2.6 Geotechnical

2.6.1 *General*

The Design-Builder shall perform all of the Geotechnical Work necessary to design and construct the Project. Elements of the Work, at a minimum, shall include the following:

- The Design-Builder shall evaluate the geotechnical requirements and perform all geotechnical explorations, geotechnical analyses, and laboratory testing that are necessary to design and construct the Project.
- All geotechnical elements of the Project that are Released for Construction (RFC) shall be fully supported with Geotechnical Recommendations, design decisions, supporting geotechnical data, calculations, plans, and specifications for construction following the requirements set forth in this Section and the WSDOT *Geotechnical Design Manual* (GDM) (Appendix D).
- The Design-Builder shall provide a Final Geotechnical Documentation Package that documents all the geotechnical findings, Geotechnical Recommendations, design decisions, calculations, and design completed for the Project in accordance with this Section.
- The Design-Builder shall provide geotechnical support, review, and inspection during construction of the Project in accordance with this Section.

2.6.1.1 Forward Compatibility

Geotechnical design and construction must meet the Forward Compatible requirements of the Contract including, but not limited to, the Forward Compatibility Plan and Section 2.13, *Bridges and Structures*.

2.6.2 *Mandatory Standards*

The following is a list of Mandatory Standards that shall be followed for all work related to this Section as referenced in Section 2.2, *Mandatory Standards*.

1. Special Provisions (Appendix B)
2. Standard Specifications M 41-10 (Appendix B)
3. WSDOT *Geotechnical Design Manual* M 46-03 (Appendix D)
4. WSDOT *Bridge and Structures Office Design Memoranda* (Appendix B)
5. WSDOT *Bridge Design Manual LRFD* M 23-50 (Appendix D)
6. WSDOT *Design Manual* M 22-01 (Appendix D)
7. WSDOT *Highway Runoff Manual* M 31-16 (Appendix D)
8. WSDOT *Materials Manual* M 46-01 (Appendix D)
9. WSDOT *Construction Manual* M 41-01 (Appendix D)
10. Standard Plans M 21-01 (Appendix D)
11. *AASHTO Guide Specifications for LRFD Seismic Bridge Design*

12. *AASHTO LRFD Bridge Design Specifications*
13. *AASHTO Manual on Subsurface Investigations*
14. *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing*
15. *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*
16. *AASHTO LRFD Road Tunnel Design and Construction Guide Specifications*
17. City of Bothell Municipal Code Chapter 20.04 Building Regulations and International Codes
18. City of Kirkland Municipal Code Title 21 Buildings and Construction

2.6.2.1 Design-Build Modifications to the Geotechnical Design Manual

When the WSDOT *Geotechnical Design Manual* refers to an activity that "shall" be done or that "is" done, those activities are mandatory. When the WSDOT *Geotechnical Design Manual* refers to an activity that "should" be done, those activities are mandatory. All references to the Bridge and Structures Office, Geotechnical Office, Structural Designer, Structural Engineer, Project Designer, Construction Project Engineer, Geotechnical Engineer, Field Exploration Manager, Field Exploration Supervisor, and Geotechnical Designer shall mean the Design-Builder. Where the WSDOT *Geotechnical Design Manual* requires approval by the State Geotechnical Engineer, the Design-Builder shall be responsible to request in writing approval from the WSDOT Engineer. Work completed without the necessary approvals will not be accepted or contractually compliant.

No changes have been made to provisions in the WSDOT *Geotechnical Design Manual* that do not apply to design-build contracts, (e.g., descriptions of WSDOT divisions and their duties, descriptions of legal authority, or descriptions of internal WSDOT procedures or policies); however, in some cases it may not be clear whether rights or responsibilities in the WSDOT *Geotechnical Design Manual* are applicable to the Design-Builder. If it is unclear whether specific provisions in the WSDOT *Geotechnical Design Manual* apply to the Design-Builder, the Design-Builder shall request clarification from the WSDOT Engineer. WSDOT will make that determination at its sole discretion. WSDOT has identified the following provisions of the WSDOT *Geotechnical Design Manual* that do not apply to design-build contracts:

- Section 1.2.2, Geotechnical Functions Delegated to the Regions
- Section 1.2.3, Coordination between HQ and Region Regarding Emergency Response
- Section 1.3, Geotechnical Support within the WSDOT Project Management Process
- Section 1.6, Geotechnical Consultant Administration
- Chapter 20, Unstable Slope Management
- Chapter 21, Material Source Investigation and Report
- Chapter 22, Geotechnical Project Development, Reports, and Support for Design-Build Projects

