Geotechnical Notes for Specifications

July 2026

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1. Introduction

Geotechnical engineering has been commonly recognized as the engineering work that includes geotechnical investigation, analysis, design, and preparing and issuing geotechnical reports. However, issuing geotechnical reports should not be the end of involvement for geotechnical engineering. To ensure the design is properly contracted and constructed, you should also assist in the development of construction contract Plans, Specifications, and Estimate (PS&E) and assist the Resident Engineer with administration of the construction contract.

To assist the development of project specifications, i.e. Special Provisions, you should be familiar with geotechnical-related sections of the Standard Specifications and Standard Special Provisions (SSPs).

Standard Specifications provide uniform contract clauses that apply to all Caltrans construction contracts while SSPs provide the means for Specification Engineers to draft project specific contract clauses and compile them into a project's Special Provisions.

To ensure consistency and maintain contract quality, an SSP can only be edited according to the instructions in the SSP. Refer to the latest SSPs in the *SSP web page* for embedded instructions for each SSP.

Edits beyond instructions in an SSP make it a Nonstandard Special Provision (NSSP). NSSPs may require a time-consuming approval process. Therefore, editing beyond instructions should be avoided. Refer to *Geotechnical Non-Standard Special Provision Process* for details.

For the development of a PS&E package, you should:

- Provide instructions for recommended edits to SSPs in the Notes for Specifications section of Geotechnical Design Reports and Foundation Reports. Do not include the Notes for Specifications section in preliminary geotechnical reports, which will not be read and referenced by specification engineers.

- Draft or assist in the preparation of NSSPs and assist the Specification Engineer with obtaining approval from the Specification Owner of the section of the Standard Specifications, and concurrence from functional units identified in the *Construction Contract Development Guide* for geotechnical NSSPs. For the Specification Owner Roster, refer to *Caltrans HQ/Design/Office Engineer Construction Contract Standards* web site.

- Review the draft PS&E package received from District or Structure Office Engineer (OE) to verify that:

    - The project plans have incorporated geotechnical recommendations provided in the Geotechnical Design Report or Foundation Report.

- The project Special Provisions include the SSPs or NSSPs edited as recommended in the Geotechnical Design Report or Foundation Report.

In a contract package, a component in one contract part applies as if appearing in each. The parts are complementary and describe and provide for a complete work.

If a discrepancy exists, governing ranking of contract parts in descending order is:

1. Special provisions
2. Project plans
3. Standard specifications
4. Revised standard plans
5. Standard plans
6. Supplemental project information – includes compilation of Geotechnical Design Reports and Foundation Reports, LOTBs, and Boring Records

Therefore, it is critical to provide concise and precise instructions and recommendations for edits of SSPs, which will be compiled into the Special Provisions.

Subsequent sections in this document provide instructions on how to provide instructions and recommendations to the Specification Engineer for SSP editing:

Section 2 Notes for Specifications – general instructions

Section 3 Geotechnical Related SSPs and Suggested Instructions – instructions for recommended specification edits and examples of content for *Notes for Specifications* section

Appendices

Appendix 1 – List of Typical SSPs for Common Geotechnical Related Construction Items

Appendix 2 – Printout of Geotechnical Related SSPs – with the instructions for specifications edits shown

2. Notes for Specifications

In the *Notes for Specifications* section, provide concise instructions or recommendations to the Specification Engineer to edit SSPs and the NSSPs posted in the *NSSP for Geotechnical Design* web page.

Do not quote the Standard Specifications in geotechnical reports. Standard Specifications are applicable to all construction contracts. Referring to or quoting from Standard Specifications creates duplication and potential to incorrectly state the Standard Specifications.

To create a clear and concise communication channel between the Geotechnical Designers, Specification Engineers, and Project Engineers, identify SSP section numbers and provide the instructions for the recommended edits. For projects with multiple construction components, list applicable SSPs and provide instructions and recommendations for edits under each construction component. An SSP may be edited for different parts of the project. For example, a large project may include multiple earth retaining systems, highway embankments, and bridges. Subsurface conditions can be different at each construction component location. Each construction component would require different edits for the same SSP.

Format section number of an SSP as follows, so that section numbers will not be shown in the pdf file of the Geotechnical Design Report or Foundation Report:

Font → Effects → Hidden

Font → Font Color → Green

(Note: Not showing section numbers is to address the issue of potential inconsistency of section numbers during interim specification publication periods.)

3. Geotechnical Related SSPs, nSSPs, and Suggested Instructions

This section may not contain a comprehensive and up-to-date compilation of geotechnical related SSPs. SSPs are updated on an as-needed basis and new SSPs are periodically developed and added into the SSP list. For up-to-date SSPs, refer to the latest SSP list provided by *Caltrans HQ/Design/Office Engineer*, which can be accessed through the following Caltrans internal web link: *Construction Contract Standards | Division of Design (ca.gov)*.

For questions on geotechnical related SSPs and specifications related issues, contact *Geotechnical.Specification@dot.ca.gov*.

For each geotechnical related SSP shown below, instructions are provided for the instructions and recommendations that should be included in the *Notes for Specifications* section. The instructions followed by "➢" are action items, while the instructions followed by "❖" are for information and clarification. These instructions were developed based on the editing instructions in each of the SSPs. When reviewing instructions provided in this section, cross reference the geotechnical related SSPs with the embedded instructions for each SSP compiled in Appendix 2.

This section is organized in the sequential order of contract items listed in the Standard Specifications.

2 Bidding

2-1.06B Supplemental Project Information

- If there are rock cores available for inspection, enter "Rock cores" in the 2nd row of the table under the “Description” column. Do not enter location of the rock cores or contact information. The email address: *Coreroom@dot.ca.gov* is provided in the Standard Specifications for bidders to contact for inspection of the rock cores.
- If there are log of test borings available, enter "Test boring layout and Log of test borings" in the 3rd row of the table under the "Description" column.

Supplemental Project Information

Means	Description
Included in the *Information Handout*	*This field will be filled in by the Specification Engineer*
Available as specified in the *Standard Specifications*	*Rock cores*
Included with the project plans	*Test boring layout and Log of test borings*
~~Available for inspection at the Transportation Laboratory~~	
~~Available for inspection at the District Office Telephone no.: _____~~	
~~Available for inspection at: _____ _____ Telephone no.: _____~~	
~~Available for inspection at: http://www.dot.ca.gov/_____~~	

- Do not self-reference titles of geotechnical reports. Specification Engineers will compile the list of documents and reports received from the project engineer and to be included in the Supplemental Project Information.
- During geotechnical review of the Draft PS&E package, verify that the list and contents of geotechnical reports and additional geotechnical information, such as rock cores, log of test borings, and test boring layout, are included in the Supplemental Project Information / Information Handout of the Draft PS&E package.

19 Earthwork

19-3 Structure Excavation and Backfill

19-3.01D(2) Soil Nail Wall and Ground Anchor Wall Zones

- Work with structure designer and plans detailer to delineate wall zones on the plans. Showing wall zones on the plans is preferred by contractors and Structure Representatives, and easier to present wall zone boundaries, which should typically follow boundaries of subsurface profiles.
- For rare occasions when wall zones are not to be shown on the plans, provide wall zones for each soil nail wall using the following table:

Using the table, the wall zones will be described as rectangular areas. This is not advised for most occasions.

Wall zone	Beginning station	End station	Upper elevation (feet)	Lower elevation (feet)
1				
…				

19-3.03A Locations and Vertical Extents of Excavation to Remove Material below Bridge or Earth Retaining System Footings

- ❖ If excavation to remove material below the bottom of bridge or earth retaining system footings are required, provide instructions in the *Recommendations* section or during design to have the plans show the locations and vertical extents of excavation. The removed material will typically be replaced with Class 2 AB and compacted.
- ➢ If material below the bottom of excavation described above must be compacted, use the table below to provide the locations that need to be compacted.

Structure Number	Alignment Line	Begin Station (or Abutment Number)	End Station (or Bent Number)

19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation

- ➢ Include a note if surface water or groundwater is expected during structure excavation (Type D) or (Type DH), but no seal course is recommended and shown.
- ❖ If surface water or groundwater is expected during structure excavation, and you determine that seal course is required, provide a recommendation for seal course (Structure excavation Type A) in the *Recommendations* section of the Foundation Report. Do not evoke SSP 19-3.03B(1).

19-3.03B(2) Soldier Pile Retaining Walls are not Built Completely from the Top Down

- ❖ This SSP removes the requirement for the soldier pile wall to be constructed from the top down. No actions or recommendations are needed from Geotechnical Design.

19-3.03E(3) Minimum Height of the Compacted Backfill behind the Lagging of a Soldier Pile wall is other than 5 feet above the first Row of Ground Anchors

- ➢ Provide the required minimum height of compacted backfill above the level of ground anchors before drilling.

19-3.04 Structure Excavation and Backfill Payment Clauses

- ❖ No actions or recommendations are needed from Geotechnical Design but refer to the Standard Specifications and SSP for details.

19-6 Embankment Construction

19-6.02B Geosynthetic Reinforced Embankment

- ➢ If backfill material must have different requirements than those specified in the Standard Specifications, provide recommended particle size distribution, plasticity index, and pH.

  Note that long-term strength of geosynthetic reinforcements can be significantly affected by backfill properties, especially gradation and angularity.

- ➢ Provide the list of primary geosynthetic reinforcements available in section 96-1.02D(2) of Standard Specifications and used in the design, such as PR1400, PR2000, and PR3200.

  Use provided different line types and associated legend on the elevation and cross-section views of the plans to show the embedment lengths, elevations, and terminating stations of geosynthetic reinforcement layers.

- ➢ Provide the list of secondary geosynthetic reinforcements available in section 96-1.02D(3) of Standard Specifications and used in the design, such as SR0800, and SR1200.

  Use different line types and associated legend on the typical cross-section view of the plans to show the embedment lengths and typical vertical spacing of geosynthetic reinforcement layers.

19-6.03B Subsidence of the Ground Surface is Anticipated, and Embankment, or Imported Borrow is Measured by Theoretical Basis

- ❖ Indicate if subsidence of ground surface is anticipated due to embankment construction and refer to the *Recommendations* section for the estimated subsidence profile and affected areas.
- ❖ Provide estimated subsidence profile and affected areas in the *Recommendation*s section so that the additional quantity and cost of embankment can be estimated by the estimator.

19-6.03D Settlement Periods and Surcharges

- ➢ If settlement periods are required at bridges, provide instructions and the settlement period in the following table. Provide surcharge height in the following table if applicable. If only settlement periods are required, and no surcharge is required, enter "0.0" in the "Surcharge height" column.

Structure Number	Support Location (Abutment or Bent No.)	Surcharge height (feet)	Settlement period (days)

- If settlement periods of roadway embankments behind earth retaining structures are required, provide instructions and the settlement period in the following table. Provide surcharge height in the following table if applicable. If only settlement periods are required, and no surcharge is required, enter "0.0" in the "Surcharge height" column.

Structure Number	Alignment Line	Begin Station	End Station	Surcharge height (feet)	Settlement period (days)

19-6.04 Payment Quantity for Anticipated Subsidence – for Embankment Construction

- No actions or recommendations are needed from Geotechnical Design but refer to the Standard Specifications and SSP for details.
- If subsidence is anticipated during embankment construction, the magnitude of anticipated subsidence should be provided in the Geotechnical Design Report, so that the payment quantity can be estimated by others. Refer to Geotechnical Design Report Guidelines.

19-7 Borrow Material

19-7.02B Local Borrow

- If requested, in the *Recommendations* section of Geotechnical Design Report, provide geotechnical assessment of local borrow identified by District.

19-7.02C Imported Borrow

- If requested, in the *Recommendations* section of Geotechnical Design Report, provide geotechnical assessment of imported borrow identified by District.
- If requested and District indicates imported borrow is neededUse the following table to provide plasticity index requirement for imported borrow placed below 4 feet of the grading plane.Specifying a Plasticity Index (PI) < 12 is recommended to reduce heaving potential of pavement to very low. If specifying imported borrow with a PI < 12 is not feasible due to costs, quantities, or availability, discuss with the district.

Quality Characteristic	Test Method	Requirement
Plasticity Index (max)	California Test 204	--

  - Add additional tables if other requirements, such as gradation requirement, for imported borrow are needed.

19-8 Lightweight Cellular Concrete Fill

- ❖ No actions are needed from Geotechnical Design but refer to the SSP for details.
- ❖ You may use lightweight cellular concrete fill to reduce anticipated settlement caused by new highway embankment or earth retaining system.

19-11 Compaction Grouting

- ❖ In the *Recommendations* section of Geotechnical Design Report, provide one of the two options described in the SSP for design and contract administration of compaction grouting.

19-12 EPS Geofoam Block

- ❖ In the *Recommendations* section of Geotechnical Design Report provides:
  - EPS geofoam types to be used and instructions for plans showing the geofoam types, locations, and extents
  - Class of gasoline resistant geomembrane
  - Class of cushion fabric if needed

19-16 Trenchless Construction

- ❖ This SSP should be used for projects that include trenchless construction for culvert or conduit installation. It may also be used for other similar projects that require trenchless construction.

19-17 Ground Movement and Vibration Monitoring

- ➢ Provide a plan with your design of layout and locations of monitoring sensors to the project engineer so that the sensors can be shown on the plan view and elevation view of the Plans.
- ➢ Indicate the start and end days of the monitoring period.
- ❖ This SSP can be used for settlement, settlement profile, areal settlement, and vibration monitoring using electronic automatic sensors and wireless data transmission.

  The SSP also requires the contractor to salvage and submit reusable equipment. Coordinate with districts to inventory and store the salvaged reusable equipment so that they can be deployed and reused for future projects as state-furnished equipment.

46 Ground Anchors and Soil Nails

46-1 General

46-1.01A Work Sequence

- ➢ Provide concise instructions on specific work sequencing concerns related to ground anchors and soil nails construction. These may include the timing of ground anchor stressing relative to the construction of other elements due to bearing capacity consideration.

46-1.03E Research Investigation

- ➢ Provide concise instructions for research activities, such as survey markers, slope indicator casings and other equipment for movement monitoring.
- ❖ Refer to the SSP for assistance needed from the contractor.

46-2 Ground Anchors

46-2.01 NSSP – Ground Anchor Verification Test

- ❖ The following set of 5 NSSPs are implementing verification test for ground anchors. This test is needed to verify geotechnical resistance from bonded length of ground anchor.

  Current performance and proof tests of ground anchors cannot isolate the geotechnical resistance within bonded length.

- ➢ Include a note, "*Recommend use of the following NSSPs:*", and provide the link to the Geotechnical Services NSSP web page for these NSSPs.

  46-2.01B NSSP – Added Definition for Verification Tests of Ground Anchors

  46-2.01C NSSP – Verification Test Specific Information

  46-2.01D(2)(c) NSSP – Ground Anchor Verification Test

  46-2.01D(3)(c) NSSP – Verification Test Acceptance Criteria

  46-2.03E NSSP – Construction of Verification Test Ground Anchors

46-2.01C Alternative Number of Ground Anchors

- ❖ This SSP is included for information only. Structure designers are responsible for providing information for this SSP if on a short time limit contract or an alternative number of ground anchors that provide the same horizontal and vertical components and distribution of the design force is allowed.

46-2.01D(2)(b)(i)Locations and Number of Ground Anchor Performance Tests

- ❖ During design, provide locations of ground anchors subject to performance test. During Geotechnical Review of Draft Structure PS&E, review the plans to verify the locations are shown.
- ➢ When the locations cannot be determined during design and shown on the plans, provide the minimum number of ground anchors subject to

performance test. Refer to instructions in the SSP for the minimum number of performance tests should be performed. During construction, assist the Structure Representative with selecting the locations.

46-2.01D(2)(b)(ii) Non-LRFD Ground Anchors or Lock-off Load of Footing Ground Anchors is ≥ 0.25 P_{TL}

- ❖ No actions or recommendations are needed from Geotechnical Design but refer to the SSP for details.

46-2.01D(3)(b)(ii) Lock-off Load of Footing Ground Anchors is ≥ 0.25 P_{TL}

- ❖ No actions or recommendations are needed from Geotechnical Design but refer to the SSP for details.

46-2.03A Expected Difficult Ground Anchor Installation due to Geotechnical Issues

- ❖ Do not use or enter geotechnical related information in this SSP.
- ❖ Provide observed or encountered geotechnical related surface conditions in geotechnical reports.
- ❖ Provide observed or encountered geotechnical related subsurface conditions in LOTBs or Boring Records.
- ❖ Provide interpreted subsurface conditions in geotechnical reports.

46-3 Soil Nails

46-3.01 NSSP - Pull to Failure of Soil Nail Verification Test

- ❖ The following set of 2 NSSPs are implementing pull to failure of soil nail verification test. This is a test needed to obtain actual soil nail geotechnical resistance.

  Current verification and proof tests of soil nails cannot provide actual geotechnical resistance of soil nails because they stop short of failing the test soil nails. Collecting actual geotechnical resistance of soil nails is needed to establish the database of geotechnical nominal resistance of soil nails for soils and rocks in California.

- ➢ Include a note, "*Recommend use of the following NSSPs:*", and provide the link to the Geotechnical Services NSSP web page for these NSSPs.

46-3.01C(1) NSSP – Added Submittal Requirement for Pull-to-Failure Verification Test Nail Bar

46-3.01D(2)(b)(ii)(B) NSSP – Load Schedule for Pull-to-Failure Verification Test (NSSP)

46-3.01D(2)(b)(ii)(C) 2% of Total Number of Production Soil Nails

- ❖ Verify the value equal to 2 percent of the total number of production soil nails for each wall or the entire project is provided in the SSP. This is the number of additional proof tests required at locations to be determined by the Engineer. (Note: The Engineer is the Resident Engineer as defined in Standard Specifications 1-1.07B Glossary.)
- ❖ The locations of these proof test nails are to be determined during construction or to be placed in zones that require special attention.

46-3.03A Expected Difficult Soil Nail Installation due to Geotechnical Issues

- ❖ Do not use or enter geotechnical related information in this SSP.
- ❖ Provide observed or encountered geotechnical related surface conditions in geotechnical reports.
- ❖ Provide observed or encountered geotechnical related subsurface conditions in LOTBs or Boring Records.
- ❖ Provide interpreted subsurface conditions in geotechnical reports.

47 Earth Retaining Systems

47-2.01A Alternative Earth Retaining Systems are allowed for Caltrans MSE Design Shown

- ❖ No actions or recommendations are needed from Geotechnical Design but refer to the SSP for details.

47-6.01A Alternative Earth Retaining Systems are allowed for Caltrans MSE or Type 1–5 retaining walls

- ❖ No actions or recommendations are needed from Geotechnical Design but refer to the SSP for details.

49 Piling

49-1 General

49-1.01D(3) Load Test Piles

- ➢ Provide load test control zones in the following table for driven piles with a diameter greater than 36 inches or if you recommended load tests.

Structure Number	Control zone	Load test pile support location

49-1.01D(4) Dynamic Monitoring of Driven Piles

- If dynamic monitoring of pile redriving should be performed other than 1 day after the pile is driven, provide the number of days. Refer to the Standard Specifications and SSP for details.
- Use the following table to provide the locations of supports and control zones that require dynamic monitoring to develop bearing acceptance criteria curves:

Structure Number	Control zone	Dynamic monitoring support location

Notes:

1) Dynamic monitoring is required:
   - for driven piles with a diameter of 18 inches and greater, or
   - if the required nominal driving resistance exceeds 600 kips.
2) You may consider additional dynamic monitoring for piles that do not satisfy the conditions identified in Note 1 above:
   - At sites with subsurface conditions that the modified Gates formula needs to be verified.
   - At locations closer to or at the support locations, while the load test and dynamic monitoring will be performed at a location within the same control zone but away from the support locations. According to SSP 49-1.01D(3), in control zones where load test is required (for piles with a diameter D > 36"), dynamic monitoring will be performed on both load test pile and anchor piles.
   - To verify the integrity of the piles when subject to the dynamic loads under proposed driving system.

49-1.01D(5) Test Borings to Verify Top of Rock Elevation if the Top of Rock Elevations Vary or are Uncertain – for Piling to be Embedded into Rock

- Use this SSP as the last resort. The preferred option is for Caltrans Geotechnical Design staff to perform this work during construction.
- Indicate if test borings are required during construction to verify top of rock. The intent of this specification is to verify top of rock, not to gather additional geotechnical data.

- Provide locations where test borings should be performed using the following table:

Structure Number	Location

- Provide the minimum depths below the specified pile tip elevation if the required minimum depths are other than 20 feet below the specified tip elevation shown. Refer to corresponding Standard Specifications and SSP for details.

49-1.03 Expected Difficult Pile Installation

- Do not use or enter geotechnical related information in this SSP.
- Provide observed or encountered geotechnical related surface conditions in geotechnical reports.
- Provide observed or encountered geotechnical related subsurface conditions in LOTBs or Boring Records.
- Provide interpreted subsurface conditions in geotechnical reports.

49-2 Driven Piling

49-2.01A(3)(a) Pile and Driving Data Form Submittal

- No actions or recommendations are needed from Geotechnical Design but refer to the SSP for expected review of the Pile and Driving Data Form submittals.

49-2.01A(3)(b) Require Driving System Submittal

- Indicate if the requirement for driving system submittals for each of the selected support locations or control zones is included in the *Recommendations* section of the geotechnical report.
- Each control zone requires a driving system submittal.
- Provide pile type, monitored support locations, and control zones using the following table:

Structure Number	Pile Type	Monitored Support Location	Control Zone

49-2.01C(2) Conditions Require Revising Specifications for Driving Equipment

- Indicate and provide instructions if any of the following conditions exist and revising the specifications is required:
  - Installing sheet piles that have no geotechnical capacity along the length of the pile. Where vibratory hammers for sheet piles may be used; provide the locations using the following table:

Structure Number	Abutment Number	Bent Number

49-2.01C(3) If Drilling for Driven Piles or Casings is Allowed or Restricted

- No action for paragraphs 1, 2, and 4.
- Use the following table to provide the locations of drilling allowed, and the bottom of the drilled hole elevation to attain the specified tip elevation.

Structure Number	Support Location	Bottom of Hole Elevation, feet

Note: According to the Standard Specifications, a "drilled hole" has a diameter less than the least dimension of the pile.

- Indicate if center-relief drilling may be necessary for open-ended CISS and steel pipe piles; provide the exclusion zone above the specified pile tip where center-relief drilling is not allowed.

Note: For open-ended steel pipe piles and CISS, center-relief drilling is not allowed before driving piles.

49-2.01C(4) Predrilling for Driven Piles in Existing Embankment is Required

- Indicate and provide the following table if:
  - piles are to be installed in existing fills with thickness greater than 5 feet, or
  - predrilling is required due proximity to an obstruction, such as underground utilities, or other structure.

Structure Number	Support Location	Bottom of Hole Elevation, feet	Condition

Note: According to Standard Specifications, a predrilled hole must be at least 6 inches larger than the greatest dimension of the pile cross section and used in embankments constructed under the contract, or near an obstruction.

- ➢ Indicate if predrill holes are needed for piles to be driven through existing concrete footings that are to remain structurally functional.

49-2.01C(5) Pile Set Period is Allowed

- ➢ Indicate if pile set period is allowed. Use the following table and provide:
  - The locations where pile set period is allowed, and
  - The set period (hours) based on the soil type at the site.

Structure Number	Support Location	Set Period (hours)

- ❖ Refer to the SSP for details.

49-3 Cast-In-Place Concrete Piling

49-3.02A CIDH Piling

- ➢ Indicate if there are CIDH concrete piles designed as end bearing. Provide the locations of the piles using the following table.

Bridge name or no.	Abutment no.	Bent no.

- ➢ Indicate if the CIDH piles will be constructed in cobbles, boulders, or hard rock.
- ➢ Indicate if the CIDH piles are 24 inches or greater in diameter.
- ❖ Refer to the SSP for details of requirements for each condition.

49-3.02B(6)(c) List of Synthetic Slurry for Steel Soldier Piles or CIDH Piles at least 24" in diameter and 5 feet in Length

- ❖ No actions or recommendations needed from Geotechnical Design but refer to the SSP for details of the synthetic slurry.
- ❖ Standard Specifications, section 49-3.02B(6)(c): "*Do not use synthetic slurries in holes drilled in primarily soft or very soft cohesive soils as determined by the Engineer.*"

49-3.02B(6)(d) Allow the Use of Water Slurry for CIDH Piles with Full-Depth Casing

- ❖ By default, water slurry is not allowed in the Standard Specifications.
- ➢ Indicate, if in the rare scenario that you allow the use of water as slurry, when a casing is used for the entire length of the drilled hole.

49-3.02C(1) CIDH Pile Drilling is anticipated through Cobbles, Boulders, or Hard Rock

- ➢ Indicate if CIDH pile drilling is anticipated through cobbles, boulders, or hard rock.

49-3.02C(4) CIDH Piles Designed as End Bearing

- ➢ Indicate inclusion of this SSP if there are CIDH concrete piles designed as end bearing.

49-3.02C(6) Installation Methods not Allowed for Permanent Steel Casing

- ➢ Provide a list of methods not allowed for installing permanent steel casings if any. Refer to the SSP for details.

49-3.02C(7) Permanent Casing for Type II CIDH Piling

- ➢ Indicate if the permanent casing must be corrugated metal pipe.
- ➢ Indicate if slurry cement backfill is allowed instead of grout. In the rare case that groundwater is below the tip of the casing, and the pile design does not rely on side resistance, then slurry cement backfill instead of grout may be allowed.
- ➢ If there are permanent casing installation methods not allowed, provide the list.
- ❖ Refer to the SSP for details.

49-3.03C(2) Clean-Out Depth for Open-Ended CISS Piles

- ➢ Indicate if other than 8 feet of the material at the bottom of piles must remain and provide the length.
- ❖ Refer to the SSP for typical practice.

49-4 Steel Soldier Piling

49-4.03B Conventional Drilling Equipment for Soils may not be Suitable and Bedrock or Boulders is shown in LOTBs; Pile Substitutions are Allowed

- ➢ Indicate if factual evidence of bedrock or boulders with soil matrix foundation material is shown on LOTBs and conventional drilling equipment for soils may not be suitable for drilling holes.
- ❖ No action for the second paragraph.

49-5 Micropiling

The SSP for micropiles divides into two categories:

Category A: Micropiles resisting primarily axial forces due to axial loading at the top of the micropile. This typically includes bridge foundations and may occasionally

include some walls. For Category A, the contractor determines the length, load testing is performed, and typically pressure grouting is used.

Category L: Micropiles subject to primarily shear and bending forces along their length due to lateral loading. This typically includes earth stabilization structures and most walls. For Category L, the State determines the length, load testing is not performed, and gravity grouting is used.

- Provide the category of micropiles for the project here, so that the SSP can be edited accordingly.

49-5.01D(4)(c)(i) Load Tests – Compression, Tension, or both; Proof, Verification, or both; Factored Test Load and Service Load

- Indicate if micropiles need to be load tested in compression.
- Indicate if micropiles need to be load tested in tension.
- Indicate if micropiles need to be load tested in both tension and compression.
- Indicate if micropiles need to be proof load tested.
- Indicate if micropiles need to be verification load tested.
- Indicate if micropiles need to be both proof and verification load tested.
- Indicate if creep test is required during the load tests.
- Review the PS&E package and verify that Factored Test Load (FTL) and Service Load (SL) for respective load tests (compression, tension, or both) are provided by Structure Design.

49-5.01D(4)(c)(ii) Verification Load Tests, Representative Supports or Wall Zones; Creep Test; Adjustment of Load Increment

- For bridges, provide location of each verification test micropile and the control zone that the verification test micropile represents using the following format:

Structure Number	Verification Test Micropile Location	Control Zone

Notes:

If load tests are required, a tension load test is preferred because it is cheaper to perform and typically provides a conservative assessment of pile compressive nominal resistance.

- For walls and slope stabilization structures, provide location of each verification test micropile and limits of the wall zone that the verification test micropile represents using the following table:

Structure Number	Verification Test Micropile Location	Wall Zone Limits	
		Begin Station	End Station

Notes:

1. Load tests are seldom required for slope stabilization and ERS applications.
2. If load tests are required, a tension load test is preferred since it is cheaper to perform and typically provides a conservative assessment of pile capacity.

- ➢ Provide instruction as to whether creep test is required during verification load test.
- ➢ Provide recommended adjustment of load increments between 1.00SL and 1.00 FTL, if needed.
- ❖ Refer to the SSP for details.

49-5.01D(4)(c)(iii) Number of Proof Load Tests; Timing of the First Proof Test; Creep Test; Adjustment of Load Increment

- ➢ Provide the number of micropiles per bridge support or wall zone to be proof load tested.
- ➢ Provide the percentage of micropiles that must be installed per bridge support or wall zone before the first proof test is performed.
- ➢ Provide instruction on whether creep test is required during proof load test.
- ➢ Provide recommended adjustment of load increments between 1.00SL and 0.80 FTL, if needed.
- ❖ Refer to the SSP for details.

49-5.01D(5)(b) Verification Load Test Acceptance Criteria

- ❖ Note: Defer to Structure Design for the maximum axial movement allowed.

49-5.01D(5)(c) Proof Load Test Acceptance Criteria

- ❖ Note: Defer to Structure Design for the maximum axial movement allowed.

49-5.03A Minimum Spacing and Elapsed Time when Installing the Next Micropile

- ➢ If the required minimum center-to-center spacing is greater than 5 feet, provide the minimum center-to-center spacing from an open hole.
- ➢ If the required grout set time is greater than 12 hours, provide the minimum elapsed time before start drilling the adjacent micropile.

Note: The default minimum center-to-center spacing is 5 feet, and at least 12 hours after initial grout has set.

49-5.03B Verification Test – Provide Geotechnical Equivalence using Isolation

- ➢ Provide the locations where the verification test micropile must be lengthened and isolated.
- ➢ Provide the amount to be lengthened and the elevation of the bottom of isolation.

Notes:

1. Isolation may be required due to the ground surface elevation being significantly higher than the cutoff elevation of the production micropiles, due to sloping strata layers, or due to other situations that cause a lack of geotechnical equivalence between the verification test micropile and the production micropiles that it represents.
2. The isolation should ensure that the verification test accounts for the same engaged length and ground materials as the production micropiles. Verification test movement criteria may need to be adjusted to be comparable to the proof test movement criteria, due to a longer elastic length.

58 Sound Walls

58-2.03A Friction Angle of the Foundation Material which Determines the Dimensions of the Sound Wall Foundation

- ➢ Verify that the Geotechnical Design Report provides the friction angle of the foundation material, which will determine the dimensions of the sound wall foundation, either piles or trench footings.
- ➢ Provide the friction angle of the foundation materials using the following table.

Sound Wall Number	Station Limits	Friction Angle (ϕ) of Foundation Materials, degrees

- ❖ Refer to the SSP and Standard Plans for details.

61 Drainage Facilities – General

61-2.01D(3) Drainage Pipe Settlement and the Characteristics of Surrounding Soils

- ❖ Pay attention to projects with culverts and drainage pipes, especially under new embankment.
- ➢ Indicate if the expected settlement of the pipe is greater than 3 inches, which will trigger field leakage tests of the pipe. Provide estimated lapse time after pipe installation and backfill before the leakage test is performed.
- ➢ Indicate if the materials around the pipeline are fine cohesionless (sand or silt) soils.

- ❖ Refer to the SSP for details.

