, design recommendations, and construction. Photos that illustrate content presented in the text should be embedded in the report if feasible.

Additionally, the following must be submitted individually (i.e., not attached to the report) for all Preliminary Foundation Reports and Foundation Reports:

1. Log of Test Borings (including As-built LOTB) and Test Boring Layout sheet
2. Calculation Package
    - The objectives of each calculation, such as bearing resistance or time rate of settlement.
    - Calculation assumptions
    - Geotechnical model used for each calculation
    - Equations used and meaning of the terms used in the equations
    - Copies of the curves or tables used in the calculations and their source.
    - The load and resistance factors, or factors of safety, used for the design
    - If the calculations are performed using computer spreadsheets – step-by-step calculations for one example to demonstrate the basis of the spreadsheet. A computer spreadsheet is not a substitute for the step-by-step calculation.
    - Summary of the calculation results that form the basis of geotechnical recommendations, including a sketch of the design, if appropriate.
3. Comment Matrix with consultant responses