2.6.2.2 Subsurface Investigation Modifications to the Geotechnical Design Manual

In addition to the requirements of the WSDOT *Geotechnical Design Manual*, the Design-Builder shall perform geotechnical investigations in accordance with the WSDOT *Highway Runoff Manual* at locations of stormwater infiltration, treatment or detention ponds, wetlands, media filter drains, Compost Amended Vegetated Filter Strips, infiltration ditches, and structures.

Where new foundations will be constructed for signals, strain poles, Illumination Systems, cantilever signs, sign bridges, Toll Gantries, Variable Message Signs (VMS), Toll Rate Signs (TRS), Intelligent Transportation Systems (ITS), and ramp meters, only a Site review is required if the new foundation will be entirely within new or existing embankments known to be constructed of gravel borrow or select borrow and compacted in accordance with Method B or C of the Standard Specifications. Otherwise, subsurface conditions shall be investigated in accordance with the WSDOT *Geotechnical Design Manual*. New explorations shall be performed for the foundations described in this paragraph if existing explorations are more than 100 feet from the foundation.

WSDOT may allow the Design-Builder to waive subsurface explorations under certain conditions, at WSDOT's sole discretion. The Design-Builder shall submit a memorandum stamped and signed by the Geotechnical Group Manager (GGM) including the justification for the request for WSDOT's Review and Comment. For all foundations where subsurface investigations are waived, the soil conditions at the foundation shall be observed during construction by the Geotechnical Special Inspector. The Engineer of Record (EOR) shall certify and document in the Final Records that the observed conditions meet the design requirements. If conditions are not adequate, the foundation shall be redesigned or the soil conditions shall be improved until the soils meet the design requirements. Explorations shall not be waived for bridges, culverts, noise walls, retaining walls, buried structures or tunnels.

2.6.2.2.1 *Exploration Requirement Modifications to the Geotechnical Design Manual*

Exploration requirements in the WSDOT *Geotechnical Design Manual* apply to new foundations constructed for signals, strain poles, Illumination Systems, cantilever signs, sign bridges, Toll Gantries, Variable Message Signs (VMS), Toll Rate Signs (TRS), Intelligent Transportation Systems (ITS), and ramp meters as noted elsewhere in Section 2.6.

Except for the structures in the paragraph above, exploration requirements in the WSDOT *Geotechnical Design Manual* are amended to include maximum distances for explorations away from a structure as noted below:

To meet GDM requirements for explorations, the explorations must be located horizontally within 25 feet of:

- Isolated foundations (of any kind)
- Strip or continuous footings
- The wall alignment, as defined by the face of the wall for both retaining and noise walls
- Bridge pier ends and centerlines

- The centerline of buried structure or culverts that are Class 1 Structures as defined in Section 2.13, *Bridges and Structures* and this Contract
- The outer edges of buried structures or culverts that are Class 2 Structures as defined in Section 2.13, *Bridges and Structures* and this Contract

To meet Contract requirements for anchored walls, additional explorations are required:

- In the anchorage zone at a horizontal distance of least 10 feet behind the wall face and no greater than 20 feet beyond the end of the anchorage zone. Other requirements from Article 10.4.2 AASHTO LRFD Bridge Design Specifications apply.

To meet Contract requirements for soil nail walls, additional explorations are required:

- Behind the face of walls as provided in Table 10.4.2-1, Article 10.4.2 AASHTO LRFD Bridge Design Specifications.

2.6.2.3 Design Procedure Modifications to the Geotechnical Design Manual

Design procedures in the WSDOT *Geotechnical Design Manual* are amended or revised as noted.