65 Concrete Pipe

65-2 Rock or Unyielding Material under the Concrete Pipe

- ❖ Pay attention to projects with reinforced concrete pipes under new embankment.
- ➢ Indicate if rock or other unyielding material may be encountered in the excavation immediately below the bottom of the pipe bedding. The rock or the unyielding material immediately below the bottom of the pipe bedding should be excavated and backfill with structure backfill material.

68 Subsurface Drains

68-2.02F(1) Permeable Material for Underdrains

- ➢ If Class 1 permeable material is not to be used for underdrains, provide the recommended permeable material, Class 2 or 3, for underdrains. Refer to Standard Specifications for details.

68-3.02 Horizontal Drain Pipe

- ➢ The default drain pipe size is 1-1/2 inches. If the project needs a drain pipe size different from the default size, select from the table in the Standard Specification.

  Note: The default size of 1-1/2 inches is the most efficient and cost effective for drilling and installation, and can be accessed by video inspection instrument and cleaning equipment.

- ➢ The default configurations of pipe slots are described in the table in the Standard Specifications. If the project needs a pipe slot configuration different from the default configuration, enter the values of pipe slot configuration in the table provided.
- ➢ Provide the Type of circular-knit geotextile sock if needed.

  Do not use circular-knit geotextile sock if the horizontal drain is installed in a drilled hold. Use only if required by other agencies. The default pipe slot width is narrower than the opening sizes of available circular-knit geotextile sock.

68-5 Permeable Material Blanket

- ➢ Provide the recommended permeable material for permeable material blanket.
- ❖ Refer to the SSP for details.

69 Overside Drains

69-2 Geomembrane and Cushion Fabric

- ➢ For each site or application, provide the selection of

- Geomembrane Class
- Smooth or Textured Geomembrane, and
- Cushion Fabric Class

71 Existing Drainage Facilities

71-3.03 Grout Port Locations – Contact Grouting to Rehabilitate Existing Drainage Structures

➢ If requested, provide recommendations for grout port locations.

72 Slope Protection

72-2.02C Nonstandard Fabric for Rock Slope Protection

➢ Provide recommended fabric specifications if the fabric selected is not described in section 96-1.02I Rock Slope Protection Fabric.

76 Wells

76-3 NSSP – Boreholes

➢ Include a note to use this NSSP, instead of existing SSP, if drilling boreholes or installing inclinometers are included in the contract.

❖ This NSSP is scheduled to be published as a section of 2026 Standard Specifications.

❖ This NSSP stipulates

- Submittals of qualification and work plans
- Applicable ASTM standards for drilling, sampling, testing, and sounding

❖ This NSSP includes specifications for inclinometer.

❖ Refer to the NSSP for details.

76-4 NSSP – Monitoring Wells

➢ Include a note to use this NSSP, instead of existing SSP, if monitoring wells are included in the contract.

❖ This NSSP is scheduled to be published as a section of 2026 Standard Specifications.

❖ Refer to the NSSP for details.

76-6 Destroy Wells

- Use the following table to provide a list of exploratory boreholes, piezometers, or wells installed during geotechnical investigation and design and to be destroyed by the construction contract.

Wells to be Destroyed

Well ID	Well Type	(Northing, Easting)	(Latitude, Longitude)	Depth (ft)	Diameter (in)	Casing Type	Time to Destroy
	e.g., piezometer, slope inclinometer, TDR, Vibrating-wire transducer						e.g., after clearing and grubbing, after conclusion of pullout tests, when ordered

96 Geosynthetics

96-1.02B Specify Filter Fabric Class

- Provide the locations/application to receive filter fabric, and the class of filter fabric.
- The selection of filter fabric should be based on the gradation of the soils at the job site. Refer to the SSP for details.

Examples

Example 1 – Geosynthetic Reinforced Embankment

19-6.02B Geosynthetic Reinforced Embankment

- Backfill gradation requirements

Sieve size	Percentage passing
1-1/2"	100
3/4"	75 – 100
No. 4	40 – 100
No. 40	0 – 80
No. 200	0 – 60

- Backfill quality characteristics requirements

Quality characteristic	Test method	Requirement
Plasticity index (max)	California Test 204	25
pH	California Test 643	5 – 9

- Primary geosynthetic reinforcements

Geosynthetic reinforcement type	Color marking
PR1000	White
PR2000	Orange
PR3200	Green

- Secondary geosynthetic reinforcements

Geosynthetic reinforcement type
SR0800

19-6.03B Subsidence of the Ground Surface is Anticipated, and Embankment, or Imported Borrow is Measured by Theoretical Basis

- Subsidence of ground surface is anticipated due to embankment construction. Please refer to the *Recommendations* section of the report for the estimated subsidence profile.

Example 2 – MSE Wall

19-3.03A Removal of Unsuitable Material below the Footings

- At the locations shown in the following table, material below the bottom of excavated unstable material must be compacted:

Structure Number	Alignment Line	Begin Station	End Station
53-1537	A-line	07+00	10+80
	A-line	14+70	18+90
	A-line	21+30	25+50

19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation

- Groundwater is expected during excavation.

19-6.03D Settlement Periods and Surcharges

Structure Number	Alignment Line	Begin Station	End Station	Surcharge height (feet)	Settlement period (days)
53-1537	B-line	05+00	11+70	5	60
	B-line	11+70	18+10	10	60
	B-line	18+10	26+50	7	30

Example 3 – Driven Piles

49-1.01D(4) Dynamic Monitoring of Driven Piles

Locations of supports and control zones that require dynamic monitoring are:

Structure Number	Control Zone	Dynamic Monitoring Support Location
24-1390	Abut 1	Abut 1
	Bents 2 – 5	Bent 3

49-2.01A(3)(b) Require Driving System Submittal

Driving System Submittals are required as described in the *Recommendations* section.

Pile type, support location, and control zone are:

Structure Number	Pile Type	Support Location	Control Zone
24-1390	CISS (24 x 0.5”)	Abut 1	Abut 1
		Abut 7	Abut 7

49-2.01C(5) Pile Set Period is Allowed

The support locations that allow pile set period and the minimum set period are shown in the following table:

Structure Number	Support Location	Set Period (hours)
24-1390	Bent 2, 3, 4	36

Example 4 – CIDH Piles

19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation

Type D structure excavation is recommended at the following support locations:

Structure Number	Support Location
24-0390	Pier 2, 3, 4

Appendix 1: SSPs for Common Geotechnical Related Construction Items

The following is a list of typical SSPs for common geotechnical related construction items. These lists are not comprehensive. For any given project, there could be other SSPs that address various geotechnical related construction issues.

Embankment

19-6.03B	Subsidence of the Ground Surface is Anticipated, and Embankment, or Imported Borrow is Measured by Theoretical Basis
19-6.03D	Settlement Periods and Surcharges
19-7.02B	Local Borrow
19-7.02C	Imported Borrow
19-18	NSSP – Ground Movement and Vibration Monitoring

Geosynthetic Reinforced Embankment

19-6.02B	Geosynthetic Reinforced Embankment
19-6.03B	Subsidence of the Ground Surface is Anticipated, and Embankment, or Imported Borrow is Measured by Theoretical Basis
19-6.03D	Settlement Periods and Surcharges
19-18	NSSP – Ground Movement and Vibration Monitoring

Spread Footings

19-3.03A	Removal of Unsuitable Material below the Footings
19-3.03B(1)	Surface Water or Groundwater is Expected during Structure Excavation
90-1.02G(6)	Concrete Placed in Soil or Water with a Corrosive Environment
90-1.02H	Concrete in Direct Contact with a Corrosive Environment

Standard Plan Earth Retaining Systems

19-3.03A	Removal of Unsuitable Material below the Footings
19-3.03B(1)	Surface Water or Groundwater is Expected during Structure Excavation
47-2.01A, 47-3.01, 47-6.01A, and 47-6.01C(2)	Alternative Earth Retaining System for Caltrans Standard Walls, MSE, or Crib Wall Designs
51-1.01A	Alternative Earth Retaining Systems for Type 1 – 5 Retaining Walls
90-1.02G(6)	Concrete Placed in Soil or Water with a Corrosive Environment
90-1.02H	Concrete in Direct Contact with a Corrosive Environment

Non-gravity cantilever Earth Retaining Systems (Solider Pile wall with lagging)

19-3.03B(1)	Surface Water or Groundwater is Expected during Structure Excavation
49-3.02B(6)(c)	Steel Soldier Piling or CIDH Piling at least 24 inches in Diameter and 5 feet in Length
49-4.01C	Drilling through Cobbles, Boulders, or Hard Rock is Anticipated
49-4.03A	Drilling through Cobbles, Boulders, or Hard Rock is Anticipated
49-4.03B	Drilled Holes through Rock Material and Pile Substitutions

90-1.02H Concrete in Direct Contact with a Corrosive Environment

Soil Nail Walls

19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation
46-1.01A Soil Nails Work Sequence
46-1.03E Research Investigation
46-3.01 NSSP - Pull to Failure of Soil Nail Verification Test
46-3.01D(2)(b)(ii)(3) 2% of Total Number of Production Soil Nails
46-3.02A Corrosivity of the Site

Ground Anchor Walls

19-3.01D (2) Ground Anchor Wall Zones
19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation
19-3.03E(3) When Minimum Height of the Compacted Backfill behind the Lagging of a Soldier Pile Wall is other than 5 Feet above the first Row of Ground Anchors
46-1.01A Ground Anchors Work Sequence
46-1.03E Research Investigation
46-2.01 NSSP – Ground Anchor Verification Test
46-2.01C Alternative Number of Ground Anchors
46-2.01D(2)(b)(i) Locations and Number of Ground Anchor Performance Tests
46-2.01D(2)(b) and 46-2.01D(2)(c) Ground Anchors as Wall Footing Anchors
46-2.02B Ground Anchor Bearing Plates on Materials Other than Concrete
46-3.02A Corrosivity of the Site

Mechanically Stabilized Embankment Wall

19-3.03A Removal of Unsuitable Material below the Footings
19-3.03B(1) Surface Water or Groundwater is Expected during Structure Excavation
47-2.01A, 47-3.01, 47-6.01A, and 47-6.01C(2) Alternative Earth Retaining System for Caltrans Standard Walls, MSE, or Crib Wall Designs
47-3.02B(3) Corrosivity and Marine Environment of the Site

Sound Walls

58-2.03A Friction Angle of the Foundation Material that Determines the Dimensions of the Sound Wall Foundation

Driven Piles

49-1.01D(3) Load Test Piles
49-1.01D(4) Dynamic Monitoring of Driven Piles
49-1.01D(5) Test Borings to Verify Top of Rock Elevation if the Top of Rock Elevations Vary or are Uncertain – for Steel Piling to be Embedded into Rock
49-2.01A(3) Require Pile and Driving Data Form and Driving System Submittal
49-2.01C(2) Conditions require Revised Specifications for Driving Equipment

49-2.01C(3) Drilling for Driven Piles or Casings is not Allowed or Restricted
49-2.01C(4) Predrilling for Driven Piles is Required
49-2.01C(5) Pile Set Period is Allowed
49-2.04B(1) Alternative "X" Piles for Lateral Load
49-2.04B(3) Substituting Structural Shape Steel Piling for Class 90, Class 140, and Class 200 Concrete Piles
90-1.02H Concrete in Direct Contact with a Corrosive Environment

CIDH Piles

49-1.01D(3) Load Test Piles
49-1.01D(5) Test Borings to Verify Top of Rock Elevation if the Top of Rock Elevations Vary or are Uncertain – for Steel Piling to be Embedded into Rock
49-3.02A CIDH Piles Designed as End Bearing
49-3.02B(6)(c) Steel Soldier Piling or CIDH Piling at least 24 inches in Diameter and 5 feet in Length
49-3.02B(6)(d) Allow the Use of Water Slurry for CIDH Piles with Full-Depth Casing
49-3.02C(4) CIDH Piles Designed as End Bearing
49-3.02C(6) Installation Methods not Allowed for Permanent Steel Casing
49-3.02C(7) Permanent Casing for Type II CIDH Piling with Optional Construction Joint Shown
90-1.02G(6) Concrete Placed in Soil or Water with a Corrosive Environment
90-1.02H Concrete in Direct Contact with a Corrosive Environment

CISS Piles

49-1.01D(3) Load Test Piles
49-1.01D(4) Dynamic Monitoring of Driven Piles
49-1.01D(5) Test Borings to Verify Top of Rock Elevation if the Top of Rock Elevations Vary or are Uncertain – for Steel Piling to be Embedded into Rock
49-2.01A(3)(b) Require Driving System Submittal
49-2.01C(2) Conditions require Revised Specifications for Driving Equipment
49-2.01C(3) Drilling for Driven Piles or Casings is not Allowed or Restricted
49-2.01C(4) Predrilling for Driven Piles is Required
49-3.03C(2) Clean-Out Depth for Open-Ended CISS Piles
90-1.02G(6) Concrete Placed in Soil or Water with a Corrosive Environment
90-1.02H Concrete in Direct Contact with a Corrosive Environment

Wells

76-3 Boreholes
76-4 Monitoring Wells
76-6 Destroy Wells

Appendix 2: Compilation of Geotechnical Related SSPs

Section 2-1.06B. Use if supplemental project information is available.

List the available supplemental project information.

If railroad relations and insurance requirements are available, insert *Railroad Relations and Insurance Requirements* in the 1st row.

If water use is restricted and the project requires 100,000 gal or more of water for nonlandscaping work, insert *Water source information* in the 1st row.

If water allowance calculations for landscaping are available, insert *Maximum Applied Water Allowance Calculations for New and Rehabilitated Landscapes* in the 1st row.

If electronic design files (e.g., cross sections, roadway design alignments, smoothness data) are available as described in Project Delivery Directive PD-06, insert the names of the files in the 2nd row.

If bridge as-built drawings are available, insert *Bridge as-built drawings* in the 2nd row.

If logs of test borings are available, insert *Logs of test borings* in the 3rd row.

Insert the telephone number in the 5th row.

For a District 10 project, insert (209) 948-7934.

For districts other than 10, insert the telephone number to call to schedule a viewing date.

If a project has more than 5,000 cu yd of earthwork construction, insert the location and the documents specified in section 5-1.25 in the 7th row. Do not include any electronic design files already listed in the 2nd row.

Add rows as necessary. Delete nonapplicable rows.

Add between the 1st and 2nd paragraphs of section 2-1.06B:

The Department makes the following supplemental project information available:

Supplemental Project Information

Means	Description
Included in the *Information Handout*	
Available as specified in the *Standard Specifications*	
Included with the project plans	
Available for inspection at the Transportation Laboratory	
Available for inspection at the District Office Telephone no.: _____	
Available for inspection at: _____ _____ Telephone no.: _____	
Available for inspection at: http://www.dot.ca.gov/_____	

Section 19-3.01D(2). Use for soil nail walls and ground anchor walls.

1–2. Insert the stations and elevations provided by Geotechnical Services. The entire wall surface must be described by the chart. Add or delete cells as needed. Insert the location of the wall. Add introductions and tables as needed.

Add to section 19-3.01D(2):

1. Use for all soil nail walls.

The wall zones for the soil nail wall at _____ are as shown in the following table:

Wall zone	Beginning station	End station	Upper elevation (ft)	Lower elevation (ft)
1				
2				
3				
4				
5				
6				

2. Use for ground anchor walls only if more than 1 wall zone is listed in the foundation report. For ground anchors under spread footings, check with Design if the wall zone is more than 50 feet in length.

The wall zones for the ground anchor wall at _____ are as shown in the following table:

Wall zone	Beginning station	End station	Upper elevation (ft)	Lower elevation (ft)
1				
2				
3				
4				
5				
6				

Section 19-3.03A. Use for bridge and retaining wall earthwork where removal of

Replace section 19-3.03A with:

19-3.03A General

ss 2 AB is not used in the roadwork, edit to specify a stable, cohesive material similar to AB. If possible, specify a material already on the Bid Item List.

Where shown, remove material below the bottom of bridge footings. Replace the material with Class 2 AB and compact it as specified for structure backfill in section 19-3.03E.

2. Edit to be consistent with District plans. If Class 2 AB is not used in the roadwork, edit to specify a stable, cohesive material similar to AB. If possible, specify a material already on the Bid Item List.

Where shown, remove material below the bottom of retaining wall footings. Replace the material with Class 2 AB and compact it as specified for structure backfill in section 19-3.03E. The relative compaction must be at least 95 percent.

3. Use if the remaining base material must be compacted. Complete the table.

A relative compaction of at least 95 percent must be attained to at least 0.5 foot below the bottom of excavated unstable material at the locations shown in the following table:

Bridge name and number	Abutment number	Bent number

Section 19-3.03B(1). Use if structure excavation (Type D) or (Type DH) is shown and no seal course is shown. Insert the type.

Add to the beginning of section 19-3.03B(1):

For footings at locations with structure excavation (Type __), ground or surface water is expected to be encountered but seal course concrete is not needed.

Section 19-3.03B(2). Use for soldier pile retaining walls if the walls are not built completely from the top down. Ensure limits of earthwork are shown. District provides cross-sections; OBD to confirm with District.

Delete the 1st paragraph of section 19-3.03B(2).

Section 19-3.03E(3). Use for soldier pile retaining walls with ground anchors if the height for the compacted backfill is other than 5 feet. Verify with the designer. Insert the backfill height. The height must be adequate to allow anchor testing.

Replace *5* in the 1st sentence of the 3rd paragraph of section 19-3.03E(3) with:

_____

Section 19-3.04. Use for structure excavation and backfill payment clauses.

Add to section 19-3.04:

1. Use for bridge and retaining walls where unstable material below the bottom of the footing is removed and replaced. Edit if the backfill is not Class 2 aggregate.

Class 2 aggregate base placed below footings is paid for as structure backfill.

2–3. Use when structure excavation (Type D) or (Type DH) is described for sometimes wet, or wet excavation, and structure excavation (bridge) is shown in the project.

2. Use when no seal course is shown on the project. Insert type (e.g., D, DH). Do not use with par. 3.

Structure excavation for footings at locations not shown as structure excavation (Type __) and where ground or surface water is encountered is paid for as structure excavation (bridge).

3. Use when a seal course is shown on the project but is not included at all locations. Insert type (e.g., D, DH). Do not use with par. 2.

Except at locations where seal course concrete is shown, structure excavation for footings at locations not shown as structure excavation (Type __) and where ground or surface water is encountered is paid for as structure excavation (bridge).

4. Use with SSP 19-3.03B(3) for pier column excavation.

Structure excavation (pier column) is measured from the bottom of the completed foundation excavation to the upper and horizontal limits shown.

5. Use if quantity of pervious backfill material is 50 cubic yards or less.

Pervious backfill material placed within the limits of payment for bridges is paid for as structure backfill (bridge). Pervious backfill material placed within the limits of payment for retaining walls is paid for as structure backfill (retaining wall).

6. Use if culvert drainage profiles are based on aerial surveys.

Replace item 3 in the list in the 6th paragraph of section 19-3.04 with:

3. Structure excavation more than 1 foot from the depth shown is paid for as a work-character change if you request an adjustment or the Engineer orders an adjustment.

Section 19-6.02B. Use for geosynthetic reinforced embankments.

1–2. Use if the backfill material must have different requirements from those specified in the Standard Specifications. Insert the percentage passing and plasticity index and pH value in the tables.

Replace the 3rd and 4th paragraphs of section 19-6.02B with:

1

The backfill must comply with the gradation requirements shown in the following table:

Sieve size	Percentage passing
1-1/2"	--
3/4"	--
No. 4	--
No. 40	--
No. 200	--

2

The backfill must comply with the quality characteristics shown in the following table:

Quality characteristics	Test method	Requirement
Plasticity index (max)	California Test 204	--
pH	California Test 643	--

3. Insert primary geosynthetic reinforcement types selected from section 96-1.02D(2) as recommended by the geotechnical designer. The begin and end stations, elevation, and reinforcement length of primary geosynthetic reinforcement must be provided by the geotechnical designer and shown on the elevation view plans.

Add to section 19-6.02B:

Use primary geosynthetic reinforcement shown in the following table:

Geosynthetic reinforcement type	Color marking
PR#####	--
--	--
--	--
--	--

4. Insert secondary geosynthetic reinforcement types selected from section 96-1.02D(3) as recommended by the geotechnical designer. The elevation, and reinforcement length of secondary geosynthetic reinforcement must be provided by the geotechnical designer and shown on the cross-section view plans.

Add to section 19-6.02B:

Use secondary geosynthetic reinforcement shown in the following table:

Geosynthetic reinforcement type
SR####
--

Section 19-6.03B. Use if subsidence of the ground surface is anticipated, and there is a bid item for either embankment, or imported borrow measured by theoretical basis.

Add to the end of section 19-6.03B:

1. Use if the project includes a bid item for embankment. Enter quantity.

A quantity of _____ cubic yards of embankment will be added to the computed embankment quantity for the anticipated effect of subsidence.

2. Use if imported borrow is measured by theoretical basis. Enter quantity.

A quantity of _____ cubic yards of embankment will be added to the computed imported borrow quantity for the anticipated effect of subsidence.

Section 19-6.03D. Use for settlement periods and surcharges.

Add to section 19-6.03D:

1. Use for settlement periods at bridges. For embankments requiring settlement periods but no surcharge; insert 0.0[a] in the surcharge height column. If no such embankments exist, delete the footnote *a* at the bottom of the table.

Settlement periods and surcharges are required for bridge approach embankments as shown in the following table:

Bridge name or number	Abutment number	Bent number	Surcharge height (feet)	Settlement period (days)

[a]At this location, construct embankment by extending the grading plane (GP) in the elevation view of the bridge embankment surcharge detail of standard plan A62B horizontally to the centerline of the abutment.

2. Use for settlement periods at earth retaining structures.

Settlement periods and surcharges are required for roadway embankments at the earth retaining structures as shown in the following table:

Earth retaining structure number	Surcharge height (feet)	Settlement period (days)

Section 19-6.04. Use for embankment construction.

Add to the end of section 19-6.04:

1. Use if the project includes a bid item for embankment and there is anticipated subsidence. Edit to include the quantity.

The payment quantity for imported borrow includes the volume of anticipated subsidence as specified in section 19-6.03B. The payment quantity for embankment includes ____ cu yd for the anticipated effect of subsidence.

Section 19-7.02B. Use for specifying the locations of local borrow sites.

Replace section 19-7.02B with:

19-7.02B Local Borrow

1. Insert locations.

In addition to the locations described for excavation, obtain local borrow from:

1. _____
2. _____

2. Use only if restoration of the local borrow site is required.

After you obtain local borrow, grade the borrow site such that it drains and blends in with the surrounding area.

Section 19-7.02C. Use for specifying imported borrow.

Add to the end of section 19-7.02C:

1. Use for imported borrow placed within 4 feet of the grading plane. Insert an R-value. Specify an R-value of 20 or the R-value of the native soil, whichever is greater. Add to the following table if other borrow requirements are specified.

Imported borrow placed within 4 feet of the grading plane must comply with the quality characteristics shown in the following table:

Quality Characteristic	Test Method	Requirement
Plasticity Index (max)	California Test 204	12
Resistance (R-value) (min)	California Test 301	--

2. Use if requirements for imported borrow placed below 4 feet of the grading plane are specified. Add to the following table if other borrow requirements are specified. Delete if not used.

Specifying a Plasticity Index (PI) < 12 is recommended. If specifying imported borrow with a PI < 12 is not feasible due to costs, quantities, or availability, consult the Highway Design Manual or District Materials Engineer for guidance.

Imported borrow placed below 4 feet of the grading plane must comply with the quality characteristics shown in the following table:

Quality Characteristic	Test Method	Requirement
Plasticity Index (max)	California Test 204	--

3. Use if gradation requirements are specified. Delete if not used.

Process the imported borrow to comply with the grading requirements.

4–5. Use if there is a mandatory source for imported borrow. Delete if not used.

4. Insert the location of the mandatory local material source.

Obtain imported borrow from the mandatory local material source at_____.

5. Insert the cost and unit.

The Department has arranged for you to obtain material from the mandatory source for $_____ per _____ for material removed from the site and used in the work. The cost of the material removed is deducted.

6. Use if restoration of the borrow site is required. Edit to suit the work. Delete if not used.

After obtaining imported borrow, grade the borrow sites and associated haul roads such that sites drain and blend in with the surrounding area. Remove any equipment on the areas before grading.

Section 19-8. Use for lightweight cellular concrete (LCC) fill.

Replace section 19-8 with:

19-8 LIGHTWEIGHT CELLULAR CONCRETE FILL

19-8.01 GENERAL

19-8.01A Summary

1

Section 19-8 includes specifications for constructing lightweight cellular concrete (LCC).

19-8.01B Definitions

2

cast density: wet density of LCC at the point of placement.

19-8.01C Submittals

19-8.01C(1) General

3

Submit a certificate of compliance for cementitious materials under section 90-1.01C(3). Include the source name and location.

4

Submit certificate of compliance for proposed admixtures under section 90-1.01C(4).

19-8.01C(2) Mix Design

5

Submit a mix design that produces a maximum cast density at point of placement and a minimum compressive strength for the class described. Include laboratory data using the mix design verifying compliance with density and strength requirements.

19-8.01C(3) Quality Control and Placement Plan

6

Submit a quality control and placement plan. Include:

1. Construction sequence showing each lift and schedule.
2. Type of equipment and tools to be used.
3. Location of equipment and batching areas.
4. List of materials.
5. Manufacturer's specifications, including mixing, delivery, placement, finishing, and curing of LCC.
6. Organization chart of names, contact information, certifications, roles, and responsibilities of those involved in the quality control program.
7. Copy of AASHTO accreditation for the laboratory conducting compressive strength testing of LCC cylinders.

19-8.01C(4) Mitigation Plan

7

If requested, submit mitigation plan for repair of damaged areas for review prior to repair work.

19-8.01D Quality Assurance

19-8.01D(1) General

8

Not Used

19-8.01D(2) Quality Control

9

Each cast density test represents no more than 300 cu yd of LCC or 1 day's production, whichever is smaller.

19-8.01D(3) Department Acceptance

10

The department accepts LCC based on cast density and compressive strength requirements specified in section 19-8.02A.

11

Remove and replace LCC that does not meet the cast density or the compressive strength requirements unless corrective measures are authorized for the LCC to remain in place.

12

Cast density must be calculated under ASTM C796/C796M using the formula for design density.

13

Prepare LCC test specimens and test compressive strength under ASTM C495/C495M as preformed foam, except:

1. During molding you may raise and drop the mold 1 inch, 3 times on a hard surface after placing each layer to close voids and release entrapped air.
2. Specimen must be moist cured in the molds from day 2 to day 7.
3. Specimen must be air dried after 7 days.
4. Specimen must be capped at both ends for testing.

19-8.02 MATERIALS

19-8.02A General

14

LCC is designated as Class I through Class IV as shown in the following table:

LCC class	Cast density (max, pcf)	Compressive strength at 28 days[a] (min, psi)
I	30	40
II	36	80
III	42	120
IV	50	160

[a]Compressive strength is determined using ASTM C495/C495M as modified in section 19-8.01D(3).

15

Materials used for LCC must be delivered, stored, and handled under the manufacturer's recommendations.

16

Cement treated permeable base must comply with section 29-3.

17

Underdrains must comply with section 68-2.

18

Filter fabric and plastic pipe must comply with section 68-4.

19. Use with SSP 69-2 for geomembrane.

Geomembrane must comply with section 69-2.

19-8.02B Cement

20

Cement must comply with the specifications for Type II or Type V portland cement or Type IL cement in section 90-1.02B. Pozzolans and other cementitious materials may be used if recommended by the manufacturer of the foaming agent.

21

Fly ash and natural pozzolans must comply with AASHTO M 295.

22

GGBFS must comply with AASHTO M 302, Grade 100 or 120.

19-8.02C Water

23

Water must:

1. Comply with section 90-1.02D with water for mixing concrete.
2. Be potable.
3. Be free of deleterious amounts of acids, alkali, salts, oils, organic materials, or other impurities that would affect the setting or strength of the LCC.

24

Non-potable water may be used if the mix design is prepared in the laboratory using the non-potable water on site.

19-8.02D Foaming Agent

25

Foaming agent must comply with ASTM C869/C869M and be tested under ASTM C796/C796M.

19-8.02E Admixtures

26

Chemical admixtures must comply with ASTM C494/C494M.

27

Admixtures for accelerating set time may be used under the manufacturer's recommendations.

19-8.03 CONSTRUCTION

19-8.03A General

28

Not Used

19-8.03B Preparation

29

Subgrade to receive LCC must be:

1. Free of loose and extraneous material.
2. Uniformly moist but free of standing or flowing water.

30

Forms must comply with section 51-1.03C(2).

31

Drainage installed through the LCC must be secured and have watertight joints.

19-8.03C Placement

32

Cement and water may be premixed and delivered to the job site.

33

Foaming agent must be mixed with cement and water at the job site using specialized equipment certified by the manufacturer of the LCC to produce a homogenous mixture. Place LCC immediately after mixing cement and water with the foaming agent.

34

Complete each batch of LCC placement within 1 hour of mixing cement and water.

35

Do not place LCC whenever the ambient air temperature is forecast by the National Weather Service to be less than 40 degrees F within 24 hours after placement. If approved by the manufacturer of the foaming agent, you may place LCC that is mixed with heated water.

36

Do not place LCC on frozen ground.

37

The nozzle distance from the final point of application must be 50 feet or less. Direct the nozzle perpendicular to the receiving surface while building the required thickness whenever possible.

38

Place LCC uniformly to maintain homogeneity of the mix. Fill to the lines, grades, and dimensions shown. Segregated areas must be removed and replaced.

39

Each lift must not exceed 3 feet in thickness unless authorized. Vertical joints in adjoining or between lifts must be staggered at least 10 feet apart. Surface stepping to achieve grade and superelevation must be at least 6 inches thick.

40

You may place LCC at grades up to 5 percent by adding a thickening agent to the mix under the manufacturer's instructions.

41

Curing of LCC must follow the manufacturer's recommendation. A minimum of 12 hour curing period is required after placement. Do not disturb the newly placed LCC during this period.

42

Before placing the next LCC lift, remove any debris and loose material from the receiving surface. The receiving surface must be free of soil, debris, and standing water.

43

The surface of the final LCC lift must be free of foreign and loose materials, depressions, and sharp edges.

44

Longitudinal construction joints in the LCC lift immediately under the pavement sections are not allowed. If stepping is required to meet grades shown, stepping of the final lift must:

1. Be at least 2 inches thick
2. Have at least 6 inches of cement treated permeable base between LCC and pavement section

45

Do not operate construction equipment on LCC until it has attained the specified compressive strength. Remove and replace LCC that is compressed, cracked, or damaged as determined by the Engineer.

46

Remove all temporary forms and plastic sheet linings after LCC has cured.

19-8.04 PAYMENT

47

Not Used

Section 19-11. Use for compaction grouting.

There are two options for compaction grouting:

Option 1 – The Department lays out the grout holes and delineates treatment zones on the plans.

For Option 1, use bid items:

198261 – Compaction Grouting (Hole)

198263 – Compaction Grouting (Grout)

Option 2 – The Contractor lays out the grout holes, spacing and pattern; the plans show the area and upper and lower elevations of the treatment zone. The pay item quantity is the volume of the treatment zone.

For Option 2, use bid item:

198264 – Compaction Grouting

Replace section 19-11 with:

19-11 COMPACTION GROUTING

19-11.01 GENERAL

19-11.01A Summary

1

Section 19-11 includes specifications for performing compaction grouting to densify subsurface materials in delineated treatment zones.

19-11.01B Definitions

2

treatment zone: Space bounded by the delineated treatment area and the upper and lower elevation limits of treatment.

19-11.01C Submittals

19-11.01C(1) General

3

Not Used

19-11.01C(2) Qualifications

4

At least 10 days before beginning work, submit the following documentation:

1. Summary of the Contractor's experience that demonstrates compliance with section 19-11.01D(2).
2. List of at least 3 projects completed in the last 3 years that demonstrate the compaction grouting contractor's ability to perform compaction grouting with similar conditions to this job. For each project include:
   2.1. Project description
   2.2. Name, email address, and phone number of the owner
   2.3. Project completion date

3. List of at least 2 personnel who will perform the work. Respective personnel must have completed at least 3 compaction grouting projects in the last 3 years that are similar to this job. For respective personnel include:
   3.1. Project list and description
   3.2. Name, email address, and phone number of the owner
   3.3. Project completion date

19-11.01C(3) Shop Drawings

19-11.01C(3)(a) General

5

Submit 5 copies of shop drawings. After review, submit from 6 to 12 copies, as requested, for authorization and use during construction.

6

Shop drawings and calculations must be stamped and signed by an engineer who is registered as a civil engineer in the State.

7

Shop drawings must include:

1. Your name, address, telephone number, and email address.
2. Plans showing the proposed layout of grout injection holes, hole diameter, and depth. Show perimeter, primary, and secondary grout injection holes. Layout the primary and secondary holes using split-spacing method. Layout the secondary holes midway between the primary holes.
3. Proposed construction method and sequence that will densify the subsurface materials and achieve the minimum requirements of densification criteria based on cone penetration test (CPT).
4. Grout mix design and test procedures, including material specifications, grain size distribution, plasticity index, and hydrometer test results of the aggregate.
5. Description of drilling methods and equipment.
6. Description of grouting methods and equipment, including mixers, grout pumps, delivery lines, and appurtenances. Provide the make, model, year, and general condition of each item.
7. Description of the casing and casing withdrawal system.
8. Methods and equipment for calibrating, measuring, and recording the proportioning of the grout constituents.
9. Methods and equipment for calibrating, measuring, and recording grout quantity pumped, pumping pressure, and pumping rate.
10. Certified calibration chart for each pump and pressure gauge.
11. Description of grout injection operations.
12. Samples of drilling and grouting logs.

8. Delete when Option 2 is used. The plans must not show the layout of the grout

Submit an alternative compaction grouting plan and method for densifying subsurface materials of the treatment zone to specified requirements.

19-11.01C(3)(b) Displacement Monitoring Plan

9

Displacement monitoring plan must include:

1. Description and layout of monitoring instruments that monitor displacement of the ground surface and structures within a 30 feet distance from any hole being grouted.
2. Description of and manufacturer's product data for instruments for monitoring displacement of pavement, ground surface, adjacent structures, storm drains, and utility conduits during compaction grouting.

3. Method and schedule to monitor and record data.
4. Sample forms of monitoring logs.

19-11.01C(4) Compaction Grouting Records

10

Submit a daily compaction grouting record in electronic and hardcopy format before the start of work each day, for holes completed the previous day. The record must include the following for each hole:

1. Hole identification and location
2. Date and time the hole was drilled
3. Hole diameter
4. Elevation at the top and bottom of the hole
5. Date and time when grouting of the hole started and ended
6. Grout pressure measured at the top of casing and at the pump
7. Volume of grout pumped per linear foot of each hole
8. Unusual conditions encountered
9. Displacement monitoring records that identify location and magnitude of any uplift or displacement of pavement, ground surface, adjacent structures, storm drains, and utility conduits during compaction grouting

19-11.01C(5) Test Results

11

Submit CPT results in electronic and hardcopy format within 24 hours of test completion. Data in the electronic format must be in comma-separated or tab-separated values format.

19-11.01C(6) Supplemental Shop Drawings

12

For subsurface materials in the treated zone that do not meet the acceptance criteria, submit supplemental shop drawings that show limits of the failed zones and revised construction method.

19-11.01D Quality Assurance

19-11.01D(1) General

13

Not Used

19-11.01D(2) Contractor Qualifications

14

The contractor must have:

1. Experience performing compaction grouting
2. Successfully completed at least 3 compaction grouting projects in the past 3 years
3. At least 2 personnel, full-time on site, who have each completed at least 3 compaction grouting projects in the past 3 years

19-11.01D(3) Quality Control

15

Displacement monitoring instruments must be accurate to ±0.05 inch.

19-11.01D(4) Department Acceptance

19-11.01D(4)(a) General

16

Perform verification and proof tests using CPT to verify the compacted density of the subsurface materials within the treatment zone.

17

Provide CPT equipment that can penetrate the soil to the required maximum compaction grouting depth. Measure cone tip resistance, sleeve friction, and pore water pressure, at 2-inch depth increments. Perform CPT under ASTM D5778.

19-11.01D(4)(b) Verification Testing

18. Verification test area must be provided by Geotechnical Services and must be

Perform verification test at locations shown and as follows:

1. At each verification test area, perform 2 CPT soundings.
2. Perform compaction grouting in the verification test area using the proposed construction method and equipment described in the shop drawings.
3. After compaction grouting in the verification test area, perform 3 CPT soundings at the center of a grout-hole pattern and at locations determined by the Engineer.

19

Perform verification test in the Engineer's presence.

20

Verification tests that fail to comply with the acceptance criteria are rejected. Submit revised shop drawings.

21

Perform additional verification compaction grouting in the area selected by the Engineer. Perform additional verification tests until the verification tests demonstrate the revised compaction grouting layout and construction method can densify the subsurface materials to the density that meets the acceptance criteria.

19-11.01D(4)(c) Proof Test

22

Perform one proof test per 800 square feet of treatment area. Perform proof test at the center of a grout-hole pattern and at locations determined by the Engineer. Perform proof test in the Engineer's presence.

23

Densification of subsurface materials by compaction grouting must be represented by proof tests within a designated treatment zone.

24

Subsurface materials represented by proof tests that fail to comply with the acceptance criteria, are rejected.

19-11.01D(4)(d) Acceptance Criteria

19-11.01D(4)(d)(i) General

25

Not Used

19-11.01D(4)(d)(ii) Density of Treatment Zone

26. Refer to Geotechnical Report for the minimum (default at 80 ksf) and average (default at 100 ksf) corrected cone tip resistances.

The subsurface materials in the treatment zones tested by CPT soundings must have:

1. Minimum corrected cone tip resistance values greater than 80 ksf
2. Average corrected cone tip resistance greater than 100 ksf for each 12-inch-depth interval

27

If the CPT sounding encounters refusal above the bottom of the compaction grouting treatment zone, perform additional CPT sounding at a location selected by the Engineer.

28

If CPT soundings indicate that the density of the subsurface materials in the treatment zone has not met the acceptance criteria, perform at least 4 additional CPT soundings to determine the limits of the failed zones.

29

Perform additional compaction grouting in the failed zone under supplemental shop drawings. Perform 2 additional proof tests per failed zone if the area of the failed zone is less than 800 square feet.

19-11.01D(4)(d)(iii) Pavement Grade

30

Pavement grade must be within 0.1 inch of original grade.

19-11.02 MATERIALS

19-11.02A General

31

Not Used

19-11.02B Grout

32

Grout must comply with section 49-3.02B(5). The aggregate must have less than 5 percent passing no. 200 sieve. The portion of aggregate passing no. 40 sieve must have a plasticity index less than 15 under ASTM D4318.

33

Do not use additives such as pumping aids, gums, gelling agents, high-plasticity clay, organic matter, or similar materials.

34

The slump must be less than 1.5 inches under ASTM C143.

19-11.03 CONSTRUCTION

19-11.03A General

35

Start construction activities after acceptance of verification test results.

36

Perform compaction grouting in the treatment areas and to the depths shown.

37

Before compaction grouting, survey and mark on the ground the exterior limits of all underground facilities, including conduits, irrigation systems, and storm drains shown and within 10 feet from the limits of the treatment zone.

38

Perform compaction grouting in the following sequence:

1. Perimeter holes
2. Primary holes on or near downslope of the treatment zone, or near a retaining wall or structure foundation
3. Remaining primary holes
4. Secondary holes

39

Do not perform grouting at any hole within 12 feet of a hole grouted within the previous 12 hours.

40

Water or grout from compaction grouting must not:

1. Fall on traffic
2. Flow across shoulders or lanes occupied by traffic
3. Flow into landscaping, gutters, or other drainage facilities
4. Be left on the surface of the pavement or embankment

19-11.03B Equipment

19-11.03B(1) General

41

Not Used

19-11.03B(2) Drilling Equipment

42

Drilling equipment must produce straight, clean holes. Drilling equipment must be capable of advancing the grout holes to the required depth through the existing soil and rock materials and buried man-made objects.

43

Drilling equipment must be capable of coring through concrete and asphalt concrete pavement for compaction grouting on paved surfaces.

19-11.03B(3) Mixer

44

Grout mixer must be an automatic, volumetric, proportioning, and mixing system complying with ASTM C885. The mixing system must be capable of continuously proportioning and mixing the grout in sufficient quantity without interruption. The mixing system must be calibrated in the presence of the Engineer before grout injection.

19-11.03B(4) Pump

45

Use a positive displacement piston pump with a piston no more than 4 inches in diameter. The pump must have the capacity to pump grout from 0.2 to 2 cubic feet per minute at continuous pressure up to 1,500 psi. Short-stroking of the pump is not allowed.

46

Pumping system must be equipped and calibrated to continuously measure, display, and electronically record volume of grout pumped and grout pressure measured at the top of grout casing and at the grout pump. Calibrate the grout volume measuring system at the beginning of work each day of pumping. Pressure range of the pressure gauges must be less than 150 percent of the anticipated maximum grout pressure.

19-11.03B(5) Grout Delivery Line and Casing

47

Grout delivery line must be watertight and no greater than 2 inches in diameter.

48

Grout casing must be from 1-3/4 to 3 inches in diameter. Grout casing must have flush joints on the interior and exterior surfaces.

19-11.03C Establishing Grout Holes

49

Core highway pavement within 24 hours before beginning compaction grouting. Do not keep drilled holes open whenever the National Weather Service predicts at least a 50 percent probability of precipitation within the following 24 hours.

50

Drill grout holes and install grout casing to the specified grouting depth.

The casing must be:

1. Watertight and have intimate contact with the surrounding soil of the resulting hole
2. Firmly held in place
3. Resistant to ejection from grout pressure or leakage of grout around the perimeter

51

Confirm depth of the grout hole before connecting the grout delivery line.

19-11.03D Grouting

52

Perform grouting of a hole in one continuous operation. If grouting is terminated for any reason before the full depth is grouted, that grout column is rejected.

53

Perform grouting in ascending grout lifts starting from the bottom. Each grout lift must be less than 2 feet.

54

Maintain grout injection rate between 0.5 and 2.0 cubic feet per minute, with the average injection rate less than 1.5 cubic feet per minute for each hole. Injection rate must not be greater than 2.0 cubic feet per minute at any time.

55

If a grouting stage is within 10 feet of a (1) pipe, (2) culvert, or (3) tunnel, grout pressure must be less than 250 psi.

56

Stop a compaction grouting stage when:

1. Pumping at a pressure of 1,000 psi or more measured at the casing top for a period of 3 minutes

3. Displacement of adjacent structure is greater than 0.1 inch, or pavement heave occurs

19-11.03E Finishing

57

After grouting, remove grout from drilled holes to at least 4 inches below the pavement surface. Clean the holes and fill with mortar. Mortar must be a prepackaged fast-setting mortar that complies with ASTM C928. Finish filled holes flush with the pavement surface.

58

If the pavement elevation is higher than the original grade by more than 0.1 inch but equal to or less than 1 inch or 25 percent of the pavement thickness, whichever is less, grind the noncompliant concrete pavement surface under section 42-3 and asphalt concrete pavement surface under 39-2.01C(16) to within 0.1 inch of original grade.

59

If the pavement elevation is higher than the original grade by more than 1 inch or 25 percent of the pavement thickness, whichever is less, remove and replace the noncompliant concrete pavement slabs under section 41-9 and the noncompliant asphalt concrete pavement under section 39-3.02.

19-11.03F Displacement Monitoring

60

Provide dedicated personnel to monitor the instruments during construction to prevent damage to the site, pavement, and structures.

19-11.04 PAYMENT

61-62. Use for Option 1. Delete par. 63.

The payment quantity for compaction grouting (hole) is the length of drilled grout hole and installed grout casing measured end to end. Payment for the grout used to construct the compaction grouting is not included in the payment for compaction grouting (hole).

62

The payment quantity for compaction grouting (grout) is the volume of the grout used.

63. Use for Option 2. Delete pars. 61 and 62.

The payment quantity for compaction grouting is the volume of the treatment zone shown.

Section 19-12.02 Provide EPS geofoam type(s), the class of gasoline resistant geomembrane, and the class of cushion fabric.

Add to section 19-12.02:

1. Insert the EPS geofoam type as provided in the Geotechnical Design Report. If there are more than one EPS geofoam types to be used, the plans should show the geofoam types, locations, and extents; and the first sentence should be changed to "… geofoam block types ___ at locations shown."

Use EPS geofoam block type ____ at locations shown.

2. Insert the class of gasoline resistant geomembrane as provided in the Geotechnical Design Report, which should be based on the required degree of survivability. Note that the geomembrane with high survivability may be difficult to conform with the 90-degree edges of the EPS geofoam blocks. The plans should show the gasoline resistant geomembrane locations and extents.

Use Class A for condition that requires very high survivability.

Use Class B for condition that requires high survivability.

Use Class C for condition that requires medium survivability.

Gasoline resistant geomembrane must be Class ____. gasoline resistant geomembrane must be able to cover and conform to 90-degree edges and corners of EPS geofoam blocks at an ambient temperature of 45 degrees F or below without applying heat.

3. Insert the class of cushion fabric as instructed in the Geotechnical Design

Cushion fabric must be Class ____.

Section 19-16. Used for trenchless excavation and installation of culvert, pipeline, or conduit.

Payment for work under this section is included into LF of corresponding culvert, pipeline, or conduit. Follow instructions for bid items included in drainage specifications.

The SSP is performance based and method independent.

To protect Caltrans asset, the pavement and buried utilities, the SSP implements 3 monitoring regimes:

1. Pavement smoothness monitoring

2. Ground surface movement monitoring

3. Subsurface movement monitoring

Pavement smoothness monitoring is required (pre-, post-, and monthly) if:

1. Annual Average Daily Traffic ≥ 100,000, [AADT ≥ 100,000], and

2. Minimum vertical distance between pavement surface and the top of bore (H) is less than 8 times the bore diameter (DB) [H < 8 DB].

Ground surface movement monitoring is always required as follows:

1. For [AADT ≥ 100,000]: monitor based on digital surface model that will not affect traffic. (pre-, post-, weekly)

2. For [AADT < 100,000]: survey with level and rod that may need traffic control. (pre-, post-, daily)

Subsurface movement monitoring at 6 feet above the bore is required to detect hidden voids if:

1. Annual Average Daily Traffic ≥ 100,000, [AADT ≥ 100,000],

2. Bore diameter is greater than 48 inches [DB > 48”], and

3. Minimum vertical distance between pavement surface and top of culvert is less than 8 times the bore diameter [H < 8 DB].

Overcut must be less than:

1. 1 inch or less than 5% of the culvert, pipeline, or conduit outside radius, whichever is less.

2. 2 inches for trenchless construction using horizontal directional drilling method.

To facilitate broadband conduit installation, the requirement is relaxed for Horizontal Directional Drilling, which is typically used for conduit installation. HDD produces greater overcut than other construction methods. The requirement is formulated to discourage the use of HDD for pipeline with outside diameter greater than 8”.

Replace section 19-16 with:

19-16 TRENCHLESS CONSTRUCTION

19-16.01 GENERAL

19-16.01A Summary

1

Section 19-16 includes specifications for installing culvert, pipeline, or conduit using trenchless method.

19-16.01B Definitions

2

bore: Borehole excavated using trenchless construction for the installation of culvert, pipeline, or conduit.

faulting: The difference in elevation between surface of adjacent concrete pavement slabs across a transverse joint determined using the FHWA ProVAL automated faulting measurements module.

overcut: Radial annular gap between bore and outer pipe wall.

19-16.01C Submittals

19-16.01C(1) General

3

Submittal that includes land survey items must be stamped and signed by a land surveyor who is registered as a land surveyor in the State, or a person licensed to practice land surveying in the State.

19-16.01C(2) Contractor Qualifications

4

Submit:

1. Active and valid State contractor license with a classification appropriate for the work to be performed under Bus & Prof Code § 7000 et seq.
2. Summary of the contractor's experience that demonstrates compliance with section 19-16.01D(3)
3. List of at least 5 projects completed in past 5 years that demonstrate the contractor's qualifications and ability to perform the work. For each project includes:
   3.1. Project description
   3.2. Project owner's name, email address, and phone number
   3.3. Project completion date

19-16.01C(3) Shop Drawings

5

Submit 5 copies of shop drawings. After review, submit 8 copies for authorization and use during construction.

6

Shop drawings must be stamped and signed by an engineer who is registered as a civil engineer in the State.

7

Shop drawings must include:

1. Your name, address, telephone number, and email address
2. Plans showing work site layout, cross sections and profile of construction equipment, shield cut, overcut, pipes, and construction operation and sequence
3. Existing utilities withing 30 feet of the construction
4. Clearances or permits required from the existing utilities for the construction
5. Details of automated electronic system for excavation and alignment monitoring that can produce continuous record
6. Details of pipe and pipe joints that can carry and uniformly distribute the thrust of jacking forces, if applicable, and other construction loads in addition to overburden, earth and hydrostatic pressures

19-16.01C(4) Calculations

8

Submit 5 copies of calculations. After review, submit 8 copies for authorization and use during construction.

9

Calculations must be stamped and signed by an engineer who is registered as a civil engineer in the State.

10

Calculations must include:

1. Bracing, shoring, and thrust block design
2. Thrust forces and distribution of the forces for trenchless construction
3. Groundwater and surface water flow, and placement and capacity of the dewatering system
4. Estimated ground surface movement profile, and contour on highway pavement and 2 horizontal planes between highway surface and the elevation of trenchless construction
5. Anticipated quantity of spoils by volume

19-16.01C(5) Work Plans

11

Submit 5 copies of work plans. After review, submit 8 copies for authorization and use during construction.

12

Work plans must be stamped and signed by an engineer who is registered as a civil engineer in the State.

13

Work plans must include:

1. Your name, address, telephone number, and email address
2. Description of the trenchless construction method, sequence of operations, type of excavated face support, and spoil removal
3. Manufacturer and type of construction equipment for excavation, boring, spoil removal, lubrication, jacking, and grouting, related operating system proposed, and capability of equipment chosen
4. Additional subsurface exploration, including locations, drilling or sounding methods, and testing methods
5. Dewatering system, and plan to divert, control, and dispose of surface water and groundwater
6. Plans to reduce movement to be less than the maximum values under sections 19-16.01D(5)(c) and 19-16.01D(5)(d)
7. Contingency plan for: failed excavated face, damaged pipe, excessive ground surface or subsurface movement, deviation of alignment exceeding tolerance, and flooding
8. Methods for inspecting and grouting voids immediately outside of the completed culvert, pipeline, or conduit
9. Mitigation plan for restoring the pavement and ground surface

19-16.01C(6) Monitoring Plans

14

Submit monitoring plans for:

1. Culvert, pipeline, or conduit grade and alignment control, including monitoring instruments, layout of instrumentation points, construction details, and monitoring frequency
2. Logging of excavated materials, including anticipated volume of excavation and measured volume of removed spoil

3. Critical operations of applicable trenchless construction, including excavation, boring, spoil removal, lubrication, jacking, installation, and grouting
4. Ground surface movement for highway section with Annual Average Daily Traffic (AADT) volume:
    4.1. Greater than or equal to 100,000: Include digital surface survey method, survey data processing and analysis method, frequency of monitoring, and digital surface file.
    4.2. Less than 100,000: Include survey method, frequency of monitoring, and survey points shown
5. Subsurface movement, including monitoring instruments and equipment, layout of monitoring alignment, method, and frequency of monitoring
6. Pavement smoothness monitoring, including monitoring instruments and equipment, method, and frequency of monitoring, report templates

19-16.01C(7) Culvert, Pipeline, or Conduit Control Line Survey

15

Submit control line survey. Control line may be on a local coordinate system if the control is referenced to the project coordinate system.

19-16.01C(8) Daily Construction Record

16

Submit daily construction record before noon the day after the completion of each work shift.

17

Daily construction record must include:

1. Date and time of operation.
2. Names of key personnel.
3. Length of constructed culvert, pipeline, conduit including coordinates and elevation of the beginning and ending (latitude, longitude and northing, easting, elevation) of the culvert, pipeline, conduit advanced during each work shift. Records must reference the project coordinate system designated by the Department.
4. Rate of advance.
5. Jacking force.
6. Problems encountered, possible causes, and mitigation performed.
7. Records and field note of:
    7.1. Any visible cracks
    7.2. Culvert, pipeline, conduit line and grade control
    7.3. Anticipated and actual volumes of spoil removed and causes of the volume discrepancy
    7.4. Groundwater table elevation if dewatering is required
8. For bore diameter greater than 48 inches, geological log of excavated face and materials, with the logging performed by a geologist who is registered as an engineering geologist in the State.

19-16.01C(9) Ground Surface Movement Monitoring Records

18

For highway section with AADT volume is equal to or greater than 100,000, submit:

1. Before construction:
    1.1. Survey data
    1.2. Surface model
    1.3. Comparison between your and the Department's surface model demonstrating compliance with the Department's Survey Manual and supplemental guidance
2. During and after construction:
    2.1. Survey data
    2.2. Surface model
    2.3. Vertical movement based on the comparison between current and preconstruction surface model

19

For highway section with AADT volume is less than 100,000, submit:

1. Before construction:
   1.1. Survey data
   1.2. Comparison between your and the Department's survey demonstrating your survey's compliance with the quality requirements
2. During and after construction:
   2.1. Survey data
   2.2. Vertical movement based on the comparison of current and the Department's preconstruction surface data

19-16.01C(10) Subsurface Movement Monitoring Records

20

If subsurface movement monitoring is required under section 19-16.01D(5)(c), submit:

1. Before construction:
   1.1. Calibration and verification report of the monitoring system
   1.2. Baseline reading
2. Monitoring records during and after construction

19-16.01C(11) Pavement Smoothness Report

21

If pavement smoothness monitoring is required under section 19-16.01D(5)(d), submit:

1. Inertial profiler certification under section 36-3.01D(2)
2. Pavement smoothness reports in the following schedule:
   2.1. Pre-construction report before work starts
   2.2. Monthly report by the 5th day of each month during construction
   2.3. Post-construction report after trenchless construction and pavement restoration are completed

22

Pavement smoothness report must include:

1. Inertial profile data with the values of 5 inertial profiler runs for each lane and average values for each lane. The begin and end positions of each inertial profile must be within 1.0 foot of the monitored section.
2. ALR.
3. Faulting at each concrete pavement joint.

23

Inertial profiler data must comply with section 36-3.01C(2).

ALR values of each inertial profile of the monitored section must be presented as a spreadsheet that includes:

1. Current and previously recorded values
2. Calculated change from pre-construction value to the nearest whole percentage
3. Values increased by more than
   3.1. 10 percent must be highlighted in yellow
   3.2. 20 percent must be highlighted in orange
4. Values greater than 180 inches per mile must be highlighted in red

24

Faulting at each concrete pavement joint must be presented as a spreadsheet that includes:

1. Current and previously recorded values
2. Values greater than 0.75 inches must be highlighted in red
3. Profile with the number of faulting greater than 0.1 inches increased by more than
    3.1. 10 percent must be highlighted in yellow
    3.2. 20 percent must be highlighted in red

19-16.01C(12) Contact Grouting Record

25

Submit contact grouting record before noon the day after the completion of each work shift.

26

Contact grouting record must include:

1. Injection locations
2. Grout quantity
3. Grout pressure
4. Measurements and observations, including heave, casing or carrier pipe movement, grout loss quantity, communication between grout ports, ground surface, and nearby utilities and storm drains
5. Problems encountered, possible causes, and mitigation performed

19-16.01C(13) Post-Construction Record

27

Submit a copy of the completed culvert, pipeline, or conduit construction inspection records, including video recording and photographs.

28

Submit as-built plans showing details and alignment of the constructed culvert, pipeline, or conduit, horizontal and elevation survey under section 19-16.01D(5)(e) based on project coordinate system, any problems encountered, and mitigation actions performed.

29

Submit as-built plans showing details of pavement restoration work performed.

19-16.01D Quality Assurance

19-16.01D(1) General

30

Not Used

19-16.01D(2) Pre-construction Meeting

31

Hold a pre-construction meeting at least 10 days before the start of culvert, pipeline, or conduit construction. The Engineer conducts the meeting.

32

Attendees must include:

1. The Engineer
2. Your project manager
3. Your project superintendent
4. Contractor or subcontractor for trenchless construction

33

Provide and present:

1. Culvert, pipeline, or conduit construction shop drawings, work plans, and calculations
2. Mitigation plans for both during and after construction
3. Construction timeline and critical path activities

19-16.01D(3) Contractor Qualifications

34

The contractor for trenchless construction of culvert, pipeline, or conduit must:

1. Have an active and valid State contractor license with a classification appropriate for the work to be performed under Bus & Prof Code § 7000 et seq.
2. Have successfully completed at least 5 projects in the past 5 years involving trenchless construction of culvert, pipeline, or conduit in similar lengths and diameters in similar geotechnical conditions
3. Employ a superintendent, who has successfully completed at least 5 of such projects

19-16.01D(4) Quality Control

35

Not Used

19-16.01D(5) Department Acceptance

19-16.01D(5)(a) General

36

Not Used

19-16.01D(5)(b) Ground Surface Movement Monitoring

37. District Design, Land Surveys, and Utilities should identify on the Plans the critical above ground structures and utilities near the culvert, pipeline, or conduit alignment that need to be monitored and the locations of the instruments to be placed. The locations should be accessible.

19-16.01D(5)(b)(i) General

Mark monitoring points on critical structures and utilities at locations shown. Include these points in monitoring surveys. Perform monitoring surveys before noon and at ambient temperature below 85 degrees F.

38

Perform ground surface survey under the Department's *Survey Manual* and supplemental guidance.

39

Notify the Engineer at least 15 days before trenchless construction for the Department to perform a pre-construction ground surface survey.

19-16.01D(5)(b)(ii) Highway section with annual average daily traffic volume equal to or greater than 100,000

40

The Department will provide:

1. Control points for ground surface movement monitoring.
2. Pre-construction digital surface model. The model will be based on a grid of points spaced not more than 1-foot apart and will extend 50 feet in each direction from the culvert, pipeline, or conduit centerline.

41

Use the provided control points for ground surface movement monitoring. Use the provided surface model to determine the movement of ground surface and embankment slope.

42

Before starting trenchless construction, perform baseline ground surface survey.

43

Perform ground surface movement monitoring survey:

1. Daily during construction
2. Biweekly for 1 month after completion of each installation

44

Produce the surface model based on the monitoring survey data and calculate the movement of monitoring points using pre-construction surface model. Each monitoring survey may have different grid points. Digital survey file must be in Civil 3D or Land XML format.

45

Each ground surface horizontal and vertical measurement must be accurate to ±0.03 feet on pavement and ±0.1 feet on unpaved surfaces at the 95 percent confidence level. Vertical movement produced by comparing current surface model with pre-construction surface model must be accurate to ±0.01 feet on pavement and ±0.1 feet on unpaved surfaces at the 95 percent confidence level.

46

If ground surface movement on the pavement above the advancing pipe meets the requirements for 2 consecutive weeks, you may reduce the frequency of monitoring survey to biweekly.

47

Notify the Engineer at completion of each installation. The Department will perform ground surface survey 1 month after completion of each installation.

48

Ground surface vertical movement must comply with the requirements shown in the following table:

Ground Surface Vertical Movement

Quality characteristic	Requirement
Critical structure monitoring points – horizontal or vertical (max, feet)	0.02
Highway surface (max, feet)	0.04
Embankment slope (max, feet)	0.2

49

If ground surface vertical movement requirements are not met:

1. Immediately stop work
2. Notify the Engineer
3. Submit an alternative construction method
4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials
5. Monitor ground surface movement in the area above the advancing pipe:
   - 5.1. Daily until no additional vertical movement is detected in the areas that exceed the movement requirements
   - 5.2. Every two days until the vertical movement meets the requirements for 2 consecutive weeks

19-16.01D(5)(b)(iii) Highway section with annual average daily traffic volume less than 100,000

50

The Department will provide pre-construction survey as the baseline survey.

51

Use the provided baseline survey for ground surface movement monitoring.

52

Before trenchless construction, perform ground surface survey under the Department's *Survey Manual* and supplemental guidance.

53

Establish monitoring points to be surveyed:

1. At critical structures as shown
2. In a grid extending 20 feet on each side of the culvert, pipeline, or conduit centerline, including embankment slopes, and spaced at:
   2.1. 5 feet along culvert, pipeline, or conduit centerline
   2.2. 10 feet along the roadway centerline

54

Perform ground surface movement monitoring survey:

1. Daily during construction
2. Biweekly for 1 month after completion of each installation

55

Notify the Engineer immediately of any discrepancies.

56

Ground surface survey and vertical movement produced by comparing the current survey with pre-construction survey must be accurate to ±0.03 feet on pavement and ±0.1 feet on unpaved surfaces at the 95 percent confidence level.

57

Notify the Engineer at completion of each installation. The Department will perform ground surface survey 1 month after completion of each installation.

58

Ground surface vertical movement must comply with the requirements shown in the following table:

Ground Surface Vertical Movement

Quality characteristic	Requirement
Critical structure monitoring points – horizontal or vertical (max, feet)	0.06
Highway surface (max, feet)	0.06
Embankment slope (max, feet)	0.2

59

If ground surface vertical movement requirements are not met:

1. Immediately stop work
2. Notify the Engineer
3. Submit an alternative construction method
4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials
5. Monitor ground surface movement in the area above the advancing pipe twice each work shift until no additional vertical movement is detected in the areas that exceed the movement requirements

19-16.01D(5)(c) Subsurface Movement Monitoring

60

Subsurface movement monitoring is required if:

1. Bore diameter is greater than 48 inches
2. Minimum vertical distance between pavement surface and top of culvert is less than 8 times the bore diameter

61. The vertical distance between the excavation and horizontal in-place

Install 3 horizontal in-place inclinometers with MEMS to monitor subsurface movement with:

1. One at 6 feet above the crown and along the center line of the culvert, pipeline, or conduit
2. One each at 6 feet above the crown and 5 feet away horizontally from each of the two spring lines of the culvert, pipeline, or conduit
3. Deviation of line and grade of each horizontal in-place inclinometer must be less than 1/60

62. District Design, Land Surveys, and Utilities should work with utility companies to identify on the Plans the critical underground utilities near the culvert, pipeline, or conduit alignment that need to be monitored and the locations of the instruments to be placed. The instruments described in this section may be installed near the utilities when needed. But consider the cost.

Install movement monitoring instruments for critical underground utilities at locations shown.