2.6.2.3.1 *Use of Cohesion*

The following restrictions will be applied in the selection of types and values of cohesion for the design of any permanent or temporary structure and slope stability:

- Apparent cohesion, as defined in the WSDOT *Geotechnical Design Manual*, shall only be allowed for work defined under Section 2-09 of the Standard Specifications, otherwise the use of apparent cohesion shall not be allowed under any other conditions, including seismic or other short term loading conditions.
- Inter-particle cohesion is allowed for use in design provided the following constraints and requirements are met in selecting values for design:
  - The use of published tables or reports suggesting typical values for representative soils shall not be used to select values for cohesion to be used in the final design, including values in the WSDOT *Geotechnical Design Manual*.
  - Values for cohesion shall be based on site-specific geologic deposition, stress history, and drainage conditions from established peer-reviewed and widely published empirical correlations and/or direct measurements.
  - Documentation for procedures and approaches shall be included in the Soil and Rock Properties for Design submittal (see Section 2.6.9.5) and in all design submittals for the final values of cohesion selected and shall include:
    - All references to the correlations and procedures relied upon and any assumptions and limitations of the correlations and procedures;
    - All laboratory classification test results including but not limited to Atterberg limits and grain size distribution with the percentage of fines passing the number 200 sieve;
    - A discussion of the applicability to the site-specific soil conditions encountered and the design value that is to be applied;

- A quantitative assessment of variability and uncertainty of the values evaluated; and
- A discussion of the basis for the selection of the final value for the design to which it is to be applied.

2.6.2.3.2 *Evaluation of Soil and Rock Properties*

Where the WSDOT *Geotechnical Design Manual* WSDOT indicates this reference "FHWA-IF-02-034, Evaluation of Soil and Rock Properties, Geotechnical Engineering Circular No. 5 (Sabatini, et al., 2002)", this updated reference " FHWA-NHI-16-072, Geotechnical Site Characterization, Geotechnical Engineering Circular No. 5 (Loehr, et al., 2016)" shall be used or inserted instead.

2.6.2.3.3 *Foundation Design Requirements for Noise Barriers*

Where the WSDOT *Geotechnical Design Manual* describes noise barrier structures designed to retain a minimal amount of soil, designer shall assume that the Standard Plan noise barrier structures have not been designed to retain any soil.

2.6.2.3.4 *Walls on Slopes*

In the WSDOT *Geotechnical Design Manual*, a near horizontal bench shall not be steeper than 10H:1V.

Preserved existing slopes above the proposed cut walls in the Hillside Area may be left in their current condition for the strength and service limit states if:

- The overall (global) stability is analyzed for both the existing and proposed conditions.
- The resulting factors of safety are not significantly different (less than 0.05 difference) for similar slip surfaces entering and exiting above the extent of the walls.

Any slopes modified by the Design-Builder shall be designed in accordance with the Contract requirements.

The extreme event limit state for the seismic scenario shall be checked at each wall location. For walls on slopes in the Hillside Area limits, a comparison of overall (global) stability analysis results for the extreme event limit state between the existing conditions of the slope without the wall and proposed conditions with the wall shall be conducted. If the factors of safety between the two conditions are not significantly different (less than 0.05) for similar slip surfaces, or if the existing slope has a factor of safety less than 0.65, the Contract requirements for the minimum factor of safety shall be waived for overall (global) stability for the extreme event limit state unless the failure of the retaining wall would impact the traveled way.

2.6.2.3.5 *Soil Nails*

In the WSDOT *Geotechnical Design Manual* 15-5.7 Soil Nails, add new sentence at the end of the sixth paragraph reading: "Note that proof and verification testing in 15-5.2.3 of the Geotechnical Design Manual, Permanent Ground Anchors, does NOT apply."

2.6.2.3.6 *Overall Stability of Slopes Above Walls*

In the WSDOT *Geotechnical Design Manual* 15-4.12 Overall Stability, add the following to the end of the second paragraph: "A slope above the wall shall meet the overall stability requirements in Chapter 7 of the WSDOT *Geotechnical Design Manual*. Existing slopes above walls that do not meet the minimum resistance factor presented in Section 7.4 of the WSDOT *Geotechnical Design Manual* for overall stability at the service limit state, do not show signs of instability in the field (e.g., tension cracks, pistol butted tree trunks), and do not directly support a structure nor if slope failure occurs will not impact and damage a structure may remain in the existing configuration if a comparative overall stability analysis is conducted and it is demonstrated the stability of the slope is not negatively impacted by the proposed wall (i.e., the resistance/safety factor for overall stability remains the same or improves). In addition, a seismic analysis shall be conducted for overall stability of the slope, a maximum resistance factor of 0.9 shall be used. This is equivalent to a safety factor of 1.1. In cases where seismic overall stability analysis indicates a slope above a wall does not meet the minimum resistance factor (factor of safety), a deformation-based analysis as described in Section 7.3 of the WSDOT *Geotechnical Design Manual* may be performed to demonstrate that deformation of the slope will not result in soil overtopping the wall. Otherwise, methods shall be employed to prevent loss of life or severe injury to the public on the roadway below. For the Hillside Area where the natural slope angle exceeds the prescribed soil friction angle and where deformation-based analysis cannot be completed, the Design-Builder may assume a maximum soil runoff height of 11 feet at the top of the wall."