63

Before trenchless construction, calibrate instruments and monitoring system. Produce calibration and verification report. Take readings at least 3 times to establish pre-construction baseline readings that are accurate to ±0.01 inches.

64

Perform subsurface movement monitoring:

1. Twice daily during construction
2. Twice weekly for 1 month after completion of each installation

65

Subsurface movement must comply with the requirements shown in the following table:

Subsurface Movement

Quality characteristic	Requirement
Subsurface movement (max, inches)	0.2

66

If subsurface movement requirement is not met:

1. Immediately stop work
2. Notify the Engineer
3. Submit an alternative construction method
4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials

19-16.01D(5)(d) Pavement Smoothness Monitoring

67

Pavement smoothness monitoring is required if:

1. AADT volume of the section of highway above the culvert, pipeline, or conduit is greater than 100,000
2. Minimum vertical distance between pavement surface and the top of bore is less than 8 times the bore diameter

68

Perform inertial profiler verification tests under section 36-3.01D(3)(b)(ii).

69

Perform preconstruction, monthly during construction, and postconstruction pavement smoothness monitoring using inertial profiler.

70

Perform pavement smoothness monitoring under section 36-3.

71

Establish control points that can trigger the beginning and end positions of each profile run for each lane. The control points must be located at least 0.2 miles from the culvert, pipeline, or conduit center line measured along the highway center line. The same control points must be used throughout the construction period.

72

Perform 3 inertial profile runs of each traffic lane between the begin and end control points. The distance measuring instrument (DMI) direction of increase and the DMI station used to record the begin control point must be the same in all profiles of the lane.

73

For concrete pavement, faulting must be determined using ProVAL Automated Faulting module, with:

1. Nominal joint spacing set to the average slab length
2. Segment length set to 528 feet
3. Joint window set to 2 feet
4. Joint detection method is set to step mode
5. Cracks unchecked

74

Pavement smoothness of both asphalt concrete and concrete pavements based on the average ALR of 5 inertial profiles of the monitored section for each lane must meet the following requirements:

1. If preconstruction average ALR is equal to or less than 180 inches per mile, the final average ALR must not increase by more than 20 percent due to construction, with the maximum allowable ALR of 180 inches per mile.
2. If preconstruction average ALR is greater than 180 inches per mile, the final average ALR must not increase by more than 5 inches/mile compared to pre-construction values.

75

Pavement smoothness of concrete pavement must meet the following additional requirements:

1. If preconstruction average faulting is equal to or less than 0.75 inches, the final average faulting must not increase by more than 0.25 inches due to construction, with the maximum allowable faulting of 0.75 inches.
2. If preconstruction average faulting is greater than 0.75 inches, the final average faulting must not increase by more than 0.10 inches compared to pre-construction values.

3. Number of faulting with value greater than 0.1 inches must not increase by more than 20 percent due to construction.

76

If pavement smoothness requirements are not met during monitoring:

1. Immediately stop work
2. Notify the Engineer
3. Submit an alternative construction method
4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials
5. Monitor pavement smoothness in the area above the advancing pipe:
   5.1. Weekly until pavement smoothness stops decreasing
   5.2. Biweekly until pavement smoothness meets the requirements for 2 consecutive measurements

19-16.01D(5)(e) Culvert, Pipeline, or Conduit Line, Grade, and Shape

77

For each culvert, pipeline, or conduit:

1. Survey and record control lines at least 7 days before starting trenchless construction.
2. Observe and adjust measurements of survey control lines weekly. Report discrepancies to the Engineer.

78

Survey and record the centerline of the constructed culvert, pipeline, or conduit after each section is advanced, or every 5 feet of advancement, whichever is shorter.

79

The line and grade of a culvert, pipeline, or conduit centerline must meet the requirements throughout the alignment, as shown in the following table:

Line and Grade

Quality characteristic	Requirement
Line deviation (max, inches)	6
Grade deviation (max, inches)	1

80

The completed culvert, pipeline, or conduit must have the shape and dimensions shown throughout its length. The flow line must be in the direction shown.

19-16.02 MATERIALS

81

Not Used

82

19-16.03 CONSTRUCTION

19-16.03A General

83

The superintendent must be present at the job site while work is in progress.

84

Perform trenchless excavation and install culvert, pipeline, or conduit to the line and grade shown. When excavation or installation is out of line or grade, make immediate alignment correction.

85

Protect existing structures, pavement, and utilities. Restore and repair immediately any damage or displacement resulting from construction.

86

Repair or replace any damaged pipe sections.

19-16.03B Excavation

87

Overcut must be less than:

1. 1 inch or 5 percent of the culvert, pipeline, or conduit outside radius, whichever is less
2. 2 inches for trenchless construction using horizontal directional drilling method

88

Notify the Engineer immediately if you encounter obstruction or conditions that impede construction.

19-16.03C Restore Highway Pavement

89

After completion of trenchless construction of culvert, pipeline, or conduit, restore highway pavement to meet the requirements in section 19-16.01D(5). Restore asphalt concrete pavement with mill and fill. Repair or replace concrete pavement with dowels for any cracks and spalling caused by construction.

19-16.04 PAYMENT

90

Not Used

Section 19-17. Use for ground movement and vibration monitoring during geotechnical related construction, such as construction of embankment, earth retaining system, ground improvement, tunnel, and trenchless construction.

Replace section 19-17 with:

19-17 GROUND MOVEMENT AND VIBRATION MONITORING

19-17.01 GENERAL

19-17.01A Summary

1

Section 19-17 includes specifications for ground movement and vibration monitoring. Ground movement and vibration monitoring include:

1. Installing ground movement and vibration monitoring sensors at locations shown
2. Installing data acquisition devices, radio transceivers, IoT gateway providing internet connection, power supply, and software or web service to process, transmit, analyze, and display monitoring data
3. Monitoring ground movement and vibration

2. Enter the construction job component, start date, which may be the start or completion of the construction of the job component, and the end of monitoring period in the construction stage as provided in the geotechnical report. Edit the first sentence to clearly identify the start and end dates of monitoring period for the job component.

Monitoring period for the construction of _____ is from the ___ of construction of the job component to __ days after completing construction of the job component. Do not start construction of the job component before acceptance of installation report, system verification report, baseline readings, and commission of installed monitoring system.

19-17.01B Definitions

3

real-time data and information: data and information that is delivered immediately after collection.

19-17.01C Submittals

19-17.01C(1) General

4

Submit:

1. Shop drawings, including:
   - 1.1. Plan sheets showing the layout of instruments, sensors, cables, tubes, conduits, data acquisition devices, radio transceivers, and cellular gateway
   - 1.2. Conceptual installation and monitoring schedules, including controlling construction activities that affect system installation, monitoring, and salvage or abandonment of equipment
   - 1.3. Equipment data sheet
   - 1.4. Manufacturer's calibration certificates that are traceable to the U.S. National Institute of Standards and Technology, if applicable
2. Installation report after the installation, including:
   - 2.1. Plan sheets showing layout, identifications, locations, coordinates, and elevations of sensors, cables, tubes, conduits, data acquisition devices, radio transceivers, and cellular gateway
   - 2.2. Drill logs with geological profiles and water levels if applicable
3. System verification report
4. Baseline readings

19-17.01C(2) Baseline Vibration Level Report

5

Include:

1. Date of existing baseline condition for each monitoring location
2. Description of each monitoring location
3. Maximum single-component and resultant peak particle velocities at 15-second intervals

19-17.01C(3) Monitoring Data and Information

6

Transmit real-time monitoring data and information electronically by wireless network or cellular data transmission. Furnish software or web service with secure login that processes, calculates, displays monitoring data, and provides warning if monitored movement or vibration exceeds threshold values described.

7

Maintain continuous and scheduled data collection and transmission. Resolve any data outage caused by damaged or faulty equipment or systems within 72 hours.

8

For data needed to determine thresholds for immediate suspension of construction, suspend construction if the data is not collected and transmitted.

9

For automated motorized total station (AMTS) ground surface movement monitoring, evaluate weather, site, and traffic conditions to set the time and frequency of readings to obtain complete data coverage in each monitoring cycle.

10

Submit both raw and processed monitoring data in csv, xml, or JavaScript Object Notation (JSON) format within 5 days after termination of each monitoring system. Include instructions on data structures and field names for monitoring data.

19-17.01C(4) Reusable Equipment

11

Salvage and submit reusable equipment to the Engineer after completion of ground movement and vibration monitoring.

12

Reusable equipment includes settlement profile and movement profile monitoring systems, data acquisition devices, data transceivers, cellular gateway, solar panel assemblies, battery packs, electricity assemblies, protective boxes, and software paid for by the project.

19-17.01D Quality Assurance

19-17.01D(1) General

13

Not Used

19-17.01D(2) Monitoring and Survey Data

14

AMTS movement monitoring data and survey data must comply with quality requirements described in the Department's *Survey Manual* and supplemental guidance.

19-17.02 MATERIALS

19-17.02A General

15

Not Used

19-17.02B Wireless Networks, Software, and Web Service

19-17.02B(1) General

19-17.02B(2) Wireless Networks

16

Wireless sensor networks include:

1. Nodes, which include standalone or embedded:
   1.1. Data acquisition device for conditioning, converting, and processing data.
   1.2. Radio transceiver for transmitting data to cellular gateway or network. Transceiver must be able to: continuously transmit real-time data and information to the cellular gateway at a consistent frequency.
2. Standalone or embedded cellular gateways that can receive data from nodes and transmit the data through cellular or satellite service to a cloud service or local network so that you, the Engineer, and the Engineer's representatives can monitor the data.
3. Solar panel assembly, battery packs, or electrical supply that can power wireless networks for the duration of monitoring period.
4. Protective enclosure with security lock for wireless nodes and cellular gateway.
5. Surge and lightning protection.

17

The nodes for wireless network must be IP67 rated with temperature range between -40 degree C and 70 degree C.

19-17.02B(3) Data Process and Display Software or Web Service

18

Furnish software or web service to the Engineer and the Engineer's representatives. The software or web service must include IT security, data backup and recovery, and features that allow users to access, process, analyze, and display data, and set threshold warning values and transmit warning immediately when a threshold is exceeded.

19-17.02C Monitoring System

19-17.02C(1) General

Not Used

19-17.02C(2) Settlement Gauge Monitoring System

19

Settlement gauge monitoring system must include:

1. Settlement gauges with a semiconductor, vibrating wire, or fiber optic pressure transducer type including a thermistor. Each settlement gauge must include:
   1.1. Factory-attached signal cables of sufficient length to route to the data acquisition system. Use system manufacturer recommended splice kit if splicing is required.
   1.2. Designated reservoir or reservoirs for each settlement gauge or circuit placed in the protective enclosure attached to a base that is outside the zone of influence shown or as ordered.
   1.3. Twin tubing when using hydraulic type of settlement system.
   1.4. Survey markers for reservoir if not outside the zone of influence.
2. Conduits for signal cables and tubes.
3. Data acquisition device and radio transceivers.

4. Solar panel assembly, battery packs, or electrical assembly that can power data acquisition device and radio transceiver for the duration of monitoring period.
5. Protective enclosure with security lock for data acquisition device, reservoir, and radio transceiver.
6. Surge and lightning protection for the monitoring system.

20

Settlement gauge must comply with the requirements shown in the following table:

Settlement Gauge

Quality characteristic	Requirement
Range (feet)	6
Resolution (max, % full scale)	±0.025
Accuracy (max, % full scale)	±0.1
Fluid type	Antifreeze solution
Temperature range (ºC)	-40–80
Thermal drift (max, % full scale / ºC)	±0.1
Corrosion resistance	Yes

19-17.02C(3) Movement Profile Monitoring System

21

Movement profile monitoring system must include:

1. In-place inclinometers (IPI) with micro-electro-mechanical systems (MEMS) that can be configured and installed horizontally to monitor settlement profile or vertically to monitor movement profile.
2. Casing for IPI MEMS sensors:
   2.1. Casing for IPI MEMS must be grooved ABS pipe with load rating of at least 1500 lb and collapse rating of at least 190 psi. Measuring axes of the casing must be clearly marked on casing outside surface.
   2.2. Casing for shape array must be bell-end style PVC pipe with inside diameter of 2 ± 0.01 inches and outside diameter of 2.38 ± 0.01 inches or grooved ABS pipe with a load rating of at least 1500 lb and collapse rating of at least 190 psi. Measuring axes of the casing must be clearly marked under manufacturer's recommendations.
3. Signal cables supplied by the system manufacturer with sufficient length to route to the data acquisition device. Use system manufacturer recommended splice kit if splicing is required.
4. Conduits for signal cables.
5. Data acquisition device and radio transceivers.
6. Solar panel assembly, battery packs, and electrical assembly that can power data acquisition device and radio transceiver for the duration of monitoring period.
7. Protective enclosure with security lock for data acquisition device, and radio transceiver.
8. Surge and lightning protection for the monitoring system.

22

Movement profile monitoring system must comply with the requirements shown in the following table:

Movement profile monitoring system

Quality characteristic	Requirement
Reading interval along profile (max, feet)	8
Resolution (arc seconds)	±4
Accuracy (arc seconds)	±10
Temperature range (ºC)	−40–80

19-17.02C(4) Automated Motorized Total Station Ground Surface Movement Monitoring System

23. Automated Motorized Total Station (AMTS) is usually paid for as a monthly rental for the duration of monitoring period.

Enter the number of monitoring prisms for the monitoring area for item 3 in the list. The default value is 8.

The practical range of current AMTS is 300 feet.

Automated Motorized Total Station (AMTS) ground surface movement monitoring system must include:

1. AMTS installed at locations shown and be able to automatically target, take, and transmit survey data of designated control prisms, monitoring prisms, and settlement monitoring location array through wireless networks
2. At least 5 control prisms for each AMTS. Place the control prisms:
   2.1. Outside the zone of influence
   2.2. In the light of sight of the AMTS throughout the duration of the monitoring period
   2.3. Evenly distributed around 360 degrees of the AMTS
   2.4. With varying distances from the AMTS
3. At least 8 monitoring prisms installed at locations evenly distributed in the monitoring coverage area of the AMTS
4. Instrument tower and brackets for AMTS must:
   4.1. Provide clearance and scanning angles so that the AMTS can scan prisms and reference points in the designated coverage areas and provide required accuracy
   4.2. Be stable and support the instruments without movement or vibrations during the monitoring period
   4.3. Include safety measures to protect AMTS from theft and protect workers while working at height
   5. Data acquisition device and radio transceiver that allows remote access for troubleshooting.
6. Solar panel assembly, battery packs, and electrical assembly that can power data acquisition device and radio transceiver for the duration of monitoring period
7. Surge and lightning protection for the monitoring system

24

AMTS ground surface movement monitoring system must comply with the requirements shown in the following table:

AMTS Ground Surface Movement Monitoring System

Quality characteristic	Requirement
Range with no-prism target surface (max, feet)	300
Angle accuracy (max, seconds)	1
Accuracy with prism (max, inches)	0.04 + 1 ppm
Accuracy with no-prism surface (max, inches)	0.08 + 2 ppm
Elevation accuracy with prism (max, inches)	0.1
Elevation accuracy with no-prism surface (max, inches)	0.2
Temperature range (ºC)	−20–50

19-17.02C(5) Vibration Monitoring System

25

Vibration monitoring system must include:

1. 3-axis vibration transducer that:
   1.1. Is factory calibrated annually by the manufacturer
   1.2. includes self-test function
2. Signal cables supplied by the system manufacturer with sufficient length to route to data acquisition device. Use system manufacturer recommended splice kit If splicing is required.
3. Conduits for signal cables.

4. Data acquisition device and radio transceiver
5. Solar panel assembly, battery packs, and electrical assembly that can power data acquisition device and radio transceiver for the duration of monitoring period.
6. Protective enclosure with security lock for data acquisition device and radio transceiver.
7. Surge and lightning protection for the monitoring system.

26

Vibration monitoring system must comply with the requirements shown in the following table:

3-Axis Velocity Transducer

Quality characteristic	Requirement
Range (in/sec)	0.01–4
Resolution (max, in/sec)	0.0025
Accuracy (max, %)	5
Frequency response range (Hz)	2–250

19-17.02C(6) Tilt Sensing System

27

Tilt sensing system must include tilt sensors that:

1. Are battery powered
2. Can transmit data using LoRa or Mesh systems to a cellular gateway
3. Can transmit data from waterproof enclosure with antennae, or connectors if the sensor is under continuous submerged condition
4. Can detect tilt motion greater than 1 degree/second
5. Can immediately transmit warnings if threshold is exceeded
6. Can be operational at any angle

28

Tilt sensing system must comply with the requirements shown in the following table:

Tilt sensor

Quality characteristic	Requirement
Range (min, degrees)	±90
Resolution (max, degrees)	0.0001
Repeatability (max, degrees)	±0.0003
Reporting frequency (max, seconds)	9.6
International Protection (IP) rating	68
Operating temperature range (ºC)	−40–80

19-17.03 CONSTRUCTION

19-17.03A General

29

Protect sensors, conduits, exposed cables, data acquisition devices, transceivers, and cellular gateway. Use hand operated compactor to compact the first 3-foot backfill over the instruments, conduits, and exposed cables. Do not operate construction equipment over the instruments and conduits before placement of hand-compacted backfill.

30

Protect monitoring systems under section 5-1.36 for the duration of monitoring. Immediately notify the Engineer upon discovering a monitoring system is damaged or no longer functioning. Repair or restore damaged monitoring system under section 5-1.39 within 3 days of discovering the damage.

19-17.03B Installation

31

Install ground movement and vibration monitoring systems at locations and elevations shown.

32

Install IPI head assemblies casing under manufacturer's instructions

33

Install 3-axis vibration transducer as follows:

1. Firmly attach on the surface of the object to be monitored, or firmly set in undisturbed soil
2. Align transducer longitudinal direction of measurement parallel to the alignment of the object
3. Align transducer transverse direction of measurement perpendicular to the alignment of the object

34

Install tilt sensors at locations with low temperature fluctuation. For tilt sensors to be subjected to direct sunlight, provide radiant barrier or sun shield.

35

Route cables through the conduits and establish data transmission links between monitoring sensor, data acquisition device, and radio transceiver.

36

Mark sensors, cables, tubes, conduits, data acquisition devices, radio transceivers, and cellular gateway to allow identification on the site.

19-17.03C System Calibration, Verification, and Maintenance

37

Calibrate and verify that the installed systems meet the requirements. Submit system calibration and verification report within 7 days of system installation. Commission equipment and instruments in the presence of the Engineer.

38

During monitoring period, maintain and calibrate installed systems under manufacturer's recommended schedules and procedures.

19-17.03D Monitor Baseline Vibration Levels

39

Before construction, monitor and record vibration at least two nonconsecutive workdays, spanning the hours during which construction activities will take place to establish baseline vibration levels.

19-17.03E Salvage Reusable Equipment

40. Remove if the entire ground movement and vibration monitoring system is paid as monthly rental.

After completion of settlement, movement, or vibration monitoring, salvage reusable equipment that is paid for by the contract and submit to the Engineer.

19-17.04 PAYMENT

41. Edit if part of the monitoring system is paid as monthly rental, such as AMTS

The ground movement and vibration monitoring systems are paid as monthly rental for the duration of the monitoring period.

Section 46-1.01A. Use for ground anchors and soil nails if the designer has a specific work sequencing concern related to ground anchor construction; for example, the timing of ground anchor stressing relative to the construction of other elements. Insert project-specific work sequencing specifications.

Add to section 46-1.01A:

_____.

Section 46-1.03E. Use for ground anchors and soil nails if research investigation is required by the designer. Notify the estimator of the need for supplemental funds. Consult the geotechnical report and edit as necessary to describe the scope of all research activities so the Contractor can estimate the impact on operations.

Replace section 46-1.03E with:

1. If used for ground anchors, replace "soil nail" with "ground anchor." Edit as necessary if the structure is not a wall.

46-1.03E Research Investigation

The Department will conduct research activities within the limits of the soil nail wall.

2. Verify that the locations of the slope indicator casings are shown. Edit as

Research activities include installing and monitoring survey markers, slope indicator casings, and other equipment at the locations shown. Survey markers are installed on the face and crest of the wall.

3

Research equipment installation is scheduled in advance. Coordinate construction activities to prevent interference with the equipment installation and monitoring.

4. Edit if the Contractor installs the equipment instead of the Department.

The Department furnishes and installs the research equipment. If the Engineer orders you to assist in installing the equipment, this work is change order work.

Section 46-2.01B. Use for verification tests for ground anchors. Use with NSSPs for sections 46-2.01C, 46-2.01D(2)(c), 46-2.01D(3)(c), and 46-2.03E.

Add to section 46-2.01B:

anchor bonded length: length of grout/ground interface that provide verifiable pullout resistance using ground anchor verification test.

anchor unbonded length: length of ground anchor measured from the finish grade to the top of anchor bonded length.

tendon bonded length: length of ground anchor tendons bonded with surrounding grout.

Section 46-2.01C. Use for ground anchors if on a short time limit contract or if an alternative number of anchors is allowed.

1. Use for a short time limit contract if strand tendons are shown on the plans.

Add to the 1st paragraph of section 46-2.01C:

You may submit a certificate of compliance for the corrosion-inhibiting grease instead of submitting a test sample and test data.

2. Use if an alternative number of ground anchors is allowed. Confirm with the designer.

Add to section 46-2.01C:

You may submit calculations and details for furnishing an alternative number of ground anchors that provide the same horizontal and vertical components and distribution of the design force as provided by the anchors shown. Include alternative structure details. Alternative design calculations and details must be sealed and signed by an engineer who is registered as a civil engineer in the State.

**Recommend by GS when Ground Anchor Verification tests are required Obtain NSSP approval from David Jang in GS.
4/1/2021**

Paragraphs 3-5. Use when ground anchor verification tests are described. Use with NSSPs for sections 46-2.01B, 46-2.01D(2)(c), 46-2.01D(3)(c), and 46-2.03E.

3.

Include the following verification test ground anchor specific information in the shop drawings:

1. Proposed locations of verification test ground anchors
2. Details for providing anchor bonded and unbonded length, including the details of how to form the terminating grout surface perpendicular to the anchor alignment.

4

If a pullout failure occurs, submit the pullout failure load as part of the test data.

5

If additional verification ground anchors are required under section 46-2.01D(2)(c)(ii), submit revised shop drawings.

Section 46-2.01D(2)(c) Ground Anchor Verification Test.

The verification test verifies pullout resistance of the grout/ground interface in the anchor bonded length. Existing ground anchor performance and proof tests allow the contribution of pullout resistance in the anchor unbonded length and cannot verify that the anchor bond length has the required pullout resistance.

Delineation of control zones should be provided in the geotechnical report and shown on the Plans for verification test.

Use with NSSP for sections 46-2.01B, 46-2.01C, 46-2.01D(3)(c), and 46-2.03E.

Add to section 46-2.01D(2):

46-2.01D(2)(c) Verification Test

46-2.01D(2)(c)(i) General

Install and test 2 sacrificial verification test ground anchors for each control zone. You may install and test the ground anchors during stability test.

2

Perform verification test to verify the installation methods and pullout resistance before installing any ground anchors.

46-2.01D(2)(c)(ii) Test Procedure

3

Perform verification test in the Engineer's presence.

4

Conduct verification test as follows:

1. Incrementally load the test ground anchor as shown in the following table:

Section 46-2.01D(3)(c). Use to specify acceptance criteria for ground anchor verification tests. Use with NSSP for sections 46-2.01B, 46-2.01C, 46-2.01D(2)(c), and 46-2.03E.

Add to section 46-2.01C(3):

46-2.01D(3)(c) Verification Test Acceptance Criteria

Ground anchors that are verification-tested must comply with the following:

1. Total measured movement at the maximum test load minus the measured residual movement at the ending alignment load exceeds 80 percent of the theoretical elastic elongation of the sum of the tendon unbonded length and the jacking length.
2. Creep movement complies with one of the following:
   2.1. For a 10-minute load hold, the creep movement measured from 1 to 10 minutes is less than 0.04 inch.
   2.2. For a 60-minute load hold, the creep movement measured from 6 to 60 minutes is less than 0.08 inch and the creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

Section 46-2.03E. Use for construction of verification test ground anchors. Use with NSSPs for sections 46-2.01B, 46-2.01C, 46-2.01D(2)(c), and 46-2.01D(3)(c).

Add to section 46-2.03:

46-2.03E Verification Test Ground Anchors

1

Construct verification test ground anchors using the same equipment, methods, anchor inclination, anchor bond length and drilled hole diameter as to be used for production ground anchors.

2

Drill, install, and grout verification test ground anchors in the Engineer's presence.

3

Install the verification test ground anchors within the limits of each control zone. Space the verification test ground anchors at least 10 feet apart.

4

Grout only anchor bonded length. Form terminating grout surface perpendicular to the ground anchor alignment using a forming device. The forming device must:

1. have a diameter no more than 1 inch smaller than the drilled hole diameter
2. be made of materials that can form a minimum 8-inch compressible zone measured along the test ground anchor alignment
3. not deform during test ground anchor installation

5

Grout overflow outside the forming device is allowed but grout overflow must not submerge the forming device.

6

Do not splice a verification test ground anchor within anchor bonded length.

7

Install casing in anchor unbonded length of the drilled hole to prevent cave in of the drilled hole before testing is complete. Before test, inspect the drilled hole for cleanliness and remove any debris in the drilled hole.

8

Remove each verification test ground anchor to 6 inches behind the finished grade after testing is complete. Fill the voids with grout.

Section 46-2.01C. Use for ground anchors if on a short time limit contract or if an alternative number of anchors is allowed.

1. Use for a short time limit contract if strand tendons are shown on the plans.

Add to the 1st paragraph of section 46-2.01C:

You may submit a certificate of compliance for the corrosion-inhibiting grease instead of submitting a test sample and test data.

2. Use if an alternative number of ground anchors is allowed. Confirm with the designer.

Add to section 46-2.01C:

You may submit calculations and details for furnishing an alternative number of ground anchors that provide the same horizontal and vertical components and distribution of the design force as provided by the anchors shown. Include alternative structure details. Alternative design calculations and details must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Section 46-2.01D(2)(b)(i). Use for ground anchors if performance test locations are not shown or if the compressive strength at loading is not 2,880 psi.

1. Use if performance test locations are not shown. Insert the number provided by the designer. For wall anchors, generally a minimum of 3 anchors but not less than 5 percent of anchors should be performance tested. For footing anchors, generally a minimum of 2 anchors but not less than 10 percent of anchors per footing should be performance tested. For footing anchors, add "at each footing" to the end of the 1st sentence.

Add to section 46-2.01D(2)(b)(i):

Performance test a minimum of ___ ground anchors. The Engineer determines which anchors are to be performance tested.

2. Use if the compressive strength at loading is not 2,880 psi. Insert the value provided by the designer. Typically, 80 percent of the 28-day compressive strength is specified as the compressive strength at loading.

Replace the 3rd paragraph of section 46-2.01D(2)(b)(i) with:

Do not stress against the concrete until it has attained a compressive strength of at least _____ psi and has cured for at least 7 days.

Section 46-2.01D(2)(b)(ii). Use for (1) ground anchors that are not designed by LRFD or (2) footing ground anchors that take seismic loading and have a lock-off load greater than or equal to 0.25P_{TL} (0.25T for non-LRFD design).

1–2. Use for footing ground anchors that take seismic loading and have a lock-off load greater than or equal to 0.25P_{TL}.

1. Use if the footing anchors that take seismic loading and have a lock-off load greater than or equal to 0.25P_{TL} are the only ground anchors in the project. Delete par. 2.

Delete item 5 in the list in the 1st paragraph of section 46-2.01D(2)(b)(ii).

2. Use if, besides the footing anchors that take seismic loading and have a lock-off load greater than or equal to 0.25P_{TL}, there are also other ground anchors in the project. Insert the locations of the footing anchors that take seismic loading and have a lock-off load greater than or equal to 0.25P_{TL}. Delete par. 1.

Replace item 5 in the list in the 1st paragraph of section 46-2.01D(2)(b)(ii) with:

5. Except for the ground anchors at _____, if the movement measured from 1 to 10 minutes is greater than 0.04 inch:
   5.1. Hold the load constant for an additional 50 minutes
   5.2. Measure and record the anchor end movement at 15, 20, 25, 30, 45, and 60 minutes
   5.3. Plot a creep curve as a function of the logarithm of time, showing the anchor end movement from 6 to 60 minutes

3. Use for horizontal ground anchors, such as those used in walls, when the

Replace the table in item 1 in the list in the 1st paragraph of section 46-2.01D(2)(b)(ii) with:

Loading Schedules

Performance test		Proof test	
Load increment	Hold time (minutes)	Load increment	Hold time (minutes)
AL	Until stable	AL	Until stable
0.25T	1–2	0.25T	1–2
AL	Until stable	0.50T	1–2
0.25T	1–2	0.75T	1–2
0.50T	1–2	1.00T	1–2
AL	Until stable	1.25T	1–2
0.25T	1–2	1.50T[a]	10 or 60
0.50T	1–2	AL	Until stable
0.75T	1–2	--	--
AL	Until stable	--	--
0.25T	1–2	--	--
0.50T	1–2	--	--
0.75T	1–2	--	--
1.00T	1–2	--	--
AL	Until stable	--	--
0.25T	1–2	--	--
0.50T	1–2	--	--
0.75T	1–2	--	--
1.00T	1–2	--	--
1.25T	1–2	--	--
AL	Until stable	--	--
0.25T	1–2	--	--
0.50T	1–2	--	--
0.75T	1–2	--	--
1.00T	1–2	--	--
1.25T	1–2	--	--
1.50T[a]	10 or 60	--	--
AL	Until stable	--	--

NOTES:
T = Anchor design force shown
AL = Alignment load = 0.10T
[a]Maximum test load

4. Use for vertical ground anchors, such as those used in footings, when the anchors are not designed by LRFD. Edit the table if the designer requires a different maximum test load.

Replace the table in item 1 in the list in the 1st paragraph of section 46-2.01D(2)(b)(ii) with:

Loading Schedules

Performance test		Proof test	
Load increment	Hold time (minutes)	Load increment	Hold time (minutes)
AL	Until stable	AL	Until stable
0.20T	1–2	0.20T	1–2
AL	Until stable	0.40T	1–2
0.20T	1–2	0.60T	1–2
0.40T	1–2	0.80T	1–2
AL	Until stable	1.00T[a]	10 or 60
0.20T	1–2	AL	Until stable
0.40T	1–2	--	--
0.60T	1–2	--	--
AL	Until stable	--	--
0.20T	1–2	--	--
0.40T	1–2	--	--
0.60T	1–2	--	--
0.80T	1–2	--	--
AL	Until stable	--	--
0.20T	1–2	--	--
0.40T	1–2	--	--
0.60T	1–2	--	--
0.80T	1–2	--	--
1.00T[a]	10 or 60	--	--
AL	Until stable	--	--

NOTES:
T = Anchor design force shown
AL = Alignment load= 0.10T
[a]Maximum test load

Loading Schedules

Verification test	
Load increment	Hold time (minutes)
AL	Until stable
0.20FTL	1–2
AL	Until stable
0.20FTL	1–2
0.40FTL	1–2
AL	Until stable
0.20FTL	1–2
0.40FTL	1–2
0.60FTL	1–2
AL	Until stable
0.20FTL	1–2
0.40FTL	1–2
0.60FTL	1–2
0.80FTL	1–2
AL	Until stable
0.20FTL	1–2
0.40FTL	1–2
0.60FTL	1–2
0.80FTL	1–2
1.00FTL[a]	10 or 60
AL	Until stable

NOTE: FTL = factored test load shown
AL = alignment load = 0.10FTL
[a]Maximum test load

2. Apply each load increment in less than 1 minute and hold it for the length of time shown in the table titled "Loading Schedules."
3. Measure and record the applied test load and the anchor end movement at each load increment.
4. When applying the maximum test load:
   4.1. Hold the load constant for 10 minutes.
   4.2. Start the observation period for the load hold when the pump starts to apply the last load increment.
   4.3. Measure and record the anchor end movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
5. If the movement measured from 1 to 10 minutes is greater than 0.04 inch:
   5.1. Hold the load constant for an additional 50 minutes.
   5.2. Measure and record the anchor end movement at 15, 20, 25, 30, 45, and 60 minutes.
   5.3. Plot a creep curve as a function of the logarithm of time, showing the anchor end movement from 6 to 60 minutes.
6. Reduce the load to the ending alignment load and record the residual movement.

Verification test ground anchors that fail to comply with the acceptance criteria are rejected.

Submit revised shop drawings for additional verification test ground anchors.

Install and test additional verification test ground anchors until they comply with acceptance criteria.

Section 46-2.01D(3)(b)(ii). Use for footing ground anchors that take seismic loading and have a lock-off load greater than or equal to $0.25P_{TL}$ (0.25T for non-LRFD design).

1. Use if the footing anchors that take seismic loading and have a lock-off load greater than or equal to $0.25P_{TL}$ are the only ground anchors in the project. Delete pars. 2 and 3.

Replace item 2 in the list in the 1st paragraph of section 46-2.01D(3)(b)(ii) with:

2. Creep movement measured from 1 to 10 minutes is less than 0.04 inch.

2–3. Use if, besides the footing anchors that take seismic loading and have a lock-off load greater than or equal to $0.25P_{TL}$, there are also other ground anchors in the project. Insert the locations of the footing anchors that take seismic loading and have a lock-off load greater than or equal to $0.25P_{TL}$. Delete par. 1.

2

Replace item 2 in the list in the 1st paragraph of section 46-2.01D(3)(b)(ii) with:

2. Except for the ground anchors at _____, creep movement complies with one of the following:
   2.1. For a 10-minute load hold, the creep movement measured from 1 to 10 minutes is less than 0.04 inch.
   2.2. For a 60-minute load hold, the creep movement measured from 6 to 60 minutes is less than 0.08 inch and the creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

3

Add to the list in the 1st paragraph of section 46-2.01D(3)(b)(ii):

4. For the ground anchors at _____, the creep movement measured from 1 to 10 minutes is less than 0.04 inch.

Section 46-2.03A. Use for ground anchors with project-specific geotechnical conditions or with a grout cover over the corrugated sheathing of other than 1 inch.

1–3. Use for project-specific geotechnical considerations.

Add to section 46-2.03A:

1. Use for expected difficult ground anchor installation.

Insert the location of the difficult installation. Insert the conditions that affect ground anchor installation as described in the foundation report. Insert other conditions that may apply, such as: low overhead clearance, underground utilities, overhead utilities, noise control, vibration monitoring, staged construction, and traffic control.

Verify and obtain concurrence from Geotechnical Services.

Use multiple pars. if foundation reports show differing conditions:

1. Along the ground anchor wall. Insert stations and elevations as provided in the foundation report.

2. For different structures.

Expect difficult ground anchor installation at _____ due to the presence of the following conditions:

1. _____
2. _____
3. _____

2. Use for horizontal ground anchors installed under a spread footing for a structure or if caving of the drilled hole could be detrimental to an existing structure. Insert the location of the ground anchors. Add stations if necessary. Create a table format for multiple locations.

Install the top level of ground anchors at _____ in drilled holes advanced with drill casing. Withdraw the drill casing as the grout is being placed in the drilled hole, keeping the end of the casing immersed in the grout.

3. Use if the ground anchors will pass through slide planes or foundation material with significant voids. Insert the location of the voids. Add stations and elevations if necessary. Create a table format for multiple locations. Confirm with the designer and Geotechnical Services.

At _____ you may encounter voids in the foundation material along the length of the drilled hole that affect drilling and grouting. Use measures such as a grout sock to avoid the excessive loss of grout into the voids encountered.

4. Use if the designer requires a grout cover over the corrugated sheathing of other than 1 inch. Insert the thickness of the cover.

Replace the 9th paragraph of section 46-2.03A with:

The diameter of the drilled hole must be large enough to provide a minimum grout cover of ___ inches over the corrugated sheathing for the full length of the tendon.

Section 46-3.01C(1). Use to test verification test soil nails to 3 x T. Use with NSSP for section 46-3.01D(2)(b)(ii)(B).

Add at the end of section 46-3.01C(1):

Submit calculations that verify the size and tensile strength of verification test nail bar can provide nominal tensile resistance at least 1.5 times the maximum verification test load described in Verification Test Loading Schedule.

Section 46-3.01D(2)(b)(ii)(B). Use to test verification test soil nail to 3 x T. The objective is to test the soil nail to failure and obtain nominal pullout resistance of the soil nails. Use with NSSP for section 46-3.01C(1).

Replace the table in item 1 of the list in the 3rd paragraph of section 46-3.01D(2)(b)(ii)(B) with:

1.

Verification Test Loading Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.20T	1–2
0.40T	1–2
0.60T	1–2
0.80T[a]	60
1.00T[b]	1–2
1.20T	1–2
1.40T	1–2
1.60T	10
1.80T	1–2
2.00T	1–2
2.20T	1–2
2.40T	1–2
2.60T	1–2
2.80T	1–2
3.00T[c]	1–2
AL	Until stable

NOTES:
T = Test load
AL = Alignment load = 0.10T
[a]Creep test.
[b]Acceptance test load for verification test.
[c]Maximum test load for verification test.

Replace item 5.5 in the list in the 3rd paragraph of section 46-3.01D(2)(b)(ii)(B) with:

2.

5.5 Increase the load incrementally to 3.00T.

Add item 5.6 at the end of list in the 3rd paragraph of section 46-3.01D(2)(b)(ii)(B):

3.

5.6 Reduce the load to the ending alignment load and record the residual movement.

Section 46-3.01D(2)(b)(ii)(C). Use for soil nails.

Insert 2 percent of the total number of production soil nails.

Add to the 1st paragraph of section 46-3.01D(2)(b)(ii)(C):

In addition to the proof test soil nails shown, install and test ____ proof test soil nails at locations determined by the Engineer.

Section 46-3.03A. Use for expected difficult soil nail installation.

Insert the location of the difficult installation. Insert the conditions that affect soil nail installation as described in the foundation report. Insert other conditions that may apply, such as: low overhead clearance, underground utilities, overhead utilities, noise control, vibration monitoring, staged construction, and traffic control.

Verify and obtain concurrence from Geotechnical Services.

Use multiple pars. if foundation reports show differing conditions:

1. Along the soil nail wall. Insert stations and elevations as provided in the foundation report.

2. For different structures.

Add to section 46-3.03A:

Expect difficult soil nail installation at _____ due to the presence of the following conditions:

1. _____
2. _____
3. _____

Section 47-2.01A. Use if alternative earth retaining systems are allowed for the Department's design shown.

Add to section 47-2.01A:

1. Insert location of MSE.

You may use an alternative earth retaining system for the mechanically stabilized embankment at _____. The alternative system must comply with section 47-6.

Section 47-6.01A. Use if alternative earth retaining systems are allowed for any of the following:

1. Mechanically stabilized embankment (MSE) system

2. Type 1–5 retaining walls

Add to section 47-6.01A:

1. If there are different options for more than 1 location within a project, list each location separately. If both of the tables below are used, replace "table" with "tables."

The alternative earth retaining system must be one of the systems shown in the following table:

2. Listed in the table below are the earth retaining systems with contact information for companies for which standard plans have been pre-approved. Design must specify which systems are applicable for each project based on the criteria below and differential settlement requirements for each wall location in the project. Delete the systems that are not allowed from the table below. Design service life is 50 years.

The following are instructions for when each system is allowed:

Reinforced Earth (5 ft cruciform concrete face panel) is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture.

Reinforced Earth (5 ft square concrete face panel) is an alternative to an MSE regardless of architectural treatment.

Retained Earth (5 ft square concrete face panel) is an alternative to an MSE regardless of architectural treatment.

MSE Plus (5 ft square concrete face panel) is an alternative to an MSE regardless of architectural treatment.

MSE Plus (5 ft high by 6 ft wide concrete face panel) is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture.

Welded Wire Wall is an alternative to a wire faced MSE.

Tensar ARES system is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture, the anticipated total settlement is less than 8", and the anticipated differential settlement at any location along the wall length is less than 0.5 percent.

Landmark (modular block faced) is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture, and there is enough space to accommodate a 4 degree face batter or vertical.

KeySystem (modular block faced) is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture.

Verdura Segmental Retaining Wall System is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture, and there is enough space to accommodate a 14 degree face batter.

Mesa Retaining Wall System is an alternative to an MSE if there is no architectural treatment or the architectural treatment is a non-pictorial concrete surface texture.

Note: A pictorial is a formed relief texture depicting birds, flowers, county seals, etc.

Proprietary earth retaining system	Website/e-mail	Address	Telephone no.
Welded Wire Wall (Steel mesh soil reinforcement with welded wire mesh facing.)	http://www.hilfiker.com	HILFIKER RETAINING WALLS 1902 HILFIKER LN EUREKA CA 95503-5711	(707) 443-5093 (800) 762-8962

Reinforced Earth – 5 ft cruciform (Steel strap soil reinforcement with 5 ft cruciform concrete face panels.)	https://www.reinforcedearth.com	THE REINFORCED EARTH COMPANY 23161 MILL CREEK DR STE 315 LAGUNA HILLS CA 92653-7907	(949) 427-3601
Reinforced Earth – 5 ft square (Steel strap soil reinforcement with 5 ft square concrete face panels.)	https://www.reinforcedearth.com	THE REINFORCED EARTH COMPANY 23161 MILL CREEK DR STE 315 LAGUNA HILLS CA 92653-7907	(949) 427-3601
Retained Earth (Steel mesh soil reinforcement with 5 ft square concrete face panels.)	https://www.reinforcedearth.com	THE REINFORCED EARTH COMPANY 23161 MILL CREEK DR STE 315 LAGUNA HILLS CA 92653-7907	(949) 427-3601
MSE Plus – 5 ft square (Steel mesh soil reinforcement with 5 ft square concrete face panels.)	http://www.mseplus.com	SSL 4740 SCOTTS VALLEY DR STE E SCOTTS VALLEY CA 95066-4240	(831) 430-9300
MSE Plus – 5 by 6 ft (Steel mesh soil reinforcement with 5 ft high by 6 ft wide concrete face panels.)	http://www.mseplus.com	SSL 4740 SCOTTS VALLEY DR STE E SCOTTS VALLEY CA 95066-4240	(831) 430-9300
ARES – 9 by 5 ft (Geogrid soil reinforcement with 9 ft wide by 5 ft high concrete face panels.)	http://www.tensarcorp.com	TENSAR INTERNATIONAL CORPORATION 2500 NORTHWINDS PKWY STE 500 ALPHARETTA GA 30009-2247	(770) 344-2090
Landmark Retaining Wall System (Geogrid soil reinforcement with modular concrete block facing at a 4 degree batter or vertical.)	http://www.anchorwall.com david.harper@oldcastle.com	ANCHOR WALL SYSTEMS INC 10714 POPLAR AVE FONTANA CA 92337-7333	(925) 459-4972 (844) 495-8210
KeySystem 1 (Steel wire grid soil reinforcement with a modular concrete block facing.)	http://www.keystonewalls.com	KEYSTONE RETAINING WALL SYSTEMS 4444 W 78TH ST MINNEAPOLIS MN 55435-5406	(952) 897-1040
Verdura Segmental	https://www.soilretention.com	SOIL RETENTION PRODUCTS	(800) 346-7995

Retaining Wall System (Geogrid soil reinforcement with modular concrete block facing at a 14 degree finished slope face.)		2501 STATE ST CARLSBAD CA 92008-1624	
Mesa Retaining Wall System (Geogrid soil reinforcement with modular concrete block facing at a 4 degree batter or vertical.)	https://www.tensarcorp.com	TENSAR INTERNATIONAL CORPORATION 2500 NORTHWINDS PKWY STE 500 ALPHARETTA GA 30009-2247	(770) 344-2090

3. Use if alternative State designed systems are shown on the plans.

Alternative State designed system	Contact information
	State of California
	State of California

Section 49-1.01D(3). Use for load test piles.

A load test pile is required for driven piles with a diameter greater than 36 inches or if recommended in the foundation report.

Notify the estimator of the need for supplemental funds.

Add to the end of section 49-1.01D(3):

1. Modify or delete table as recommended by Geotechnical Services. Table for control zones and load test pile support locations must not be shown on the plans.

The Department performs load tests on the load test pile at each control zone as shown in the following table:

Bridge no.	Control zone	Load test pile support location

2. Use for driven load test piles.

Driven load test piles and anchor piles are monitored for dynamic response during the final 25 feet of driving under section 49-1.01D(4).

Section 49-1.01D(4). Use for dynamic monitoring of driven piles.

Dynamic monitoring is required for driven piles (1) with a diameter or greatest cross sectional side dimension of 18 inches and greater, or (2) if the required nominal driving resistance exceeds 600 kips, or (3) if recommended in the foundation report.

Unless otherwise recommended in the foundation report, piles with a diameter or greatest cross-sectional side dimension:

1. From 18 inches to 36 inches, dynamic monitoring is performed on the driven production pile.

2. Greater than 36 inches, dynamic monitoring is performed on the driven load test pile and anchor piles.

1. Use if recommended in the foundation report to specify other than 1 day for when the pile will be redriven. Insert number of days.

Replace item 6 in the list in the 8th paragraph of section 49-1.01D(4) with:

6. After ___ days, install the instrument package on the pile and attach the cables as directed by the Engineer. Resume driving the pile to the specified tip elevation operating the driving hammer at a piston stroke height or fuel setting specified by the Engineer. Warm up the driving hammer before restriking begins by applying at least 20 blow counts to (1) another pile at a location authorized by the Engineer or (2) timber mats placed on the ground.

Add to the end of section 49-1.01D(4):

2. Modify or delete table as recommended by Geotechnical Services. Do not use for load test and anchor piles.

The Department performs dynamic monitoring of the first production pile driven for each control zone at the support location shown in the following table:

Bridge no.	Control zone	Dynamic monitoring support location

Section 49-1.01D(5). Use if steel piling is to be embedded into rock and the top of rock elevations vary.

Test borings are used to verify top of rock elevation. It is not the intent of this specification to gather any other geotechnical data. Use only if requested by the Office of Geotechnical Services.

1. Use to specify test boring locations. Delete the table and edit accordingly for only 1 location.

Add to section 49-1.01D(5):

Perform test borings at the locations shown in the following table:

Bridge no.	Location

2. Use to revise the depth of drilling below the specified tip elevation. Insert depth required.

Replace the 5th paragraph of section 49-1.01D(5) with:

Drill test borings by rotary drill methods to a depth of at least __ feet below the specified tip elevation shown. Test borings must be at least 3 inches in diameter.

Section 49-1.03. Use for expected difficult pile installation. Use this SSP for all types of pile installation.

Insert the conditions that affect pile installation as described in the foundation report. Insert other conditions that may apply, such as: low overhead clearance, underground utilities, overhead utilities, noise control, vibration monitoring, staged construction, and traffic control.

Verify and obtain concurrence from Geotechnical Services.

Insert bridge no. and support locations for difficult pile installation. List specific conditions for each location.

Add to section 49-1.03:

Expect difficult pile installation due to the conditions shown in the following table:

Pile location		Conditions
Bridge no.	Support location	

Section 49-2.01A(3). Use for driven piles. Retain Pile and Driving Data Form.

1. Use for all driven piles except if a driving system submittal or dynamic monitoring is requested by Geotechnical Services. Insert bridge number, pile type, and support location (e.g. Abutment 1, Bent 2).

Add to section 49-2.01A(3)(a):

Before installing driven piles, submit a Pile and Driving Data Form for each pile type for each of the support locations shown in the following table:

Bridge no.	Pile type	Support location

2. Use if a driving system submittal or dynamic monitoring is requested by Geotechnical Services. Insert bridge number, pile type, and support location (e.g. Abutment 1, Bent 2) or control zone.

Add to section 49-2.01A(3)(b):

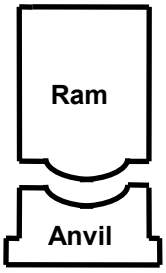
Before installing driven piles, submit a driving system submittal for each pile type for each of the support locations or control zones shown in the following table:

Bridge no.	Pile type	Support location or control zone

CALIFORNIA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION LABORATORY

PILE AND DRIVING DATA FORM

Structure Name :_____ Contract No.:_____
_____ Project:_____
Structure No.:_____ Pile Driving Contractor or
Dist./Co./Rte./Post Mi:_____ Subcontractor_____(Pile Driven By)



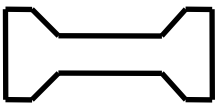
Hammer

Manufacturer:_____ Model:_____
Type:_____Serial No.:_____
Min Rated Energy: _____ at ___ Length of Stroke ____ Fuel Setting
Max Rated Energy: _____ at ___ Length of Stroke ____ Fuel Setting
Ram Weight:_____kips

Modifications: _____
_____
_____

Capblock (Hammer Cushion)

Material:_____
Thickness:_____in Area:_____in^2
Modulus of Elasticity - E:_____ksi
Coefficient of Restitution - e:_____

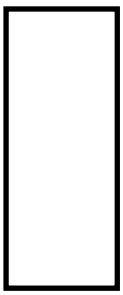


Pile Cap

[Helmet / Bonnet / Anvil Block / Drivehead] Weight:_____ kips

Pile Cushion

Material:_____
Thickness:_____in Area: _____in^2
Modulus of Elasticity - E:_____ksi
Coefficient of Restitution - e:_____



Pile

Pile Type:_____
Length (In Leads):_____ft
Lb/ft.:_____Taper:_____
Wall Thickness:_____in
Cross Sectional Area:_____ in^2
Design Pile Capacity:_____kips
Description of Splice:_____
_____
Tip Treatment Description:_____
_____

DISTRIBUTE:

- ☐ Translab, Foundation Testing
- ☐ Translab, Geotechnical Design
- ☐ Resident Engineer

Note: If mandrel or follower is used to drive the pile, attach separate manufacturer's detail sheet(s) including weight and dimensions.

Submitted By:_____
Date:_____Phone No.:_____

Section 49-2.01C(2). Use if revising the specifications for driving equipment.

Add to section 49-2.01C(2):

1. Use only for locations with low overhead clearance, generally less than 20 feet.

You may use internal drop hammers that strike the tip of closed ended piles or impact hammers that do not comply with the minimum energy requirements to advance piles to within 3 feet of the specified tip elevation at the locations shown in the following table:

Bridge name or no.	Abutment no.	Bent no.

2. Use only for sheet piles or for CISS piles that have no geotechnical capacity along the length of the pile or casing. If only 1 location, delete the table and delete *at the locations shown in the following table:*. Delete *rotators, or oscillators* if this paragraph is used only for sheet piles.

You may use vibratory hammers, rotators, or oscillators to install sheet piles or steel shells for CISS concrete piles at the locations shown in the following table:

Bridge name or no.	Abutment no.	Bent no.

3. Use for boulders, clay lenses, and other natural obstructions to pile driving, including abandoned culverts, slabs, footings, etc. Depth of excavation at uplift piles should be limited. Use only with steel piles. Edit as necessary.

If you encounter obstructions to driving, provide special driving tips or heavier pile sections, subexcavate below the bottom of footing, or take other measures to prevent damage to the pile during driving.

Section 49-2.01C(3). Use if drilling to assist pile driving is not allowed or is restricted by the foundation report.

Replace the paragraph of section 49-2.01C(3) with:

1. Use if drilling is not allowed for any structures on the project.

Delete paragraphs 2 and 3.

Do not use drilling to attain the specified tip elevation shown for driven piles.

2–3. Use if drilling is not allowed at specific locations and drilling is restricted at other locations. Insert locations.

2

For _____, do not use drilling to attain the specified tip elevation shown for driven piles.

3

Before driving piles, you may drill holes with a diameter not greater than the least dimension of the pile to attain the specified tip elevation shown for driven piles at the locations and to the bottom of hole elevations shown in the following table:

Bridge no.	Abutment no.	Bent no.	Bottom of hole elevation

Add to section 49-2.01C(3):

4. Use if drilling is not allowed at specific locations and may be allowed at other locations. Insert locations where drilling is not allowed per the foundation report.

For _____, do not use drilling to attain the specified tip elevation shown for driven piles.

5. Use if center-relief drilling may be necessary for open-ended CISS and steel pipe piles. Insert depth not to be drilled. Check the plans and foundation report. If SSP 49-3.03C(2), par. 1 is used, match the depth with the clean out depth of the CISS piles.

Drilling through the center of open-ended steel shells or steel pipe piles to attain the specified tip elevation may be necessary. The diameter of the drilled hole must be less than the inside diameter of the pile. Equipment or methods used for drilling holes must not cause quick soil conditions or cause scouring or caving of the hole. Drilling must not be used within __ feet of the specified tip elevation. Do not drill before driving piles.

Section 49-2.01C(4). Use for driven piles if predrilling is required.

Add to section 49-2.01C(4):

1. Use for all piles in existing embankments and fills in excess of 5 feet or if predrilling is required due to a close proximity to an obstruction.

At existing embankments and fills, drive piles in predrilled holes at the locations and to the bottom of hole elevations shown in the following table:

Bridge name or no.	Abutment no.	Bent no.	Bottom of hole elevation

2. Use if piles must be driven through concrete footings that are to remain structurally functional.

Predrill holes through existing concrete footings for driving of steel piles at the locations shown. Do not damage the existing concrete to remain in place. Drilling methods and equipment must be authorized before starting the drilling.

Section 49-2.01C(5). Use if a pile set period is allowed as an option by Geotechnical Services instead of longer piling.

Add to section 49-2.01C(5):

1. Insert location.

If piles at _____ do not attain the nominal driving resistance at the specified tip elevation shown, the Engineer will select 2 piles or 10 percent of piles in the footing, whichever is greater, to stand 1 foot above specified cut-off elevation for a set period without driving. The set period must be at least 12 hours.

2

After the set period has elapsed, redrive the selected piles in the footing. Driving hammer must be warmed up before restrike begins by applying at least 20 blow counts to (1) another pile or (2) timber mats placed on the ground. Redriving consists of operating the driving hammer at full rated energy on the pile and calculating the nominal driving resistance of the pile.

3

If the nominal driving resistance is attained for each pile designated to be redriven, the remaining piles in that footing are considered satisfactory and further driving is not required. If redriving the designated piles demonstrates that the nominal driving resistance has not been attained, redrive all piles in the footing until the nominal driving resistance is attained.

Section 49-3.02A. Use for any of the following:

1. If CIDH concrete piles are designed as end bearing

2. For CIDH piling if drilling is anticipated through cobbles, boulders, or hard rock

3. For CIDH concrete piles at least 24 inches in diameter

1. Use if CIDH concrete piles are designed as end bearing.

Add to section 49-3.02A(1):

The CIDH concrete piles shown in the following table are specified as end bearing:

Bridge name or no.	Abutment no.	Bent no.

2. Use for CIDH piling if drilling is anticipated through cobbles, boulders, or hard rock. Consult with Structure Construction, designer, or Foundation Report for a determination.

Replace section 49-3.02A(3)(a) with:

49-3.02A(3)(a) General

Submit as an informational submittal the proposed drilling equipment operational capacities or descriptions for:

1. Downward force in lb
2. Torque in ft-lb
3. Rotational speed in rpm
4. Rate of penetration in ft/hr
5. Number and type of drilling cutters or drilling teeth on drilling tool

3–7. Use for CIDH concrete piles at least 24 inches in diameter.

3

Add to section 49-3.02A(3):

49-3.02A(3)(l) Experience Qualifications

At least 15 days before the start of CIDH concrete pile construction, submit as an informational submittal the following experience qualifications in compliance with section 49-3.02A(4)(f):

1. List of CIDH concrete pile installations performed by the drilling contractor. The submittal must include:
   1.1. Project description
   1.2. Name and phone number of the owner
   1.3. CIDH pile plans
   1.4. Log of test borings
   1.5. Estimated dates of major CIDH pile installation activities

1.6. CIDH pile acceptance testing reports

2. List of on-site foremen and drill rig operators who will perform the CIDH concrete pile work and a summary of each individual's experience. The submittal must include:
   2.1. Detailed summary of each individual's experience in CIDH pile excavation operations and placement of assembled reinforcing cages and concrete
   2.2. Experience from at least 3 relevant projects, including:
      2.2.1. Project Description
      2.2.2. Date of work
      2.2.3. Actual work performed
      2.2.4. Name and phone number of a reference person for each project
   2.3. Proof of on-site foremen and drill rig operators experience qualifications

Add to section 49-3.02A(4):

4

49-3.02A(4)(f) Experience Qualifications

The drilling contractor must have successfully constructed at least 3 separate foundation projects in the last 5 years. The foundation projects must:

1. Have CIDH piles of similar or larger diameter and depth, and installed under similar substructure conditions to this contract
2. Demonstrate experience with drilling fluids and successful construction of CIDH piles under the wet conditions

5

Each on-site foremen and drill rig operator must have 2 years of experience installing CIDH concrete piles on at least 3 projects. The CIDH pile foundations must be of similar or larger diameter and depth, and installed under similar subsurface conditions to this contract.

6

On-site foremen experience must be supervising construction of CIDH concrete pile foundations. Indirect supervision of on-site CIDH concrete pile construction operations is not acceptable.

7

Drill rig operator experience must be in construction of CIDH concrete pile foundations.

Section 49-3.02B(6)(c). Use for steel soldier piling or CIDH piling at least 24 inches in diameter and 5 feet in length.

Add to section 49-3.02B(6)(c):

1

The synthetic slurry must be one of the materials shown in the following table:

Material	Manufacturer
SlurryPro CDP	KB INTERNATIONAL LLC 735 BOARD ST STE 209 CHATTANOOGA TN 37402 (423) 266-6964
Super Mud	PDS CO INC 105 W SHARP ST EL DORADO AR 71731 (870) 863-5707
Shore Pac	CETCO 2870 FORBS AVE HOFFMAN ESTATES IL 60192 (800) 527-9948
Terragel or Novagel Polymer	GEO-TECH SERVICES LLC 220 N. ZAPATA HWY STE 11A-449A LAREDO TX 78043 (210) 259-6386
BIG FOOT	MATRIX CONSTRUCTION PRODUCTS 50 S MAIN ST STE 200 NAPERVILLE IL 60540 (877) 591-3137
POLY-BORE	BAROID INDUSTRIAL DRILLING PRODUCTS 3000 N SAM HOUSTON PKWY EAST HOUSTON TX 77032 (877) 379-7412

2

Use synthetic slurries in compliance with the manufacturer's instructions. Synthetic slurries shown in the above table may not be appropriate for a given job site.

3

Synthetic slurries must comply with the Department's requirements for synthetic slurries to be included in the above table. The requirements are available from:

OFFICES OF BRIDGE DESIGN
P.O. BOX 168041
MS# 9-4/11G
SACRAMENTO, CA 95816-8041

4

SlurryPro CDP synthetic slurry must comply with the requirements shown in the following table:

SlurryPro CDP

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 ≤ 67.0[a] ≤ 64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 50–120 ≤ 70
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.
[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

5

Super Mud synthetic slurry must comply with the requirements shown in the following table:

Super Mud

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 ≤ 64.0[a] ≤ 64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 32–60 ≤ 60
pH	Glass electrode pH meter or pH paper	8.0–10.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.
[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

6

Shore Pac synthetic slurry must comply with the requirements shown in the following table:

Shore Pac

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 ≤ 64.0[a] ≤ 64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 33–132 ≤ 118
pH	Glass electrode pH meter or pH paper	8.0–11.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

7

Terragel or Novagel Polymer synthetic slurry must comply with the requirements shown in the following table:

Terragel or Novagel Polymer

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 ≤ 67.0[a] ≤ 64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 45–104 ≤ 104
pH	Glass electrode pH meter or pH paper	6.0–11.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

8

BIG-FOOT synthetic slurry must comply with the requirements shown in the following table:

BIG-FOOT

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 ≤ 64.0[a] ≤ 64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 30–125 55–114
pH	Glass electrode pH meter or pH paper	8.5–10.5
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

9

POLY-BORE synthetic slurry must comply with the requirements shown in the following table:

POLY-BORE

Quality characteristic	Test method	Requirement
Density: During drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	 62.8–65.8[a] 62.8–64.0[a]
Viscosity: During drilling (sec/qt) Before final cleaning and immediately before placing concrete (sec/qt)	Marsh funnel and cup, API RP 13B-1, section 7.2	 50–80 50–80
pH	Glass electrode pH meter or pH paper	7.0–10.0
Sand content, percent by volume: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	 ≤ 1.0

NOTE: Slurry temperature must be at least 40 °F when tested.

[a]If authorized, you may use slurry in a salt water environment. The allowable density of slurry in a salt water environment may be increased by 2 pcf.

Section 49-3.02B(6)(d). Use for CIDH piling at least 24 inches in diameter and full-depth casing if Geotechnical Services allows the use of water slurry.

Replace section 49-3.02B(6)(d) with:

1

49-3.02B(6)(d) Water Slurry

You may use water as slurry if a casing is used for the entire length of the drilled hole.

2

Water slurry must comply with the requirements shown in the following table:

Water Slurry Requirements

Quality characteristic	Test method	Requirement
Density: Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1, section 5	63.5[a]
Sand content: Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 10	≤ 0.5

[a]If authorized, you may use salt water slurry. The allowable density of the slurry may be increased by 2 pcf.

Section 49-3.02C(1). Use for CIDH piling if drilling is anticipated through cobbles, boulders, or hard rock.

Consult with Structure Construction and Foundation Report.

1

Add to section 49-3.02C(1):

Drilling equipment must be equipped with instrumentation to accurately measure the downward force in pounds. The instrumentation dial or display must be clearly visible for reading during operation.

Section 49-3.02C(4). Use if CIDH piles are end bearing. Edit *3 inches* if different from the clearance shown.

Add to section 49-3.02C(4):

If the hole is drilled below the specified tip elevation shown, the reinforcement must extend to within 3 inches of the bottom of the drilled hole for the piles that are specified as end bearing.

Section 49-3.02C(6). Use for permanent steel casings. Delete methods of installation not allowed per the Foundation Report.

Add to section 49-3.02C(6):

Install permanent steel casings by impact or vibratory hammers, oscillators, rotators, or by placing in a drilled hole.

Section 49-3.02C(7). Use for Type II CIDH piling if (1) an optional construction joint is shown and the CIDH piling is less than 5 feet in diameter, (2) Geotechnical Services requires corrugated metal pipe for the casing, (3) Geotechnical Services allows the use of slurry cement backfill to backfill the casing, or (4) Geotechnical Services restricts the method of casing installation.

1. Use if an optional construction joint is shown and the CIDH piling is less than 5 feet in diameter.

Replace the 1st paragraph of section 49-3.02C(7) with:

Section 49-3.02C(7) applies to CIDH concrete piles if an optional construction joint is shown and you choose to construct the optional construction joint.