2.6.2.4 Seismic Hazard Modifications to the Bridge Design Manual and the GDM

As an alternative to a site-specific seismic hazard analysis which incorporates basin effects, the determination of a code/specification based seismic hazard for either the SEE or FEE level as defined in Section 6-3.1 of the WSDOT GDM shall be obtained according to WSR-22-11-010. The amendments in the Washington State Register (WSR) 22-11-010 shall be used with modifications as appropriate for use with the project technical requirements and Mandatory Standards in lieu of the references to ASCE 7-22. These amendments will produce a multi-period response spectrum for use in routine design. Site classification shall be completed per WSR 22-11-010. The multi-period response spectrum code/specification seismic hazard shall be determined from: https://staging-earthquake.usgs.gov/nshmp/hazard/dynamic using an appropriate site class and return period. The "National Seismic Hazard Model (NSHM) Conterminous U.S. 2018" model should be used. The analysis shall be completed without scaling to the maximum direction for consistency with AASHTO, unless near fault effects are determined to be important per the Mandatory Standards.

2.6.2.5 Design Requirements for Buildings

In the WSDOT *Geotechnical Design Manual* 17-5.2 Design Requirements for Buildings, the first sentence is replaced by: Foundations shall be designed in accordance with the provisions outlined in the 2018 International Building Code and the Municipal Codes of the Cities of Kirkland and Bothell.

2.6.2.6 Geotechnical Data

A *Geotechnical Baseline Report* (Appendix G), a *Geotechnical Data Report* (GDR) (Appendix G), and a Geotechnical Data Report Supplement (Appendix G) have been prepared for the Project. The soil conditions and groundwater levels provided in the GDR are known only at each specific exploration location at the time of the exploration. If long term groundwater monitoring was performed, the groundwater levels provided in the GDR are known only at each piezometer location and depth during the monitoring period indicated in the GDR.

WSDOT has gathered and assembled geotechnical Reference Documents that may be relevant to the Design-Builder's Work. This information is provided in Appendix G.

2.6.3 *Personnel Requirements*

2.6.3.1 Geotechnical Group Manager

The Design-Builder shall provide a GGM to manage and review all aspects of the geotechnical design and construction Work completed for the Project. The GGM shall ensure that all geotechnical Work for permanent Project elements is completed in accordance with the Request for Proposal (RFP) and that Work by others for temporary elements is coordinated and compatible with the permanent Work. The GGM shall coordinate the geotechnical Work activities with the Project Quality Manager to ensure that all geotechnical Work is completed in accordance with the Contract, RFC Documents, and the Quality Management Plan (QMP).

The GGM shall have a minimum of 10 years of supervisory experience in geotechnical design and construction. The GGM shall be a Professional Engineer.

2.6.3.2 Design Professionals – Civil Engineers, Engineering Geologists, Hydrogeologists, and Geologists

All Geotechnical Recommendations, design decisions, calculations, field design changes, plans, and specifications shall bear the seal of the design professional responsible for the Work in accordance with Section 1-02.3 of the *General Provisions*.

2.6.3.3 Peer Reviewer

The Peer Reviewer shall be selected by the Design-Builder. The Design-Builder shall provide a submittal for Review and Comment to the WSDOT Engineer demonstrating how the Peer Reviewer meets the required qualifications. The Peer Reviewer shall be a Professional Engineer and have a minimum of 15 years total of design and construction experience in the areas of:

- Structural and geotechnical seismic design
- Total and effective stress Site response analysis
- Dynamic soil testing, soil liquefaction, and lateral spreading
- Seismic ground motions
- Soil structure interaction
- All functions of the Peer Review and Peer Reviewer shall be included in the Contract Price

2.6.3.4 Geotechnical Field Personnel

Geotechnical field personnel working on behalf of the GGM, not including Geotechnical Special Inspectors (GSIs), shall have a minimum of 2 years of experience with the specific type of field Work they will be performing. The Design-Builder may use geotechnical field personnel that do not have 2 years of experience, provided that the Design-Builder trains the staff for the Work that they will perform, prior to the actual performance of the Work.