2–4. Use only one of these paragraphs.

Replace item 5 in the list in the 2nd paragraph of section 49-3.02C(7) with:

2. Use if corrugated metal pipe is required.

5. Be corrugated metal pipe and placed in a drilled hole. Casings placed in a drilled hole must comply with section 49-3.02C(6).

3. Use if slurry cement backfill is allowed. Delete methods not allowed for the installation of the casing.

5. Be installed by impact or vibratory hammers, oscillators, rotators, or by placing in a drilled hole. Casings placed in a drilled hole must comply with section 49-3.02C(6) except slurry cement backfill may be used instead of grout.

4. Use if not all methods listed are allowed for the installation of the casing. Delete methods not allowed.

5. Be installed by impact or vibratory hammers, oscillators, rotators, or by placing in a drilled hole. Casings placed in a drilled hole must comply with section 49-3.02C(6).

Section 49-3.03C(2). Use to revise the clean out depth of open-ended CISS piles.

Insert the number of feet that should not be cleaned out at the bottom of the pile. Eight feet is specified in the Standard Specifications. Generally, use at least 2 times the pipe diameter. Check the plans and foundation report.

Replace item 4 in the list in the 3rd paragraph of section 49-3.03C(2) with:

4. Bottom ___ feet of the pile must not be cleaned out.

Section 49-4.03B. Use for steel soldier piling.

Add to section 49-4.03B:

1. Use if rock foundation material or boulders with soil matrix foundation material is shown on the LOTB or foundation report.

Rock subsurface foundation material is anticipated at the soldier pile retaining wall location. Conventional drilling equipment for drilling in soils may not be suitable for drilling holes for the steel soldier piling.

2. Use if pile substitutions are allowed.

If you substitute piles with a larger diagonal dimension for the piles shown, ream or enlarge the drilled hole to provide a hole diameter at least 4 inches larger than the diagonal dimension of the pile.

Section 49-5. Use for micropiles. Micropiles are also known as pin piles, minipiles, root piles, or needle piles.

For purposes of editing this SSP, micropiles are divided into the following 2 categories:

Category A: Micropiles experiencing primarily axial forces due to axial loading at the top of the micropile. This would typically include bridge foundations and may occasionally include some walls. For Category A, the Contractor determines the length, load testing is performed, and pressure grouting is used.

Category L: Micropiles experiencing primarily shear and bending forces along their length due to lateral loading. This would typically include earth stabilization structures and most walls. For Category L, the State determines the length, load testing is not performed, and gravity grouting is used.

Confirm the category with the designer. These categories are a guide to editing this SSP based on how Caltrans projects are typically done. However, nonstandard editing may be required for some projects.

For all micropiles, the plans must show:

1. Micropile layout, spacing, and inclination

2. Steel reinforcing element dimensions, yield strength, and any no-splice zones or no-joint zones

3. Grout compressive strength and grout cover

4. Anchorage details and amount of embedment into the concrete structure

5. Corrosion protection details, if required

For Category A micropiles only, the plans must show:

1. Value of FTL and whether it is for compression or tension load testing

2. Verification test micropile locations

3. Length of the pipe, HSS, or casing

4. Limits of the micropile length dimensioned as *Length to be determined by the Contractor*

5. If required, minimum micropile length per par. 98

For Category L micropiles only, the plans must show:

1. Micropile length or tip elevation

For all micropiles, the foundation report must discuss:

1. Any requirements for isolating micropiles from settling embankment

2. Any corrosion protection requirements

For Category A micropiles only, the foundation report must discuss:

1. Location of each verification test micropile and a description of which production micropiles are represented by each verification test micropile

2. Number of proof load tests required per footing or wall zone

3. For walls and earth stabilization structures, the limits of the wall zones

4. Whether verification and proof load testing are in tension, compression, or both

5. Whether creep testing is required for the verification or proof load testing

6. Whether measures need to be taken to provide geotechnical equivalence between the verification test micropile and the production piles it represents per par. 105

7. If required, minimum micropile length per par. 98

For Category L micropiles only, the foundation report must discuss:

1. Micropile length or tip elevation

Replace section 49-5 with:

49-5 MICROPILING

49-5.01 GENERAL

49-5.01A Summary

1

Section 49-5 includes specifications for constructing micropiles.

2. Use if the plans show an HS threaded bar with fy=120 ksi as a center bar. Delete *and couplers* if splices are not allowed.

HS threaded bars and couplers must comply with the specifications for HS steel prestressing bars in section 50.

3. Use if the plans show bar reinforcing steel as a center bar.

Bar reinforcing steel must comply with section 52, except you may use deformed bar reinforcing steel that complies with ASTM A615/A615M, Grade 60.

49-5.01B Definitions

4

micropile: Small-diameter, bored, CIP composite pile, in which the applied load is resisted by steel reinforcing elements, grout, and frictional ground-grout bond.

5

steel reinforcing element: Steel element used to strengthen or stiffen a micropile, such as bar reinforcing steel, HS threaded bar, pipe, hollow structural section (HSS), or casing.

49-5.01C Submittals

49-5.01C(1) General

6

Do not order materials nor install micropiles until the experience qualifications, shop drawings and calculations, and installation plan are authorized.

49-5.01C(2) Experience Qualifications

7. For Category L micropiles, replace *Construction details, structural details, and load test results* in item 2 with *Construction details and structural details*.

Submit the following experience qualification information:

1. Summary of the micropile subcontractor's experience that demonstrates compliance with section 49-5.01D(2).
2. Construction details, structural details, and load test results from at least 3 completed micropile installations performed by the micropile subcontractor in the last 5 years. The installations must be from 3 separate projects of similar scope to this Contract. Include a project description and the owner's name and current phone number.

3. List of on-site foremen and drill rig operators who will perform the micropile work and a summary of each individual's experience that demonstrates compliance with section 49-5.01D(2).

8. Edit if a different number of days is required for the review, except delete the paragraph if the number of days is 15.

Allow 10 days for review.

49-5.01C(3) Shop Drawings and Calculations

9

Submit micropile shop drawings and calculations electronically to sc.office.associates@dot.ca.gov.

10. Edit if a different number of days is required for the review, except delete the 1st sentence if the number of days is 20.

Allow 30 days for review.

11

The shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

12. Edit to suit the project. Delete item 7 for Category L micropiles. Delete item 3.8 if corrosion protection is not required. Delete item 6 if par. 80 is not used. Insert either *pipe*, *HSS*, or *casing* in the blank in item 6, according to the type of element specified in section 49-5.02B(2). If no splices or joints are allowed in any steel reinforcing elements, modify item 3.5 to read *Steel reinforcing element details, including sizes and lengths*.

The shop drawings and calculations must include:

1. Name, address, and phone number of the micropile subcontractor
2. Plan view, including:
   2.1. Station and offset at the beginning and end of the micropile structure and at any change in the structure's horizontal alignment
   2.2. Identification and location of each exploratory borehole
   2.3. Location of any existing utilities, adjacent existing structures, and other potential interferences
   2.4. Micropile layout and spacing
   2.5. Unique identification number for each micropile
3. Typical sections, including:
   3.1. Micropile inclination
   3.2. Drilled hole diameter
   3.3. Micropile tip elevation
   3.4. Micropile cutoff elevation
   3.5. Steel reinforcing element details, including sizes, lengths, splice or joint types, and splice or joint locations
   3.6. Centralizers and any spacers
   3.7. Micropile anchorage details
   3.8. Corrosion protection details
4. Material properties
5. General notes for constructing the micropiles, including overall construction sequencing
6. Data demonstrating the adequacy of any threaded joints in the _____ for the tension load specified in section 49-5.02B(2)
7. Calculations for the micropile length

13. Use if API N80 casing is shown on the plans. If par. 80 is not used, delete item 3.

If you propose an alternative to the API N80 casing shown, include with the shop drawings and calculations:

1. Calculations demonstrating that the structural capacity of the alternative pipe, HSS, or casing is greater than the structural capacity of the API N80 casing shown
2. Details and calculations for any anchorage changes needed to accommodate the alternative pipe, HSS, or casing
3. Data demonstrating the adequacy of any threaded joints for the value of tension specified in section 49-5.02B(2) if this value is greater than 25 percent of the yield capacity of the alternative pipe, HSS, or casing

49-5.01C(4) Installation Plan

14. Edit to suit the project. Delete items 3 and 4 if they do not apply. Delete item 6 if this requirement is not in the foundation report. Delete item 7 if no splices or joints are allowed in any steel reinforcing elements. For Category L micropiles: (1) delete items 9.6, 11, and 12, (2) delete *including details for post-grouting, if used* in item 9.3, (3) modify item 9.4 to read *Methods and equipment for monitoring and recording grout depth and volume as the grout is placed*, and (4) delete *initial pump pressures or* in item 9.5. Delete item 11.5 if par. 105 is not used.

Submit a micropile installation plan, including:

1. Detailed construction procedures, including personnel, materials, testing, and equipment.
2. Layout drawing showing the micropile installation sequence.
3. Information on headroom and space requirements for installation equipment that verifies that the equipment can perform at the job site.
4. Provisions for constructing micropiles near underground facilities.
5. Drilling or coring methods and equipment, including methods to:
   5.1. Provide drilled hole support
   5.2. Drill a straight hole
   5.3. Advance through boulders and other obstructions
   5.4. Prevent detrimental ground movements
6. Provisions for isolating micropiles from settling embankments.
7. Length of steel reinforcing element sections to be used, splice or joint locations, and any splice or joint location restrictions.
8. Methods for placing, positioning, and supporting steel reinforcing elements.
9. Grouting plan, including:
   9.1. Grout mix design. Include test results from an authorized laboratory for the compressive strength of the mix at 3, 7, 14, and 28 days and the density of the mix.
   9.2. Procedures for monitoring grout quality.
   9.3. Placement procedures and equipment, including details for post-grouting, if used.
   9.4. Methods and equipment for monitoring and recording grout depth, volume, and pressure as the grout is placed.
   9.5. Grouting rate calculations, upon request. Base the calculations on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid to be displaced, if applicable.
   9.6. Minimum cure time and strength requirements for performing load testing.
10. Plan for the control and disposal of surface and groundwater, drill flush, and waste grout.
11. Load testing plan, including drawings and calculations that describe:
    11.1. Testing procedures.
    11.2. Reaction load system capacity and equipment setup.
    11.3. Types and accuracy of the primary and secondary instrumentation equipment to be used for applying and measuring the test loads and top of micropile movements.
    11.4. Installation details for the instrumentation to be used for applying and measuring the test loads and measuring the top of micropile movements.
    11.5. Provisions for isolating verification test micropiles as specified under section 49-5.03B.
12. Calibration reports and data for each test jack, pressure gauge, load cell, and electronic displacement transducer to be used. The load cell calibration chart must show applied load versus millivolts per volt.

15

The installation plan must be sealed and signed by an engineer who is registered as a civil engineer in the State.

16. Edit if a different number of days is required for the review, except delete the paragraph if the number of days is 15.

Allow 20 days for review.

49-5.01C(5) Mill Test Reports

17. If project special provisions include an exception to the Buy America specifications, consult with Structure Specifications Research and Development.

Submit certified mill test reports for each heat number of each type of steel reinforcing element at least 7 days before using the materials in the work. The certified mill test reports must include ultimate strength, yield strength, elongation, and chemical composition.

49-5.01C(6) Installation Logs

18. For Category L micropiles, delete *and pressures* in item 11. Delete item 13 if no splices or joints are allowed in any reinforcing elements.

Submit each installation log as an informational submittal within 1 business day of the micropile installation. The installation log must include:

1. Micropile identification number and location
2. Names of superintendent, drill rig operator, grout plant operator, and any other personnel involved in the micropile installation
3. Date, time, and duration of drilling, steel reinforcing element installation, and grout placement
4. Drilling or coring method and speed
5. Details of any hole stabilization method used
6. Description of soil or rock encountered
7. Quantity of groundwater encountered
8. Description of any unusual installation behaviors or conditions
9. Drilled hole diameter
10. Micropile tip elevation
11. Log of grout quantities and pressures, including the time and micropile depth
12. Lengths of steel reinforcing elements
13. Details of splicing operations, including locations of the splices or joints

49-5.01C(7) Grout Test Results

19

Submit grout test results for density, efflux time, and compressive strength within 1 business day of testing.

49-5.01C(8) Load Test Data

20–22. For Category L micropiles, delete pars. 20–22 and add *Not Used*.

20

Submit load test data within 1 business day of the completion of a verification or proof load test. Load test data must include:

1. Micropile identification number and location
2. Installation date
3. Load test date
4. Testing personnel
5. Load testing equipment
6. Raw data from the electronic data acquisition system
7. Readings from the secondary load and displacement measurement systems recorded at each load increment

8. Specified curves plotted using data from the electronic data acquisition system
9. Comparison of the load test results and the acceptance criteria

21

Load test data must be sealed and signed by an engineer who is registered as a civil engineer in the State.

22. Edit if a different number of days is required for the review, except delete the paragraph if the number of days is 15.

Allow 10 days for review.

49-5.01D Quality Assurance

49-5.01D(1) General

23

Not Used

49-5.01D(2) Experience Qualifications

24. For Category L micropiles, delete *and load testing* from item 1.

The micropile subcontractor must:

1. Be experienced in micropile construction and load testing
2. Have successfully constructed at least 5 projects in the last 5 years involving a combined total of at least 100 micropiles
3. Have previous micropile drilling and grouting experience in soil or rock similar to the soil or rock for this Contract

25

Each on-site foreman and drill rig operator must have experience installing micropiles on at least 3 projects completed in the last 5 years.

49-5.01D(3) Preconstruction Meeting

26

Schedule and hold a micropile preconstruction meeting at least 5 business days after submitting the micropile shop drawings, calculations, and installation plan and at least 10 days before starting micropile construction. You must provide a meeting facility.

27

The meeting must include the Engineer, your representatives, representatives from the micropile subcontractor, and representatives from any other subcontractor to be involved in the micropile construction.

28. For Category L micropiles, delete item 7.

The Engineer conducts the meeting. Be prepared to discuss:

1. Contractual relationships and delineation of responsibilities among you and the subcontractors
2. Contacts and communication protocol between you and your representatives, the subcontractors, and the Engineer
3. Coordination of the construction schedule and activities
4. Anticipated subsurface conditions
5. Structural, geotechnical, and construction requirements
6. Materials testing
7. Load testing

49-5.01D(4) Quality Control

49-5.01D(4)(a) General

29

Not Used

49-5.01D(4)(b) Grout Testing

30

Before placing grout into each micropile:

1. Test the grout density under API RP 13B-1 using the Baroid mud balance. Take the grout test samples directly from the grout plant.
2. Test the grout efflux time under California Test 541. Take the grout test samples at the point of placement.

31

Test the grout compressive strength under ASTM C109/C109M at an authorized laboratory. Test at least 1 set of three 2-inch grout cubes from each grout plant each day of operation or for every 10 micropiles installed, whichever occurs more frequently. Take the grout test samples directly from the grout plant.

32–59. For Category L micropiles, delete pars. 32–59, including the headings.

49-5.01D(4)(c) Load Testing

49-5.01D(4)(c)(i) General

32

Section 49-1.01D does not apply to micropile load testing.

33. Edit if a lower grout strength is allowed for load testing.

The grout for each load test micropile must attain the compressive strength shown before you perform the load test.

34

Notify the Engineer at least 10 days before you perform each load test.

35

Perform each load test in the Engineer's presence.

36. Use if tension load testing is recommended in the foundation report. If only verification load testing or only proof load testing is performed in tension, edit accordingly.

Perform verification and proof load testing in tension under ASTM D3689, except do not use the loading apparatus described as "Tensile Load Applied by Hydraulic Jack(s) Acting Upward at One End of Test Beam(s)."

37. Use if compression load testing is recommended in the foundation report. If only verification load testing or only proof load testing is performed in compression, edit accordingly.

Perform verification and proof load testing in compression under ASTM D1143/D1143M.

38. Use if both compression and tension verification load testing or both compression and tension proof load testing are recommended in the foundation report. Edit to suit the project. For proof load testing, edit as appropriate or add an additional requirement.

Perform tension and compression verification load tests on the same verification test micropile. Perform the tension load test first.

39. Use if tension load testing is recommended in the foundation report. In item 1, insert the value of FTL in tension from the plans. In item 2, insert the value of the service load in tension provided by the designer. Service load is not the same as design load. Service load is the unfactored demand in LRFD design. If the values of FTL and SL vary for different supports or wall zones, create a table.

For tension load testing:

1. FTL in the load test schedule must be equal to _____ kips
2. SL in the load test schedule must be equal to _____ kips

40. Use if tension load testing is performed on micropiles containing both a center bar and a pipe, HSS, or casing element. If the designer requires that the test load be applied to both the center bar and the pipe, HSS, or casing, change *the center bar only* to *both the center bar and the pipe/HSS/casing*. Choose either *pipe*, *HSS*, or *casing* according to the type of element specified in section 49-5.02B(2).

Apply the test loads for tension load testing to the center bar only.

41. Use if compression load testing is recommended in the foundation report. In item 1, insert the value of FTL in compression from the plans. In item 2, insert the value of the service load in compression provided by the designer. Service load is not the same as design load. Service load is the unfactored demand in LRFD design. If the values of FTL and SL vary for different supports or wall zones, create a table.

For compression load testing:

1. FTL in the load test schedule must be equal to _____ kips
2. SL in the load test schedule must be equal to _____ kips

42. Use if micropiles are near an existing structure.

Do not use an existing structure as part of the reaction system unless authorized.

43

Use a load cell as the primary load measurement system. The load cell must:

1. Be of the bonded electrical resistance strain gauge type.
2. Have a full scale range no greater than 150 percent of the maximum test load.
3. Be moisture resistant.
4. Be temperature compensated. The maximum temperature sensitivity at zero load must be ±0.05 percent of full scale per degree F.
5. Have a resolution within ±0.025 percent of full scale.
6. Have an accuracy within ±0.25 percent of full scale.

44

Use electronic displacement transducers as the primary movement measurement system. Displacement transducers must be capable of measuring to 0.001 inch and have enough travel to allow the load test to be performed without resetting.

45

Apply the test loads using a hydraulic jack. Use the gauge in the jack and pressure gauge assembly as the secondary load measurement system. Jack ram travel must be sufficient to allow the load test to be performed without resetting the equipment. The pressure gauge must be graduated in 100 psi increments or less.

46

The load cell, the electronic displacement transducers, and the jack and gauge assembly must be calibrated by an authorized laboratory accredited for calibration services using equipment traceable to NIST. The jack and gauge assembly must be calibrated as a unit.

47

Use an electronic data acquisition system to simultaneously monitor and record readings from the primary load and displacement measurement systems. The electronic data acquisition system must continuously take readings at regular intervals from the load cell and electronic displacement transducers.

48

The Department may verify the test loads using Department-furnished load cells. Upon request, furnish the resources necessary to install and support the Department's testing equipment at the load testing location and to remove the equipment after the testing is complete.

49-5.01D(4)(c)(ii) Verification Load Testing

49

Perform verification load testing on each verification test micropile installed.

50. Use for bridges. In column 1, insert the bridge number. In column 2, insert the location of each verification test micropile. In column 3, insert the abutment or bent names for the production micropiles represented by the verification test micropile. Add or delete rows as necessary.

The verification test micropile at each listed location represents the production micropiles at the support locations shown in the following table:

Bridge no.	Verification test micropile location	Support locations

51. Use for walls and slope stabilization structures. In column 1, insert the bridge number. In column 2, insert the location of each verification test micropile. In column 3, insert the beginning and end stations of the wall zone for the production micropiles represented by the verification test micropile. Add or delete rows as necessary.

The verification test micropile at each listed location represents the production micropiles in the wall zone shown in the following table:

Bridge no.	Verification test micropile location	Wall zone limits	
		Beginning station	End station

52. Use if creep testing is not recommended during verification load testing. If recommended by the geotechnical designer, the increments between 1.00SL and 1.00FTL can be made smaller by adding load increment rows.

Perform verification load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Verification Load Test Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.25SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	5
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	1–2
0.80SL + 0.20FTL	1–2
0.60SL + 0.40FTL	1–2
0.40SL + 0.60FTL	1–2
0.20SL + 0.80FTL	1–2
1.00FTL[a]	5
0.75FTL	1–2
0.50FTL	1–2
0.25FTL	1–2
AL	Until stable

NOTES:
AL = alignment load, 0.10SL
SL = service load
FTL = factored test load
[a]Maximum test load

2. At each load increment:
   2.1. Apply the load in less than 1 minute.
   2.2. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.
   2.3. Measure and record the top of micropile movement at the end of the hold time.
3. Plot the applied test load versus the top of micropile movement at each load increment.

53. Use if creep testing is recommended during verification load testing. If recommended by the geotechnical designer, the increments between 1.00SL and 1.00FTL can be made smaller by adding load increment rows.

Perform verification load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Verification Load Test Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.25SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	10 or 60
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	1–2
0.80SL + 0.20FTL	1–2
0.60SL + 0.40FTL	1–2
0.40SL + 0.60FTL	1–2
0.20SL + 0.80FTL	1–2
1.00FTL[a]	5
0.75FTL	1–2
0.50FTL	1–2
0.25FTL	1–2
AL	Until stable

NOTES:
AL = alignment load, 0.10SL
SL = service load
FTL =factored test load
[a]Maximum test load

2. At each load increment:
   2.1. Apply the load in less than 1 minute.
   2.2. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.
   2.3. Measure and record the top of micropile movement at the end of the hold time.
3. At the 1st application of 1.00SL, perform the creep test as follows:
   3.1. Hold the load for 10 minutes.
   3.2. Measure and record the top of micropile movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
   3.3. If the movement measured from 1 to 10 minutes is greater than 0.04 inch, continue the creep test as follows:
      3.3.1. Hold the load for an additional 50 minutes.
      3.3.2. Measure and record the top of micropile movement at 15, 20, 25, 30, 45, and 60 minutes.
      3.3.3. Plot the top of micropile movement as a function of the logarithm of time from 6 to 60 minutes.
4. Plot the applied test load versus the top of micropile movement at each load increment.

49-5.01D(4)(c)(iii) Proof Load Testing

54–55. Use for micropiles at bridge supports. If there is more than 1 micropile footing and the number of proof test micropiles varies among footings, edit to be location specific.

54. Insert the minimum number of proof load tests recommended in the foundation report. Typically, 10 percent of the micropiles or a minimum of 2 micropiles are tested per footing.

Perform proof load tests on _____ micropiles per footing. The Engineer selects each micropile to be proof load tested. The Engineer does not notify you of which micropile is to be proof load tested until after the micropile has been installed.

55. Insert a value for percent of micropiles. A minimum of 25 percent is recommended.

The 1st micropile proof load test at a footing must be performed after at least ____ percent of the micropiles at the footing have been installed.

56–57. Use for micropiles at walls and slope stabilization structures. If there is more than 1 micropile wall or slope stabilization structure and the number of proof test micropiles per wall zone varies among walls and slope stabilization structures, edit to be location specific.

56. Insert the minimum number of proof load tests recommended in the foundation report. Typically, 15 percent of the micropiles or a minimum of 2 micropiles are tested per wall zone.

Perform proof load tests on _____ micropiles per wall zone. The Engineer selects each micropile to be proof load tested. The Engineer does not notify you of which micropile is to be proof load tested until after the micropile has been installed.

57. Insert a value for percent of micropiles. A minimum of 25 percent is recommended.

The 1st micropile proof load test in a wall zone must be performed after at least ____ percent of the micropiles in the wall zone have been installed.

58. Use if creep testing is not recommended during proof load testing. If recommended by the geotechnical designer, the increments between 1.00SL and 0.80FTL can be made smaller by adding load increment rows.

Perform proof load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Proof Load Test Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	5
0.80SL + 0.20(0.80FTL)	1–2
0.60SL + 0.40(0.80FTL)	1–2
0.40SL + 0.60(0.80FTL)	1–2
0.20SL + 0.80(0.80FTL)	1–2
0.80FTL[a]	5
AL	Until stable

NOTES:
AL = alignment load, 0.10SL
SL = service load
FTL = factored test load
[a]Maximum test load

2. At each load increment:
   2.1. Apply the load in less than 1 minute.
   2.2. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.
   2.3. Measure and record the top of micropile movement at the end of the hold time.
3. Plot the applied test load versus the top of micropile movement at each load increment.

59. Use if creep testing is recommended during proof load testing. If recommended by the geotechnical designer, the increments between 1.00SL and 0.80FTL can be made smaller by adding load increment rows.

Perform proof load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Proof Load Test Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.25SL	1–2
0.50SL	1–2
0.75SL	1–2
1.00SL	10 or 60
0.80SL + 0.20(0.80FTL)	1–2
0.60SL + 0.40(0.80FTL)	1–2
0.40SL + 0.60(0.80FTL)	1–2
0.20SL + 0.80(0.80FTL)	1–2
0.80FTL[a]	5
AL	Until stable

NOTES:
AL = alignment load, 0.10SL
SL = service load
FTL = factored test load
[a]Maximum test load

2. At each load increment:

2.1. Apply the load in less than 1 minute.
2.2. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.
2.3. Measure and record the top of micropile movement at the end of the hold time.

3. At the 1st application of 1.00SL, perform the creep test as follows:
   3.1. Hold the load for 10 minutes.
   3.2. Measure and record the top of micropile movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
   3.3. If the movement measured from 1 to 10 minutes is greater than 0.04 inch, continue the creep test as follows:
      3.3.1. Hold the load for an additional 50 minutes.
      3.3.2. Measure and record the top of micropile movement at 15, 20, 25, 30, 45, and 60 minutes.
      3.3.3. Plot the top of micropile movement as a function of the logarithm of time from 6 to 60 minutes.
4. Plot the applied test load versus the top of micropile movement at each load increment.

60–66. For Category L micropiles, delete pars. 60–66. Keep the heading *49-5.01D(5) Department Acceptance*, delete the other headings, and add *Not Used*.

49-5.01D(5) Department Acceptance

49-5.01D(5)(a) General

60

Not Used

49-5.01D(5)(b) Verification Load Test

61. Insert in items 1 and 2 the maximum axial movement allowed. If tension verification load testing is not being done, delete item 1, delete *For compression testing, the* in item 2, and capitalize *Axial* in item 2. If compression verification load testing is not being done, delete item 2, delete *For tension testing, the* in item 1, and capitalize *Axial* in item 1. Delete item 4 if verification creep testing is not being done.

Each verification load test must comply with the following acceptance criteria:

1. For tension testing, the axial movement at the top of the micropile measured from the initial alignment load to the 1st application of 1.00SL must not exceed _____ inch at the end of the 1.00SL hold time.
2. For compression testing, the axial movement at the top of the micropile measured from the initial alignment load to the 1st application of 1.00SL must not exceed _____ inch at the end of the 1.00SL hold time.
3. Slope of the applied test load versus the top of micropile movement must not exceed 0.025 inch per kip at the maximum test load.
4. Creep test movement must comply with one of the following:
   4.1. For a 10-minute load hold, the movement measured from 1 to 10 minutes must be less than 0.04 inch.
   4.2. For a 60-minute load hold, the movement measured from 6 to 60 minutes must be less than 0.08 inch and the rate of movement must be linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

62

If a verification load test fails to comply with the acceptance criteria, the verification test micropile is rejected. Revise the micropile length, installation methods, or both, and submit revised shop drawings, calculations, and installation plan.

63

After the revised submittals are authorized, install and test a new verification test micropile that incorporates the changes at an authorized location near the rejected verification test micropile. If post-

grouting the micropile is the only change, you may post-grout and retest the rejected verification test micropile instead of installing a new verification test micropile.

64

If the new or retested verification test micropile fails to comply with the acceptance criteria, repeat the process specified above until a verification test micropile complies with the acceptance criteria.

49-5.01D(5)(c) Proof Load Test

65. Insert in items 1 and 2 the maximum axial movement allowed. If tension proof load testing is not being done, delete item 1, delete *For compression testing, the* in item 2, and capitalize *Axial* in item 2. If compression proof load testing is not being done, delete item 2, delete *For tension testing, the* in item 1, and capitalize *Axial* in item 1. Delete item 4 if proof creep testing is not being done.

Each proof load test must comply with the following acceptance criteria:

1. For tension testing, the axial movement at the top of the micropile measured from the initial alignment load to the 1st application of 1.00SL must not exceed _____ inch at the end of the 1.00SL hold time.
2. For compression testing, the axial movement at the top of the micropile measured from the initial alignment load to the 1st application of 1.00SL must not exceed _____ inch at the end of the 1.00SL hold time.
3. Slope of the applied test load versus the top of micropile movement must not exceed 0.025 inch per kip at the maximum test load.
4. Creep test movement must comply with one of the following:
   4.1. For a 10-minute load hold, the movement measured from 1 to 10 minutes must be less than 0.04 inch.
   4.2. For a 60-minute load hold, the movement measured from 6 to 60 minutes must be less than 0.08 inch and the rate of movement must be linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

66. For walls and slope stabilization structures, replace *footing* with *wall zone* at 2 locations in item 1 and at 1 location in item 2.

If a proof load test fails to comply with the acceptance criteria, the micropile is rejected. Suspend micropile construction and comply with one of the following procedures:

1. Post-grout and retest the rejected micropile. If the post-grouted micropile complies with the acceptance criteria when retested, post-grout all of the micropiles in the footing using identical methods. Any proof load test performed on a micropile before the post-grouting does not count toward the total proof load tests required for the footing.
2. Proof load test all the micropiles in the footing that have been constructed unless otherwise authorized. Submit a plan for replacing rejected micropiles or for installing additional micropiles, including details for any micropile or footing changes required to provide the total micropiling support capacity shown. Suspend micropile construction until the plan is authorized.

49-5.02 MATERIALS

49-5.02A General

67. Delete for Category L micropiles.

Use identical materials and element sizes for a verification test micropile as to be used for the production micropiles it represents.

68

Welding must comply with AWS D1.1.

49-5.02B Steel Reinforcing Elements

49-5.02B(1) General

69. If project special provisions include an exception to the Buy America specifications, consult with Structure Specifications Research and Development.

Mill secondary steel reinforcing elements must not be used.

70. Use if steel reinforcing elements are not allowed to contain any splices or joints. Edit if some types of reinforcing elements are allowed to contain splices or joints and other types are not, and move the requirement to section 49-5.02B(2) or 49-5.02B(3) if appropriate.

Steel reinforcing elements must not contain splices or joints.

49-5.02B(2) Pipe, Hollow Structural Sections, and Casing

71–74. Edit the above heading to show only the type of element that is specified below. Use 1 paragraph and delete the other 3 paragraphs. If the designer chooses to use a steel designation other than the 4 options below, edit accordingly. Delete pars. 71–80 and add *Not Used* if no pipe, HSS, or casing is shown on the plans.

71. Use if the plans show pipe with fy=35 ksi.

Pipe must comply with ASTM A53/A53M, Type E or S, Grade B.

72. Use if the plans show HSS with fy=42 ksi.

HSS must comply with ASTM A500/A500M, Grade B.

73. Use if the plans show HSS with fy=46 ksi.

HSS must comply with ASTM A500/A500M, Grade C.

74. Use if the plans show casing with fy=80 ksi.

Casing must comply with API N80.

75–76. Use if API N80 casing is shown on the plans.

75. Insert the value of the maximum hole diameter provided by the designer. This value must not exceed 13 inches or 1/3 of the micropile center-to-center spacing. Delete item 4 if no grout is shown between the casing and the soil. Delete item 5 if corrosion protection is not recommended in the foundation report or if the corrosion protection does not include a sacrificial thickness.

You may use alternative pipe, round HSS, or casing instead of the API N80 casing shown if:

1. Structural capacity of the alternative pipe, HSS, or casing is greater than or equal to the structural capacity of the API N80 casing shown
2. Alternative pipe, HSS, or casing complies with the requirements for casing specified in section 49-5
3. Drilled hole diameter does not exceed _____ inches
4. Grout cover on the alternative pipe, HSS, or casing is greater than or equal to the grout cover on the API N80 casing shown
5. Thickness of the alternative pipe, HSS, or casing is greater than or equal to the thickness of the API N80 casing shown

76

Alternative pipe, HSS, or casing must comply with one of the following specifications or another authorized specification:

1. ASTM A1085/A1085M
2. API N80
3. API P110
4. API 5L, minimum PSL1

77. Insert either *Pipe*, *HSS*, or *Casing* in the blank, according to the type of element specified in pars 71–74.

_____ to be welded for structural purposes must have a carbon equivalency as defined in AWS D1.1, Annex H5.1, not exceeding 0.47 percent and a sulfur content not exceeding 0.05 percent.

78. Delete *and splices* if no welded splices are allowed in the pipe, HSS, or casing.

Welded seams and splices must be CJP welds.

79. Delete if no welded splices are allowed in the pipe, HSS, or casing.

Circumferential welds must comply with section 49-2.02B(1)(b).

80. Use if the following 3 conditions apply: (1) pipe, HSS, or casing is shown, (2) the pipe, HSS, or casing is designed to provide tension resistance, and (3) the tension resisted by the pipe, HSS, or casing exceeds 25 percent of the yield capacity of the pipe, HSS, or casing. Insert either *pipe*, *HSS*, or *casing* according to the type of element specified above. Insert the value of tension provided by the designer. Delete if no threaded joints are allowed in the pipe, HSS, or casing.

Threaded joints for the _____ must be capable of developing at least ____ kips in tension.

49-5.02B(3) Bar Reinforcing Steel

81–82. Delete if bar reinforcing steel is not shown on the plans, and delete the section heading.

81. Delete if no splices are allowed in the bar reinforcing steel.

Bar reinforcing steel splices must be service splices.

82

For anchorages that require threading nuts and plates onto bar reinforcing, you may cut threads into the bar reinforcing steel if you provide the next larger bar number designation from that shown.

49-5.02C Anchorage Components

83. Use if the plans show stud connectors or concrete anchors. If the plans show concrete anchors, change *Stud connectors* to *Concrete anchors*.

Stud connectors for the micropile anchorage must comply with the specifications for studs in clause 9 of AWS D1.1.

84. Use if the plans show fy=50 ksi for the anchorage plates.

Steel plates for the micropile anchorage must comply with ASTM A709/A709M, Grade 50, or ASTM A572/A572M, Grade 50.

85. Use if the plans show fy=36 ksi for the anchorage plates.

Steel plates for the micropile anchorage must comply with ASTM A709/A709M, Grade 36, or ASTM A36/A36M.

86. Use if the anchorage detail on the plans shows nuts.

Nuts and washers for the micropile anchorage must be capable of holding the bar at a load producing a tensile stress of at least the specified minimum ultimate tensile strength of the bar.

49-5.02D Grout

87

Grout must be a stable, neat grout consisting of cement and water. Cement must comply with section 90-1.02B(2). Water must comply with section 90-1.02D.

88

If authorized, you may use an admixture in the grout. The admixture must comply with sections 90-1.01C(4) and 90-1.02E, except the admixture must not contain chloride ions in excess of 0.25 percent by weight nor be an accelerating admixture.

89

If authorized, you may add fine aggregate to the grout. Fine aggregate must comply with section 90-1.02C(3). Grout with fine aggregate must:

1. Have a slump of at least 7 inches when measured under ASTM C143/C143M
2. Have an air content of no more than 2 percent when measured under California Test 504
3. Not contain air-entraining admixtures

90

Mix the grout as follows:

1. Add the water to the mixer followed by the cement and any admixtures or fine aggregate.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.
3. Agitate the grout continuously until the grout is pumped.
4. Do not add water after the initial mixing.

91

Grout must comply with the following requirements:

1. Density must be greater than or equal to the density submitted with the authorized mix design.
2. Efflux time must be at least 11 seconds.
3. Compressive strength must be at least that shown at 28 days.

49-5.02E Centralizers and Spacers

92

Centralizers and spacers must be fabricated from plastic, steel, or other material that is not detrimental to the steel reinforcing elements. Do not use wood centralizers or spacers.

93

Centralizers and spacers must be strong enough to support the steel reinforcing elements during construction activities.

49-5.02F Corrosion Protection

94–97. If corrosion protection is not recommended in the foundation report, delete pars. 94–97 and add *Not Used*. Edit accordingly if the corrosion protection is required only at certain locations.

94. Use if encapsulation is recommended for bar reinforcing steel or HS threaded bars. Insert either *Bar reinforcing steel* or *HS threaded bars* in the first blank and insert either *pipe*, *HSS*, or *casing* in the second blank, according to what is shown on the plans.

_____ must be encapsulated. The encapsulation must:

1. Be shop fabricated using HDPE corrugated tubing that complies with ASTM D3350, Type III, with UV stabilizer
2. Have a minimum nominal wall thickness of 60 mils
3. Provide at least a 0.20-inch inside annulus between the bar and the tubing that is fully grouted before installation
4. Be watertight
5. Be capable of:
   5.1. Transferring stresses from the grout surrounding the bar to the grout bonding to the ground

5.2. Withstanding abrasion, impact, and bending during handling and installation
5.3. Resisting internal grouting pressures
5.4. Resisting chemical attack from aggressive environments and grout

6. Be cleaned of oil, grease, dirt, and other extraneous substances and have any damage repaired or replaced before installation
7. Extend at least 5 feet into the _____

95. Use if epoxy coating is recommended for bar reinforcing steel or HS threaded bars. Insert either *Bar reinforcing steel* or *HS threaded bars* in the first blank and insert either *pipe*, *HSS*, or *casing* in the second blank, according to what is shown on the plans.

_____ must be epoxy coated. The epoxy coating must:

1. Comply with section 52-2.03, except the bend test requirements are waived and the epoxy thickness must be from 10 to 12 mils
2. Extend at least 5 feet into the _____

96. Use if galvanization is recommended for bar reinforcing steel.

Bar reinforcing steel must be galvanized under section 52-3.

97. Delete for Category L micropiles. Insert the type of corrosion protection required above for production micropiles: Encapsulation, Epoxy coating, or Galvanizing.

_____ is not required for steel reinforcing elements used in verification test micropiles.

49-5.03 CONSTRUCTION

49-5.03A General

98–100. Delete for Category L micropiles.

98. Tip elevations for tension and compression must not be shown on the plans. Delete the 2nd sentence unless required by the designer, and use it only for a load case other than tension or compression. Insert the load case (e.g., lateral load, group effect, etc.).

Determine the micropile length and installation methods necessary to comply with the micropile load test acceptance criteria. Your proposed micropile tip elevation must not be higher than that shown in the Pile Data Table for _____.

99

You may perform additional geotechnical investigation for the purpose of determining the micropile length and installation methods.

100

Do not construct any production micropiles until the test results are authorized for the verification test micropile that represents the production micropiles.

101. The values for 5 feet and 12 hours may be edited if other values are recommended in the foundation report. For Category L micropiles, delete *, pressure grout, or post-grout*.

Do not drill, pressure grout, or post-grout a micropile that is within a center-to-center spacing of 5 feet from an open micropile hole or a micropile in which the initial grout has set for less than 12 hours.

49-5.03B Verification Test Micropiles

102–107. For Category L micropiles, delete pars. 102–107 and add *Not Used* under each heading.

102

Install a verification test micropile at each location shown. Notify the Engineer at least 7 days before installing a verification test micropile.

103. Edit accordingly if the test site is not supposed to be level.

Excavate the verification load test site as necessary to provide a level work area. Keep the test site free of water throughout the testing.

104

Construct each verification test micropile in the Engineer's presence. Use identical drilling and grouting methods, inclination, tip elevation, and dimensions as to be used for the production micropiles it represents.

105. Use if (1) the foundation report recommends taking measures to provide geotechnical equivalence between the verification test micropile and the production micropiles it represents and (2) if these measures are not shown on the plans. Insert the location of the verification test micropile, or delete *at* _____ if there is only 1 verification test micropile on the project. Edit if this paragraph applies to more than 1 verification test micropile. Insert the elevation to which isolation is required, or edit the paragraph if measures other than isolation are recommended.

Isolate the verification test micropile at _____ down to an elevation of _____ such that the soil above this elevation is not engaged.

106

After the verification load test results are authorized, remove the verification test micropile and any anchor piles as specified for removing portions of bridges in section 60-2.02.

49-5.03C Proof Test Micropiles

107. Edit accordingly if the test site is not supposed to be level.

Throughout proof load testing, maintain the test site in a condition that is level and free of water.

49-5.03D Drilling

108

Select drilling equipment and methods that are suitable for drilling through the conditions to be encountered without causing damage to any overlying or adjacent structure or service and without causing detrimental ground movements.

109

Use temporary casing or another authorized drilled hole support method in caving or unstable ground.

110. Use if micropiles are constructed near settlement-sensitive structures.

Do not use vibratory pile-driving hammers to advance casing.

111. Use if coring through concrete (e.g., adding micropiles to an existing footing).

Core through concrete structures using methods that do not shatter or damage the concrete adjacent to the hole.

112

Each drilled hole must comply with the following tolerances:

1. Centerline of the drilled hole must not deviate from the micropile location shown by more than 3 inches.
2. Center-to-center spacing of the drilled holes must not deviate from the micropile spacing shown by more than 3 inches.
3. Axis of the drilled hole must not deviate from the alignment shown by more than 1-1/2 inches per 10 feet of length.

113

Remove any material dislodged or drawn into the hole during micropile construction. The drilled hole must be open along its full length to the hole diameter shown before placing grout or any steel reinforcing elements not used to case the drilled hole.

114

Dispose of drill cuttings under section 19-2.03B.

49-5.03E Placing and Splicing Steel Reinforcing Elements

115

Place the steel reinforcing elements before withdrawing any temporary casing.

116. Delete if no splices or joints are allowed in any reinforcing elements, and also delete *and Splicing* in the heading above.

Splice the steel reinforcing elements such that the axes of the 2 spliced lengths are aligned.

117. Use if both a center bar and a pipe, HSS, or casing are shown on the plans. Delete if bar splices are not allowed or if pipe, HSS, or casing threaded joints are not allowed. Insert either *pipe*, *HSS*, or *casing* according to the type of element specified in section 49-5.02B(2).

If the _____ has threaded joints, locate any bar splices at least 2 _____ diameters from any threaded joint.

118. Use if both a center bar and a pipe, HSS, or casing are shown on the plans.

Use spacers to separate steel reinforcing elements. Place the spacers at 10-foot maximum intervals.

119. Confirm that the plans show centralizers that comply with these requirements. Edit *10-foot* if the designer requests a smaller maximum interval.

For steel reinforcing elements not used to case the drilled hole, use centralizers to support the element in the center of the hole and to provide at least the specified grout cover. Place the centralizers at 10-foot maximum intervals, with the uppermost centralizer a maximum of 5 feet from the top of the micropile and the lowermost centralizer from 2 to 5 feet from the bottom of the micropile.

120. Delete both occurrences of *and spacers* if par. 118 is deleted.

Attach centralizers and spacers to the steel reinforcing elements such that the centralizers and spacers (1) are secure enough to withstand installation stresses and (2) allow the free flow of grout without misalignment of the steel reinforcing elements.

121

Before you insert each steel reinforcing element into a drilled hole, clean the surface of the element of deleterious substances, such as soil, mud, grease, and oil.

122

If you cannot insert a steel reinforcing element into the drilled hole to the required depth without difficulty, remove the reinforcing element, clean any grout from the surface of the reinforcing element, clean or redrill the hole, and reinsert the reinforcing element. Do not force or drive a reinforcing element into a drilled hole. Micropiles with partially inserted steel reinforcing elements are rejected.

49-5.03F Grouting

123

Grout each micropile the same day the hole is drilled.

124

You may place the grout before or after placing the steel reinforcing elements.

125

Place the grout within 1 hour of mixing.

126

Inject the grout at the lowest point of the drilled hole. Continue the injection until uncontaminated grout flows from the top of the micropile.

127

Grout each micropile in 1 continuous operation. Use grouting procedures that ensure complete continuity of the grout column.

128

If temporary casing is used, extract the casing in stages. After you remove each length of casing, bring the grout level back up to ground level before removing the next length of casing. Maintain the grout at a level above the bottom of the temporary casing adequate to prevent displacement of the grout by material from outside the casing. The tremie pipe or casing must extend at least 10 feet below the grout level in the drilled hole at all times during grout placement.

129. Delete for Category L micropiles.

If grout is placed under pressure:

1. Measure and record the grout quantity and pumping pressure
2. Use a grout pump equipped with a pressure gauge
3. Place a 2nd pressure gauge at the point of injection into the top of the micropile
4. Use pressure gauges capable of measuring pressures of at least 150 psi or twice the actual grout pressure used, whichever is greater
5. Do not use compressed air to directly pressurize the fluid grout

130

Grout tubes may remain in the hole after the completion of grouting but must be filled with grout before pile acceptance.

131

Maintain the grout level at or above the micropile cutoff elevation until the grout has set.

132

Provide a positive means of support for maintaining the position of the steel reinforcing elements until the grout has set.

133. Delete for Category L micropiles.

Load test micropiles must remain undisturbed until the grout is strong enough to provide anchorage during load testing.

134

Dispose of material resulting from grouting.

49-5.03G Ground Heave and Subsidence

135. Delete for Category L micropiles.

Control the grout pressures and grout takes to prevent heave and fracturing of soil or rock formations.

136

If you observe signs of ground heave or subsidence, immediately notify the Engineer and suspend the drilling and grouting operations. If the Engineer determines that the movements require corrective action, take the actions necessary to stop the movement and perform repairs.

49-5.03H Installation Logs

137

Prepare a separate installation log for each micropile.

49-5.04 PAYMENT

138

Section 49-1.04 does not apply.

139. Delete for Category L micropiles.

Verification test micropiles are paid for as micropiles.

Section 58-2.03A. Use for sound walls on piles or trench footings that reference Standard Plan B15-1, B15-5, B15-8, or B15-15.

Insert the sound wall location and the angle of internal friction. Check with Geotechnical Services/Office of Bridge Design for the value of ϕ. Add a table of locations if necessary.

Add to section 58-2.03A:

The angle of internal friction (ϕ) to be used with the plans for the soil at sound wall _____ is _____.

Section 61-2.01D(3). Use for field leakage testing of culvert and drainage pipes (1) where settlement is expected to be in excess of 3 inches, (2) for areas having fine cohesionless soils, or (3) whenever infiltration or exfiltration water quality issues exist (e.g., water permits, local agency regulations, etc.).

1. Use if settlement of a pipeline is expected to be in excess of 3 inches. Modify the number of days as necessary to ensure adequate settlement of embankment.

Replace the 10th paragraph of section 61-2.01D(3)(a) with:

Perform final leakage testing of culverts and drainage pipes from 30 to 45 days after backfilling around the pipe unless a different time period is authorized.

2. Use for fine cohesionless soils.

Replace 1000 in the 1st sentence of item 2 of the 1st paragraph of section 61-2.01D(3)(b) with:

600.

3. Use if infiltration or exfiltration water quality issues exist, (e.g., water permits, local agency regulations, etc.)

Replace 1000 in the 1st sentence of item 2 of the 1st paragraph of section 61-2.01D(3)(b) with:

200.

Section 65-2. Miscellaneous RCP requirements for freeze-thaw and corrosive environments, difficult excavation, and timber bulkheads.

1–2. Use when reinforced concrete pipe is allowed on projects constructed at elevations above 3,000 feet. Otherwise delete pars. 1 and 2.

1

Add to section 65-2.01C:

Submit a certificate of compliance for wet-cast pipe and test reports for measured air entrainment.

2

Add to section 65-2.02A:

Wet-cast pipe must be made from concrete placed and consolidated by conventional equipment using concrete with a slump of 2 inches or more. Wet-cast pipe must contain 5.5 ± 1.5 percent air by volume determined under ASTM C231.

3. Use if the designer indicates that results from AltPipe software require adjustment to concrete mix design and/or minimum cover over the reinforcement due to corrosive conditions. Edit the table by adding cementitious material content values as provided by AltPipe. If corrosive conditions are not indicated, delete par. 3.

Replace the 2nd paragraph of section 65-2.02A with:

For cementitious material content, use one of the options shown in the following table. You may use SCM.

Minimum Cementitious Material Content in Pounds per CY

Minimum Concrete Cover	Minimum cementitious material content based on maximum water to cementitious material ratio	
	0.35	0.40
1.00 inch	----lb/cu yd	----lb/cu yd
1.25 inches	----lb/cu yd	----lb/cu yd
1.50 inches	----lb/cu yd	----lb/cu yd

4–5. Use if (1) it is anticipated that rock or other unyielding material will be encountered in the excavation below the bottom of the bedding shown on Standard Plan A62DA; otherwise delete pars. 4 and 5.

Include supplemental funds in the Engineer's Estimate for excavation work.

Add to section 65-2.03B:

4

If you encounter solid rock or other unyielding material at the planned elevation of the bottom of the bedding shown, remove the material below the bottom of the bedding to a depth of 1/50 of the height of the embankment over the top of the culvert but not less than 6 inches or more than 12 inches. Backfill the resulting trench below the bottom of the bedding with structure backfill material under section 19-3.03E. Do not compact the outer bedding before pipe placement.

5

The excavation and backfill below the planned elevation of the bottom of the bedding shown is change order work.

6. Use if timber bulkheads are shown; otherwise delete. If used, show timber bulkheads on the project plans.

Add to section 65-2.03B:

Construct and place timber bulkheads across the ends of unconnected reinforced concrete. Wood for timber bulkheads must be construction heart grade redwood at least 1 inch thick.

Section 68-2.02F(1). Use to specify Class 2 or Class 3 permeable material for underdrains.

1. Insert the Class 2 or Class 3 as recommended by the Office of Roadway Geotechnical Engineering. Edit as directed by the Office of Roadway Geotechnical Engineering.

Replace the 3rd paragraph of section 68-2.02F(1) with:

Use ____ permeable material for underdrains.

Section 68-3.02. Use to specify pipe size of horizontal drains if not shown, change slotted pipe requirements if different from the standards, and add circular-knit geotextile sock if required.

1. Use if drain pipe size is different from the default size of 1-1/2-inches, and is not shown. Delete if not used.

Replace the 3rd paragraph of section 68-3.02 with:

If not shown, use a __-inch pipe.

2. Use if pipe slot requirements are different from the table. Edit table as

Replace the 4th paragraph of section 68-3.02 with:

Slotted pipe must have slots equally spaced along the pipe circumference and comply with the requirements shown in the following table:

Pipe Slots

Pipe Size, nominal inside diameter (inches)	Number of slot rows	Slot width (inches)	Slot length (inches)	Slot spacing (inches)
--	--	--	--	--

3–4. Use if one of the following conditions applies:

1. Circular-knit geotextile sock is needed for special cases that do not need drilling for horizontal drain installation, such as horizontal drains for mechanically stabilized embankment (MSE) system.

2. Pipe slots are wider than 0.01 inch and there is a need to prevent sedimentation of soil particles into the drainpipe.

Select circular-knit geotextile type based on soil particle size distribution. Delete if not used.

3

Add to the end of section 68-3.02:

Use circular-knit geotextile sock Type __.

4

Circular-knit geotextile sock must comply with ASTM D6707 and the requirements shown in the following table:

Circular-Knit Geotextile

Quality characteristic	Test method	Type A	Type H	Type K
Permittivity (min, sec^{-1})	ASTM D4491	2.4	2.75	1.2
Apparent opening size, average roll value (max, µm (US Sieve))	ASTM D4751	600 (30)	425 (40)	150 (100)
Puncture strength (min, lb)	ASTM D6241	180		

Section 68-3.03. Use if circular-knit geotextile sock is required.

Add between the 6th and 7th paragraphs of section 68-3.03:

1

Handle and store circular-knit geotextile sock under the manufacturer's instructions and ASTM D4873. During shipment and storage, circular-knit geotextile sock must be wrapped in protective covering. Store and protect circular-knit geotextile sock from sunlight, mud, dirt, dust, debris, and detrimental substances.

2

Wrap slotted PVC plastic pipe in circular-knit geotextile sock. Extend geotextile at least 2 feet beyond the slotted pipe length. Secure geotextile to the pipe with ties or tapes spaced at 10 feet or less and at both ends.

3

Before installation, inspect circular-knit geotextile sock. Circular-knit geotextile sock with tears or cuts must be patched as follows:

1. Overlay the damaged area with the same circular-knit geotextile sock. The overlay must extend at least 18 inches on both sides of the damaged area and must cover the entire circumference of the wrapped pipe in the area where the repair is being made.
2. Secure the overlaid geotextile with ties or adhesive tape to prevent the overlay from moving or shifting during installation.

Section 68-5. Use if permeable material blanket is described.

Replace section 68-5 with:

68-5 PERMEABLE MATERIAL BLANKET

68-5.01 GENERAL

1

Section 68-5 includes specifications for installing permeable material blankets.

68-5.02 MATERIALS

2. Insert the class of permeable material.

Permeable material for permeable material blanket must be Class _____ and must comply with section 68-2 except for payment.

3

Filter fabric must comply with section 96-1.02B.

68-5.03 CONSTRUCTION

4

Place filter fabric as follows:

1. Ensure the subgrade complies with the compaction and elevation tolerance specified for the material involved before placing the filter fabric on the subgrade.
2. Handle and place filter fabric under the manufacturer's instructions.
3. Align and place the fabric without wrinkles.
4. Overlap or stitch adjacent borders of the fabric from 12 to 18 inches. The preceding roll must overlap the following roll in the direction the permeable material is being spread or must be stitched. If the fabric is joined by stitching, the fabric must be stitched with yarn of a contrasting color. The size and composition of the yarn must be as recommended by the fabric's manufacturer. There must be 5 to 7 stitches per inch of seam.
5. Cover the fabric with the planned thickness of permeable material or aggregate subbase material as shown within 24 hours after the filter fabric has been placed.
6. Maintain at least 6 inches of the material between the fabric and your equipment during spreading and compaction of the permeable material and aggregate subbase. Where embankment material is to be placed on the filter fabric, maintain at least 18 inches of embankment material between the fabric and your equipment. Do not operate or drive equipment or vehicles directly on the filter fabric.

68-5.04 PAYMENT

5

Not Used

Section 69-2. Use for geomembrane and cushion fabric.

Replace section 69-2 with:

69-2 GEOMEMBRANE AND CUSHION FABRIC

69-2.01 GENERAL

69-2.01A Summary

1

Section 69-2 includes specifications for placing geomembrane for overside drains.

69-2.01B Definitions

2

Not Used

69-2.01C Submittals

3. Edit when not using cushion fabric and when not seaming.

Submit before installation:

1. Shop drawings, which must include:
   1.1. Proposed panel layout identifying the seams and details
   1.2. Construction equipment and method
2. Quality control plan for:
   2.1. Material handling
   2.2. Storage
   2.3. Installation
   2.4. Geomembrane and seam tests
   2.5. Repair
3. Test seam samples

69-2.01D Quality Assurance

4. ASTM D4437 provides options for nondestructive testing, which includes ASTM D5641, ASTM D5820, ASTM D6365, and ASTM D7006. If any specific tests are preferred, edit as appropriate.

Perform nondestructive testing of geomembrane seams over the full length of seamed tracks under ASTM D4437.

5

Perform destructive testing of geomembrane seams under GSI GRI Test Method GM14 and GM19 and ASTM D7747 and ASTM D7749.

6

When tested under the ASTM D7747 and ASTM D7749, the seam strength and related properties of geomembrane must have the values of the geomembrane with the same thickness and formulation as shown in GSI GRI Test Method GM19.

7

Mark, number, measure, and report each location that fails nondestructive testing.

69-2.02 MATERIALS

8. Specify the application and the class of geomembrane based on the required degree of survivability. For multiple applications, copy par. 11 and edit.

Use Class A for condition that requires very high survivability as instructed in the Geotechnical Design Report.

Use Class B for condition that requires high survivability as instructed in the Geotechnical Design Report.

Use Class C for condition that requires medium survivability as instructed in the Geotechnical Design Report.

Geomembrane for ____ must be Class __.

9. Insert *smooth* or *textured* as instructed in the Geotechnical Design Report.

Geomembrane must be _____ on both sides.

10. Edit as necessary.

Geomembrane must be:

1. Water and gasoline resistant
2. Free from holes, bubbles, blisters, and contamination by foreign matter
3. Be able to conform to subgrade irregularities by its own weight without heating, bending, or overburden placed on it

11. Edit as instructed in the Geotechnical Design Report.

Cushion fabric must be Class __.

69-2.03 CONSTRUCTION

12

Remove loose or extraneous material, large rocks, and sharp objects from the subgrade that may come in contact with the geomembrane and cushion fabric. Compact subgrade to receive geomembrane under section 19-5.03B.

13. Edit for cushion fabric.

Place geomembrane and cushion fabric as shown.

14. Delete if not using cushion fabric.

Cushion fabric must be placed below and above geomembrane.

15. Edit for cushion fabric.

Geomembrane and cushion fabric must not be installed:

1. In standing water
2. While raining
3. During strong winds
4. When the temperature is below 32 degrees F

16

The geomembrane must rest in intimate contact with the subgrade.

17. When not using cushion fabric, delete *or cushion fabric*.

Do not operate equipment or vehicles directly on geomembrane or cushion fabric.

18. Delete when not using cushion fabric.

Cushion fabric pieces must be shingled. Overlaps must be at least 12 inches. Patch or replace cushion fabric damaged during construction. The patch material must extend at least 18 inches beyond damaged area.

19

Place geomembrane in a manner that minimizes handling and seaming.

20. Use when welding of geomembrane sheets is not required as instructed in the Geotechnical Design Report.

Geomembrane sheets must be shingled with the upstream piece on top of the downstream piece. Overlaps must be at least 18 inches. Geomembrane sheets must be seamed by welding or solvent-bonding at subgrade with slopes 5 percent or less.

21. Use when on-site welding of geomembrane sheets is required as instructed in the Geotechnical Design Report.

Geomembrane sheets must be welded or solvent-bonded. Overlap must be at least 6 inches. The seaming overlap must be smooth and free of wrinkles. Seam must be at least 1 inch wide. Seams must follow the direction of the slope. Butt seams or roll-end seams are not allowed.

22

Patch or replace geomembrane damaged during construction. The patch material must have rounded corners and extend at least 6 inches on all sides of damaged area. Patched and damaged geomembrane must be field seamed by welding or solvent-bonding.

23. Delete when anchor trenches are not shown. Edit for cushion fabric.

Anchor the transverse and longitudinal edges of the geomembrane and cushion fabric in trenches at least 8 inches deep.

24. Delete when there are no culverts, transitional devices, or headwalls shown.

At the joint between geomembrane and culvert, culvert transitional device, or headwall:

1. No cushion fabric is required
2. Overlaps must be:
    2.1. At least 6 inches
    2.2. Closely fitted
    2.3. Secured
    2.4. Sealed watertight

25. Delete when not using rocks over the geomembrane.

Place rocks such that the rock drop will not damage the geomembrane and cushion fabric. Place rocks from downstream and up slope. Minimize spreading of rocks to avoid damaging geomembrane and slippage of cushion fabric.

69-2.04 PAYMENT

26

The payment quantity for geomembrane does not include the additional quantity used for overlaps.

Section 71-3.03. Use for injecting grout from within the culvert to fill voids between culvert outer wall and the surrounding ground. The culvert must be at least 60 inches in diameter and human entry must be possible.

If the only work on the project is culvert contact grouting, include a bid item for mobilization.

Replace section 71-3.03 with:

71-3.03 CONTACT GROUTING

71-3.03A General

1

Section 71-3.03 includes specifications for drilling, probing voids, installing grout ports, pumping grout from within the culvert, and filling voids between the culvert outer wall and the surrounding ground.

2

Submit a grout plan under section 71-3.01A(3)(d) and include the tabulated probe results. Obtain authorization before starting grouting.

71-3.03B Materials

3

Not Used

71-3.03C Construction

4

Before starting contact grouting of the culvert, assemble equipment and materials at the job site.

5

Grouting activities must comply with section 13. Furnish pumps, if necessary, to remove drill cuttings, wastewater, and excess grout.

6. Edit to suit the work. Grout port locations must be shown on the plans, and grout port location information may be included in the geotechnical recommendations. Delete third sentence if not applicable.

Install grout ports at the 2, 4, 8, and 10 o'clock circumferential positions every 6 feet along the culvert as shown. Install valves or removable plugs at grout ports to verify grout coverage and control grout flow. Extend grout ports through the invert paving using steel pipes or suitable packers. Grout ports must be watertight. If authorized, you may screw grout ports in place or attach them by other methods. Do not weld grout ports to galvanized surfaces.

7

Probe at each grout port location. The probe must be at least 4 feet long, fit through the grout ports, and be rigid enough to sense probe refusal.

8. If this work is anticipated, include supplemental funds

If ordered, hammer soundings and additional probing for voids is change order work.

9

Prevent deformation of the culvert and culvert lining during grouting.

10. If grouting around a concrete culvert or a metal culvert with a concrete lining add "or if cracking of concrete occurs" to the 2nd sentence.

Pump grout into voids until it appears that all water and air has been ejected. Plug grout ports or close port valves as soon as you stop pumping the grout.

11

The maximum injection pressure at the nozzle must not exceed 5 psi for fluid, unsanded grout mix.

12

Monitor the culvert for deformation and cracks. If cracking occurs in a concrete culvert or lining, reduce the grout injection pressure. If deformation of the existing structure exceeds 1/2 inch at any location, reduce the grout injection pressure.

13

Repair any permanent deformations or cracks resulting from your grouting work. The Department does not pay for these repairs.

71-3.03D Payment

14

Record the quantity of grout that is installed and submit this quantity. The Department does not pay for grout that leaks through to the inside of the culvert. The Department does not pay for grout material that is wasted, disposed of, or remaining on hand after completion of the work.

Section 72-2.02C. Use for nonstandard fabric for RSP.

1. Edit to suit the work.

Replace the paragraph in section 72-2.02C with:

Fabric must comply with the specifications for _____.

Section 76-1. Use if any section 76 SSP other than SSP 76-6 is included.

Replace section 76-1 with:

76-1 GENERAL

76-1.01 GENERAL

76-1.01A Summary

1

Section 76-1 includes general specifications for constructing and rehabilitating wells and for constructing exploration holes.

76-1.01B Definitions

2

casing string: Sections of blank well casing and well screen, with bottom cap and centralizers, combined as 1 piece.

76-1.01C Submittals

76-1.01C(1) General

3

Submit permits before starting job site well activities.

4. Insert name of specific RWQCB.

Submit as informational submittals:

1. Copies of analytical test results and logs sent to SWRCB. Do not fax them.
2. Laboratory results for the formation samples.
3. Well Completion Report, after completion of work and before Contract acceptance.
4. ANSI/AWWA A 100, *Water Wells*. Submit it before starting job site well activities.
5. Report of Waste Discharge, as defined in the Water Code § 13260, filed with the _____ RWQCB if the onsite discharge of contains chlorinated water. Filing the report is change order work.

76-1.01C(2) Product Data

5

Submit at least 5 copies of product data. Each copy must be bound together and include an index. The index must include equipment names, manufacturers, and model numbers. Two copies will be returned.

6

Product data must include catalog cuts, performance data, installation instructions, and additional documentation.

7

Catalog cuts must include:

1. Manufacturer's name
2. Catalog or part number
3. Size
4. Chemical composition
5. SDS
6. Installation instructions

76-1.01D Quality Assurance

76-1.01D(1) General

8. Delete for exploration holes; replace with 'Not used'.

Supply and operate pumping equipment used for well development tests and well tests. Pumping equipment for well development tests and well tests remains your property.

76-1.01D(2) Regulatory Requirements

9. Insert the name of the county. Insert the name of specific Regional Water Quality Control Board if required.

Work must comply with:

1. Ordinances of _____ County
2. *Water Well Standards*, Bulletin 74-81
3. *Water Well Standards*, Bulletin 74-90
4. Water Code, §§ 13750.5–13753
5. _____ RWQCB, waste discharge requirements

76-1.01D(3) Permits

10. Insert the name of the county.

Obtain permits required from _____ County.

76-1.01D(4) Quality Control

76-1.01D(4)(a) General

11

Not Used

76-1.01D(4)(b) Test Instrumentation

12. Delete for exploration holes; replace with 'Not used'.

Instrumentation for well tests must indicate water depth within 10 seconds of the time specified. Water depth measurements must be accurate to within 0.1 feet.

76-1.01D(4)(c) Well Development Tests

13–16. Delete for exploration holes; replace with 'Not used'.

13. Insert maximum and minimum flow rates.

Pumping equipment for well development tests must have a power supply capable of operating continuously for at least 36 hours. Test pump must discharge at a rate of at least ___ gpm at the water level encountered in the well and be capable of reducing flow to no more than ___ gpm.

14

Perform step-drawdown tests under ANSI/AWWA A 100, appendix E, "Well Development." Each step must be 3 hours except you may stop the test after 2 hours if the plot of drawdown versus the logarithm of time is a flat line.

15

Perform constant rate tests under ANSI/AWWA A 100, appendix E, "Well Development." Each test must be 2 hours except you may stop the test if 3 successive plots of drawdown versus the logarithm of time is a flat line. Plot the water level versus the logarithm of time for each test.

16

Between tests, allow the water level in the well to return to a static condition in which the plot of water level versus the logarithm of time is a flat line.

76-1.01D(4)(d) Well Tests

17–22. Delete for exploration holes; replace with 'Not used'.

17. Insert the maximum and minimum flow rates.

Pumping equipment for well tests must have a power supply capable of operating continuously for at least 36 hours. The test pump must discharge at a rate of at least ___ gpm at the water level encountered in the well and be capable of reducing flow to not more than ___ gpm.

18

Perform well tests in the following order:

1. Static water-level test
2. Steady-state test
3. Recovery water-level test

19

Perform the static water level test with the pump off. Measure the water level in the well every 20 minutes until 3 consecutive readings are the same.

20–21. The steady-state test time is for 24 hours, followed by the recovery water level test for 6 hours. Adjust the times in pars. 20 and 21 if the test period is longer.

20

Perform the steady-state test with the pump running continuously. Maintain the pump discharge rate within 5 percent during the test. Plot the water level in feet versus time in minutes as shown in the following table:

Time (t) (minutes)	Measure water level (frequency)
t = 0 (turn pump on)	Once
0 < t ≤ 12	Every minute
14 ≤ t ≤ 20	Every 2 minutes
25 ≤ t ≤ 50	Every 5 minutes
60 ≤ t ≤ 100	Every 10 minutes
120 ≤ t ≤ 300	Every 30 minutes
400 ≤ t < 1400	Every 100 minutes
t = 1440 (turn pump off)	Once

21

Start the recovery water level test at t = 1440 minutes with the pump off. Plot the water level in feet versus time in minutes as shown in the following table:

Time (t) (minutes)	Measure water level (frequency)
1440 < t ≤ 1452	Every minute
1454 ≤ t ≤ 1460	Every 2 minutes
1465 ≤ t ≤ 1490	Every 5 minutes
1500 ≤ t ≤ 1540	Every 10 minutes
1560 ≤ t ≤ 1800	Every 30 minutes

22

If the test pump stops pumping for at least 1 percent of the elapsed time from t=0 to t=1440, the steady-state test has failed. Start the testing sequence over with the static water level test.

76-1.01D(4)(e) Water Quality Analysis

23–24. Delete for exploration holes; replace with 'Not used'.

23

Send water samples for analysis to a CDPH-certified laboratory. Analyze samples under 22 CA Code of Regs, Div 4, Ch 15.

24

The analysis must include the constituents listed in 22 CA Code of Regs in (1) art 3 § 64421, "Primary Standards-Bacteriological Quality," (2) art 4 § 64431, "Primary Standards-Inorganic Chemicals," (3) art 5.5 § 64444, "Primary Standards-Organic Chemicals," (4) art 16 § 64449, "Secondary Drinking Water Standards," and the following:

1. Bicarbonate
2. Carbonate
3. Hydroxide alkalinity
4. Calcium
5. Magnesium
6. Sodium
7. Total hardness
8. pH
9. Temperature
10. Turbidity

76-1.02 MATERIALS

76-1.02A General

25. Delete for well rehabilitation; replace with 'Not used'.

Do not use cable tool drilling methods.

76-1.02B Drilling Fluid

26–27. Delete for well rehabilitation; replace with 'Not used'.

Drilling fluid must be water.

27

If authorized, you may add small quantities of bentonite or organic base polymer material to the drilling fluid. Do not add toxic or dangerous substances. Before using additives, submit SDS sheets and a work plan for removal of the additives from the well. Remove the additives before Contract acceptance.

76-1.02C Gravel Pack

28–29. Delete for exploration holes; replace with 'Not used'.

Gravel pack material requirements and impurity levels must comply with ANSI/AWWA A 100. Test for gradation under ASTM C136/C136M. Gravel pack material must be certified under NSF/ANSI 61.

29

Store gravel material on a protective sheet with cover.

76-1.03 CONSTRUCTION

76-1.03A General

30

Notify the Engineer at least 10 days before mobilization.

31

Mobilization, demobilization, and final cleanup includes the following:

1. Moving onto the well site
2. Setting up equipment
3. Removing tools, equipment, and machinery
4. Removing excess materials
5. Removing cuttings, drilling fluid, and rubbish
6. Filling in sumps and excavations
7. Restoring ground to original condition unless otherwise shown

32

When the well site is unattended, cover the opening. Maintain the borehole integrity.

33

Potable water must be supplied in quantities such that a water shortage does not cause a delay in the work.

76-1.03B Formation Sample Collection

34–36. Delete for well rehabilitation; replace with 'Not used'.

Collect and store formation samples under ANSI/AWWA A 100. Collect formation samples (1) at least once every 5 feet, (2) at a change in formation, and (3) at an aquifer.

35

Formation samples must be stored onsite and available for the Engineer's review.

36

After completion of drilling, select a representative group of formation samples and send them to a Department Authorized Laboratory for analysis. Include a stratigraphic log. Lab results must include gradation curves for each sample.

76-1.03C Well Disinfection

37. Delete for exploration holes; replace with 'Not used'.

Disinfect wells under ANSI/AWWA A 100 section 4.9, "Well Disinfection." After disinfection, discharge water from the well until the discharged water has no noticeable chlorine odor. Chlorinated water must be disposed of properly.

76-1.03D Video Survey

38–41. Delete for exploration holes; replace with 'Not used'.

Survey the well interior using a video camera from the ground surface to the bottom of drilled hole, then back to the surface. The survey must include a current date and time stamp and the depth of the video camera relative to the surface.

39

The video camera must have an attached light that clearly illuminates the casing or well screen being videotaped. The video camera must be mounted downward facing but must be able to clearly view all of the casing or well screen.

40

If anomalies exist in the casing or well screen, the survey must include close-up video screen capture or still photos of these areas.

41

The survey must be recorded on a read-only DVD or other Engineer-authorized data-storage device viewable on any PC with an operating system of Windows XP or newer. Label the device with (1) contract number, (2) well location, and (3) date produced.

76-1.04 PAYMENT

42

Not Used

Section 76-3. Use for drilling exploration holes.

Replace section 76-3 with:

76-3 EXPLORATION HOLES

76-3.01 GENERAL

76-3.01A Summary

1

Section 76-3 includes specifications for constructing exploration holes.

2

The exploration hole includes:

1. Drilling the borehole
2. Collecting formation samples
3. Completing the well logs
4. Destroying the borehole

76-3.01B Definitions

3

exploration hole: Uncased, temporary borehole whose purpose is the determination of hydrologic conditions at a job site.

76-3.01C Submittals

4

Submit a work plan for the destruction of the exploration hole.

5

Submit the following as informational submittals:

1. Daily drilling reports
2. Geophysical log
3. Log of test borings

76-3.01D Quality Assurance

6

Not Used

76-3.02 MATERIALS

7

Not Used

76-3.03 CONSTRUCTION

76-3.03A General

8

The daily drilling reports must be available to the Engineer at the job site. The daily drilling reports must comply with ANSI/AWWA A 100.

9

Log the borehole under the Department's *Soil and Rock Logging, Classification, and Presentation Manual.* Collect and store formation samples.

10

When the drilling is complete, make a geophysical log of the borehole. Clean the borehole of obstructions and recondition the drilling fluid before starting logging. Start the log at the bottom of the bore and end at the surface. The geophysical log must include:

1. Single point resistance
2. Short-normal resistivity
3. Long-normal resistivity
4. Spontaneous potential
5. Natural gamma
6. Caliper

11

Prepare the log of test borings under the Department's *Soil and Rock Logging, Classification, and Presentation Manual*.

76-3.03B Incompletion of Exploration Hole

12. Insert name of county.

If your operations do not allow the exploration hole to be completed as described, destroy the exploration hole under the Ordinances of _____ County and 22 CA Code of Regs § 64560.5.

13

After destroying the exploration hole, move the drilling operation a short distance and drill another exploration hole. The Engineer must authorize the location.

14

Satisfactory samples collected from the destroyed exploration hole are acceptable. Resume sample collections such that each formation and aquifer is sampled and the intervals specified are maintained.

76-3.03C Destruction of Exploration Hole

15

After the log of test borings and geophysical log are accepted, destroy the exploration hole. Return the job site to its original condition.

16. Insert name of county.

Unless otherwise required by _____ County:

1. Sealing material must be neat cement or bentonite complying with ANSI/AWWA A 100. Do not use bentonite chips.
2. Top 3 feet must be compacted-native material with no organic material.

76-3.04 PAYMENT

17

The Department does not adjust payment for the costs involved in moving the drilling activity.

SS Coordinator: Add section 76-3 with:

76-3 BOREHOLES

76-3.01 GENERAL

76-3.01A Summary

Section 76-3 includes specifications for drilling boreholes to log subsurface materials, obtain subsurface material samples, and perform in-situ test or monitoring.

76-3.01B Definitions

borehole: Drilled to obtain subsurface material samples for logging or testing or to perform in-situ testing or monitoring.

spoil return: Mixture of in-situ soil, drill cuttings, groundwater, and cementitious and additive materials. Spoil return may be liquids, semi-solids, or solids.

76-3.01C Submittals

76-3.01C(1) General

Reserved

76-3.01C(2) Qualifications

Submit:

1. List of at least 5 projects completed in the last 3 years that demonstrate the contractor's ability to perform geotechnical drilling, rock coring and soil, rock, and groundwater sampling with similar objectives and conditions to this job
2. For each project include:
   2.1. Project description
   2.2. Project location
   2.3. Project owner’s name, email address, and phone number
   2.4. Project completion date
   2.5. Work performed
   2.6. Personnel performed the work
3. Your C-57 license
4. Certification of your authorized AASHTO Accredited laboratory for soil and rock laboratory test
5. Name of accredited laboratory under State Water Resources Control Board Environmental Laboratory Accreditation Program for groundwater sampling and test
6. Name and qualification of the company and personnel performing geophysical or hydrologic tests

76-3.01C(3) Work Plan

Submit:

1. Your company name, address, telephone number, and email address
2. Layout, numbering, and northing and easting coordinates of boreholes
3. Top and bottom elevations of boreholes
4. Description, make, model, type, year, and condition of drilling equipment capable of retrieving samples at the locations described and to the depths specified
5. Certificate of hammer efficiency calibration
6. Drilling schedule
7. Drilling method and equipment
8. Sampling method and equipment
9. Testing method and equipment

10. Monitoring method and instrument
11. Water management plan
12. Spoil return management plan, including method and equipment for containment, treatment, test, and disposal of spoil return
13. Traffic control plan
14. Site access plan
15. Example daily drilling report
16. Well permits from local enforcement agency
17. Underground Service Alert ticket number

76-3.01C(4) Daily Drilling Report

Submit daily drilling record by noon, in digital data and pdf formats, of the next day's work shift. Include:

1. Date, start and end time
2. Drilling equipment ID, type, model number
3. Description of obstructions, interruptions, or other difficulties during drilling and how they were resolved
4. For each borehole
   - 4.1. Identification number
   - 4.2. Start and end time
   - 4.3. Latitude/Longitude and Northing/Easting
   - 4.4. Top and bottom elevations accurate to ±0.1 feet
   - 4.5. Top and bottom elevations of each drilling type and method used
   - 4.6. Quantities of consumable materials used
   - 4.7. Quantity of grout used for destroying borehole
   - 4.8. Groundwater elevation
   - 4.9. Energy efficiency ratio of standard penetration test hammer
5. For each subsurface material sample
   - 5.1. Identification number
   - 5.2. Top and bottom elevations accurate to ±0.1 feet
   - 5.3. Type and method used to retrieve the sample
6. For each in-situ test
   - 6.1. Identification number
   - 6.2. Top and bottom elevations of the test accurate to ±0.1 feet
   - 6.3. Type and method of test
   - 6.4. Equipment used

76-3.01C(5) Laboratory Test Report for Soil and Rock

Submit laboratory test report, in digital data and pdf formats, by noon a day after the test is completed. Include:

1. Test date
2. Sample ID
3. Sample depth, length, diameter
4. Test result
5. Digital photos of sample before and after test

Laboratory test report for soil and rock must be reviewed, digitally signed by an engineer who is registered as a civil engineer in the State.

76-3.01C(6) Borehole Log

Submit borehole log in electronic database file format within 15 days after completing a borehole and required laboratory tests. The borehole log must:

1. Be compatible with the Department’s borehole database
2. Comply with the Department’s Soil and Rock Logging, Classification, and Presentation Manual

Each borehole log must be reviewed, sealed, and signed or digitally locked by an engineer who is registered as a civil engineer in the State or a geologist who is registered as a professional geologist in the State.

76-3.01C(7) Geophysical Logging Report

Submit geophysical logging report, in digital data and pdf formats, by noon a day after the test is completed. Include:

1. Date, start and end time
2. Borehole ID
3. Top and bottom elevations accurate to ±0.1 feet
4. Test result

Geophysical logging report must be sealed and signed by a professional geophysicist who is registered as a professional geophysicist in the State.

76-3.01C(8) Hydrogeology Report

Submit hydrogeology report, in digital data and pdf formats.

Hydrogeology report must be sealed and signed by a certified hydrogeologist who is registered as a hydrogeologist in the State.

76-3.01C(9) Groundwater Test Report

Submit groundwater test report, in digital data and pdf formats.

Groundwater test report must include tests for:

1. pH
2. Corrosivity
3. Other properties as described

76-3.01C(10) Well Completion Report

Submit Well Completion Report under Department of Water Resources requirements.

Submit a copy of the Department of Water Resources Well Completion Report within 20 days after the completion of each borehole or inclinometer, as informational submittal.

76-3.01D Quality Assurance

Not Used

76-3.02 MATERIALS

76-3.02A General

Comply with section 76-6.02

76-3.02B Inclinometer

76-3.02B(1) Casing

Casing must be made of ABS plastic or fiberglass.

Casing must have 4 internal grooves spaced 90 degrees apart. Each groove must have a consistent and flat surface for the wheels of the inclinometer probe. Groove spiral must be less than 0.3 degrees per 10 feet.

Top and bottom caps of casing must be watertight and made of ABS. Top cap must be removable.

Casing connections must be watertight.

Casing must comply with the requirements shown in the following table:

Inclinometer Casing

Quality characteristic	Test method	Requirement
Collapse strength (min, psi)	ASTM D1599	155
Load strength (min, psi)	ASTM D2412	900
Temperature rating (°F)	ASTM D1525	-20–190

76-3.02B(2) Protective Cover

Above-ground protective cover must be aluminum or steel casing with a lockable cover at the top.

Above-ground protective cover must be constructed using steel casing with at least 5-foot-long and at least 4-inch in diameter. Protective cover must extend at least 2 feet above ground and with a lockable hinged cover.

Flush-mounted protective cover must be 12-inch-long steel casing with at least 4-inch in diameter with a cast-iron cover. The cover must be with AASHTO H-20 load rating and fixed down with threaded stainless-steel bolts with lubricant and waterproof gasket.

76-3.02B(3) Grout

Grout must be non-shrink that comply with ASTM C1107 and consist of Portland cement, additives, bentonite, and water.

Composition of grout must produce grout that is not stiffer than surrounding subsurface materials after cure and must allow casing to accurately reflect displacement of the surrounding subsurface materials.

Refer to the following grout mix guide to produce grout that is compatible with surrounding subsurface materials.

Grout Mix Guide

Installation Environment	Soft soils		Hard soils and rock	
Material	Common ratio	Ratio by weight	Common ratio	Ratio by weight
Portland cement and additives	94 lb	1	94 lb	1
Bentonite	39 lb	0.4	25 lb	0.3
Water	75 gallons	6.6	30 gallons	2.5

76-3.03 CONSTRUCTION

76-3.03A General

Log boreholes under the Department's *Soil and Rock Logging, Classification, and Presentation Manual.* Collect and store samples as directed.

76-3.03B Equipment

76-3.03B(1) Drilling and Sounding Equipment

Provide drilling equipment that is capable of drilling through hard rock and to the depth described.

Standard penetration test hammer must be tested for energy efficiency within last 12 months.

Electronic cone penetration test cone must be calibrated within last 12 months.

76-3.03B(2) Sampling Equipment

Provide sampling equipment that can retrieve soil, rock, and water samples with the least disturbance to the sample and subsurface condition. Sampler assemblies, including liners, drive shoe, retainers, core barrel, core liners must comply with section 76-3.03C.

76-3.03B(3) In-situ Test Instruments

Reserved

76-3.03B(4) Monitoring Instruments

Reserved

76-3.03C Drilling, Sampling, Testing, and Sounding

Drill borehole under ASTM D420, D653, D3740, D6169, D6286, and D6914.

Drill borehole in soil under ASTM D1452, D5784, and D5872.

Drill borehole in rock under ASTM D2113, D5781, D5782, D5783, D5875, and D5876.

Perform geotechnical sampling, in-situ test and instrumentation under ASTM D1586, D2573, D3550, D4403, D4719, D8359, D6519, and D6907.

Perform cone penetration test under ASTM D5778.

Perform groundwater sampling under ASTM D4448, D5903, D6089, and D7069

76-3.03D Borehole Geophysical Logging

Perform borehole geophysical logging under ASTM D5753, D6167, D6727, D6274, D6820.

76-3.03E Install Inclinometer

Install inclinometer under ASTM D6230, and D7299.

Clean the borehole before installing inclinometer casing. Attach bottom cap to the first section of inclinometer casing and insert the casing into the borehole. Add remaining casing sections. Fill the casing with clear water to counter buoyancy if needed.

Align the top of the casing so that one of the grooves is oriented in the downslope direction or as directed by the Engineer. Do not rotate casing when subsequent casing sections are added.

Inclinometer casing must be centered in the borehole to allow grout to surround and support the casing.

After installing inclinometer casing, fill the annulus between the casing and borehole wall with grout using a tremie pipe. Grout surface must be 6 to 8 inches lower than the top of design casing elevation.

Separation of solid ingredients and water during and after placement is not allowed.

Place a dead weight at the top of the casing or insert a retrievable dead weight inside the casing to secure casing in place during curing. Place additional grout 48 hours after placing the initial grout.

Cover the casing with inclinometer top cap.

Install protective cover.

For above-ground protective cover, install weather resistant keyed brass padlock to secure the cover. Key the lock to the Department key code. Provide the padlock key.

76-3.03F Abort Borehole

If you need to abort an borehole due to unexpected conditions such as obstruction, notify the Engineer. Destroy the borehole under section 76-6.

Drill a substitute borehole near the aborted borehole and at location determined by the Engineer.

If samples collected from the aborted borehole are accepted, start sampling in the substitute borehole immediately below the lowest elevation of the accepted samples.

76-3.03C Destroy Borehole

Destroy borehole under section 76-6.

76-3.04 PAYMENT

Not used

Section 76-4. Use for monitor wells.

Replace section 76-4 with:

76-4 MONITOR WELLS

76-4.01 GENERAL

76-4.01A Summary

1

Section 76-4 includes specifications for constructing monitor wells.

76-4.01B Definitions

2

monitoring well: Any artificial excavation by any method for the purpose of monitoring fluctuations in groundwater levers, quality of underground waters, or the concentration of contaminants in underground waters under Water Code § 13712.

76-4.01C Submittals

3

Submit product data for:

1. Protective casing and cover
2. Well cap
3. Blank well casing
4. Well screen
5. Gravel pack material
6. Annular space seal

4

Submit calculations for the computed volume of gravel material to be added.

5

Submit daily drilling reports as informational submittals.

76-4.01D Quality Assurance

6

Not Used

76-4.02 MATERIALS

76-4.02A General

7

Concrete must be minor concrete.

76-4.02B Protective Casing

8–9. Delete for watertight vaults.

The protective casing must be steel and at least 4 feet long with a hinged cover. The casing cover must be steel and have provisions for padlocking. The cover must have permanent monitor well identification complying with *Water Well Standards*, Bulletin 74-90.

9

Furnish a padlock until Contract acceptance.

76-4.02C Well Cap

10

The well cap must be J-type, with wing nut and expandable gasket to form a watertight seal. The well cap must include an attachment eye on the bottom and have permanent identification as a monitor well.

76-4.02D Blank Well Casing

11. Insert schedule 40 or 80, or the standard dimension ratio rating.

Blank well casing must be PVC pipe casing. PVC pipe casing must be _____ PVC thermoplastic well casing pipe complying with ASTM F480.

12

PVC joints must be flush threaded. Where lubrication is required, use the pipe manufacturer's lubricant. Do not use solvent-welded joints.

76-4.02E Well Screen

13. The designer reviews the gravel pack gradation and the character and sieve

Determine the screen opening size based on aquifer and soil requirements. The well screen opening size must be authorized before installation.

14

Well screen connections must be threaded.

15. Insert schedule 40 or 80, or the standard dimension ratio rating.

Well screen must be _____ PVC complying with ASTM F480.

16

PVC well screen must (1) be from the same manufacturer and have the same diameter as the blank well casing and (2) have flush threaded ends and machine-made, evenly-spaced slotted openings perpendicular to the axis of the casing.

76-4.02F Filter Pack

17

Filter pack material must comply with the specifications for gravel pack material. Test for gradation under ASTM C136/C136M.

76-4.02G Annular Space Seal

18. Insert the name of the county.

Unless otherwise specified by _____ County, sealing materials must (1) comply with ANSI/AWWA A 100 and (2) be neat cement, bentonite, or concrete. Do not use bentonite chips.

19. Use if a transition seal is shown.

The transition seal must be clean, washed, fine sand.

76-4.03 CONSTRUCTION

76-4.03A General

20

Maintain daily drilling reports.

21. Use if the well screen size and length are not shown.

Collect formation samples during drilling operations at least every 10 feet.

22

Construct the concrete base under *Water Well Standards*, Bulletin 74-90. Pour the base before the annular seal has set. Where the top of the monitor well is shown below grade, construct a watertight vault under *Water Well Standards*, Bulletin 74-90.

23

Do not disturb the well for 48 hours after placing sealing material and constructing the base.

24

Clean and develop the well. Do not use chemical development.

25

If pump surging is used, pipe the discharge water to the storm drain system or to an authorized location where it does not cause erosion, damage to equipment or plantings, or interference with ongoing work.

76-4.03B Casing String

26

Furnish a welded or threaded cap on the lower end of the casing string.

27

Install centralizers above and below well screen section. Install additional centralizers at no more than 10 feet apart.

28

The casing string must be lowered by gravity into the well. Do not drive or force the casing string into place. Suspend the casing string until the annular space has been sealed. Do not allow the casing string to rest on the bottom of the hole.

76-4.03C Filter Pack

29

Gravel material must be delivered in bags. Store the bags on a protective sheet with a cover.

30

Place the gravel material by tremie tube. Add water to the gravel material where required to facilitate flow down the tube. Lower the tremie tube to the bottom of the well before adding gravel.

31

Maintain the alignment of the casing string while the filter pack is placed.

76-4.04 PAYMENT

32

Not Used

SS Coordinator: Add section 76-4 with:

76-4 MONITORING WELLS

76-4.01 GENERAL

76-4.01A Summary

Section 76-4 includes specifications for installing monitoring wells to monitor groundwater table elevation, groundwater quality, or concentration of contaminants in groundwater.

76-4.01B Definitions

monitoring well: Borehole that provides access to sampling for groundwater quality, or concentration of contaminants in groundwater, or with installed instrument for monitoring groundwater table elevation.

76-4.01C Submittals

76-4.01C(1) General

Reserved

76-4.01C(2) Product Data

Submit product data for:

1. Protective casing and cover
2. Well cap
3. Blank well casing
4. Well screen
5. Filter pack material
6. Annular space seal

76-4.01C(3) Calculation of Filter Pack Volume

Submit calculations for volume of filter pack material.

76-4.01C(4) Well Completion Report

Submit Well Completion Report under Department of Water Resources requirements.

Submit a copy of the Department of Water Resources Well Completion Report within 20 days after the completion of each monitoring well, as informational submittal.

76-4.01D Quality Assurance

Reserved

76-4.02 MATERIALS

76-4.02A General

Concrete must be minor concrete.

76-4.02B Well Casing and Fittings

Well casing and fittings must be schedule 40 PVC plastic pipe**{** XE "Pipe:plastic, monitoring well" **}** and comply with NSF/ANSI 14 and ASTM F480.

If not shown, use pipe with a nominal pipe size of 2 inches.

Pipe joints must be flush threaded. Where lubrication is required, use manufacturer's lubricant. Do not use solvent weld.

76-4.02C Centralizer

Centralizer must provide at least 2 inches annulus between outside diameter of casing and the borehole wall throughout the entire length of casing.

76-4.02D Well Screen

Well screen**{** XE "Well screen:monitoring well" **}** must have slots equally spaced along the pipe circumference and comply with the requirements shown in the following table:

Well Screen Slots

Pipe Size, nominal inside diameter (inches)	Number of slot rows	Slot width (inches)	Slot length (inches)	Slot spacing (inches)
2.0	3	0.01	0.6–0.8	0.25
2.5	3	0.01	0.6–0.8	0.25
3.0	3	0.01	1.0–1.2	0.25
4.0	4	0.01	1.0–1.2	0.25

The slot length is measured on the inner surface of the pipe.

76-4.02E Well Cap

For monitoring well extended above ground, use schedule 40 PVC cap.

For monitoring well with flush mount protective cover, use J-type cap with wing nut and expandable gasket that provides watertight seal. Include an attachment eye at the bottom of cap. The cap must be lockable by a padlock.

76-4.02F Protective Cover

Protective cover must comply with *Water Well Standards* section of Bulletin 74-90.

Protective cover must include permanent monitor well identification.

Above-ground protective cover must be steel and extend at least 2 feet above ground with a lockable hinged cover.

Flush-mounted protective cover must be 12-inch-long steel casing by 4-inch in diameter with a cast-iron cover. The cover must be AASHTO H-20 load rated and affixed to the casing with threaded stainless-steel bolts with lubricant and waterproof gasket.

76-4.02G Annular Seal

Comply with section 76-6.02.

76-4.02H Filter Pack Seal

Filter pack seal material must be sodium bentonite and comply with NSF/ANSI 60. Filter pack seal material may be pellets or chips with bulk density of 70–80 pcf, or slurry.

76-4.02I Filter Pack

Filter pack material must consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition.

Filter pack material must comply with the following gradation requirements or as directed.

Filter Pack Gradation Requirements

Sand pack mesh name	1% Passing size	10% Passing size	30% Passing size	60% Passing size	Uniformity Coefficient
	(mm (US Sieve))				
20-40	0.250 (60)–0.425 (40)	0.425 (40)–0.500 (35)	0.500 (35)–0.600 (30)	0.600 (30)–0.850 (20)	1.1–1.6

Protect filter pack material from contacting with pollutants, contaminants, and foreign substances, such as clay or vegetative matter.

76-4.03 CONSTRUCTION

76-4.03A General

Install monitoring well under ASTM D5092, D5521, D5787, D6452, and *Monitoring Well Standards* section of Bulletin 74-90.

76-4.03B Drill Borehole

Drill borehole under section 76-3.

Borehole diameter must be at least 4 inches larger than the outside diameter of monitoring well casing.

76-4.03C Install Well Casing

Clean the borehole before installing well casing and screen.

Casing, couplings, centralizers, and other components of well casing must be clean and free of contaminants at time of installation.

Space centralizers at 8-foot maximum intervals for the full length of the casing. Place the uppermost centralizer less than 2 feet from the top of casing and the lowermost centralizer at 2 feet from the bottom of casing.

Attach bottom cap to the first section of monitoring well casing and insert the casing into the borehole.

Add and join the remaining screen and casing sections.

Casing joint must be watertight.

Do not drive or force the casing string into place. Protect casing from impact that may damage or weaken the casing.

Do not rest casing assembly on the bottom of borehole.

Suspend casing assembly until completion of annular seal placement.

76-4.03D Place Filter Pack

Use tremie pipe to place filter pack material at filter pack section of borehole as shown. Measure the top of filter pack and volume of filter pack placed to verify filter pack has not bridged.

76-4.03E Place Filter Pack Seal

Place filter pack seal material at borehole section shown or as directed.

For filter pack seal material with sodium bentonite pellets or chips, add water after placement of filter pack seal. Do not displace filter pack seal material. Wait at least 1 hour after placement of water for filter pack seal material to properly hydrate before placing annular seal.

Sound the top of the filter pack seal to verify that no bridging occurred during placement.

76-4.03F Place Annular Seal

Place annular seal at borehole section shown or as directed.

Comply with *Water Well Standards* section of Bulletin 74-90.

76-4.03G Install Protective Cover

Install protective cover under *Water Well Standards* section of Bulletin 74-90.

76-4.04 PAYMENT

Not Used

Section 96-1.02B. Use for projects with filter fabric.

Add to section 96-1.02B:

1. Specify the application and the class of filter fabric (based on testing of soil on the job site). For multiple applications, copy paragraph 1 and edit. If the soil is not tested, specify Class A as the default.

Use Class A if less than 15 percent passes a no. 200 sieve.

Use Class B if 15 to 50 percent passes a no. 200 sieve or the plasticity index is more than 7.

Use Class C if more than 50 percent passes a no. 200 sieve.

Filter fabric for ____ must be Class __.