2.6.3.5 Instrumentation Personnel

The Design-Builder's personnel responsible for the installation, calibration, and monitoring of instrumentation such as inclinometers, piezometers, wells, settlement devices, standard penetration testing, and Becker hammer testing shall have a minimum of 2 years of experience with the specific type of instrumentation they will be operating.

2.6.3.6 Geotechnical Special Inspector

The Design-Builder shall provide GSIs. A GSI shall have a minimum of 5 years of experience of geotechnical inspection experience or be the EOR for the Project element being inspected. GSIs shall report to the GGM. If the Design-Builder trains GSIs, the GGM shall review the training records and document that the trained staff are capable of performing Geotechnical Special Inspection. GSIs shall not be employed by, or be a member of, a Subcontractor, crew, or individuals performing the Work being inspected. GSIs shall report their findings to the Project Quality Manager, the GGM, and EOR.

2.6.3.7 Non-Destructive Shaft Testing Personnel

Personnel providing non-destructive shaft testing and reporting services shall be a Professional Engineer and have a minimum of 2 years of experience in testing and interpretation of the method utilized and shall have performed similar tests on a minimum of three deep foundation projects in the last 2 years.

2.6.3.8 Engineer of Record

The Design-Builder shall provide one or more EORs to perform or supervise performance of geotechnical design of the Work and ensure that construction is completed in accordance with the geotechnical design requirements. The EOR shall seal Geotechnical Recommendations, calculations, field design changes, plans, and specifications for the Work element they performed or supervised. The EOR shall be a Professional Engineer and have a minimum of 5 years of experience in geotechnical design and construction.

2.6.4 *Subsurface Investigation*

The Design-Builder shall review the available information in the GDR and perform subsurface investigations to meet the requirements of applicable laws, permits, and the Contract.

2.6.4.1 Subsurface Investigation Plan

The Design-Builder shall prepare Subsurface Investigation Plan(s) (SIP). The SIP shall be submitted to the WSDOT Engineer for Review and Comment prior to beginning subsurface investigation Work including earthwork needed to provide access for

the exploration. Weekly progress reports are required whenever subsurface investigations are occurring.

The Design-Builder may supplement the SIP at any time, provided the supplements are submitted to the WSDOT Engineer for Review and Comment.

The Design-Builder shall determine the specific locations for explorations and scope of exploration in the SIP. The Design-Builder shall secure all rights of entry, permits, and environmental and archaeological clearances necessary to perform the Work consistent with Section 2.8, *Environmental*. All geotechnical activities will be subject to requirements for Vegetation Protection Plans in 2.15, *Roadside Restoration*.

All subsurface investigations shall be conducted in accordance with the WSDOT *Geotechnical Design Manual* and the exploration requirements identified in this Contract. Field tests shall be conducted in accordance with WSDOT, American Association of State Highway and Transportation Officials (AASHTO), and American Society for Testing and Materials (ASTM) testing procedures, in that hierarchal order.

Geotechnical instrumentation used for Site characterization purposes such as piezometers, pore pressure transducers, and slope inclinometers shall be included in the SIP, and do not need to be included in the Geotechnical Instrumentation Plan (GIP).

2.6.4.2 Subsurface Investigation Surveying

All geotechnical explorations, including, but not limited to, borings, resource protection wells, hand holes, test pits, and cone penetrometer locations, shall be surveyed. All geophysical lines shall be surveyed. The survey shall determine elevation and State Plane Coordinates to a minimum accuracy of 0.01 feet, which shall be included on the explorations; these include, but are not limited to, boring logs, Cone Penetration Test (CPT) logs, hand hole logs, test pit logs, and geophysical data.

2.6.4.3 Subsurface Investigation Samples

The Design-Builder shall retain, store, and protect all soil and rock samples from field explorations performed as part of the Work. These samples shall be retained until Completion, after which time, the Design-Builder shall dispose of the samples. If requested, the Design-Builder shall deliver samples to the WSDOT State Materials Laboratory at 1655 S. 2nd Avenue SW, Tumwater, before Completion and at no additional cost to WSDOT.

2.6.4.4 Subsurface Investigation and Well Decommissioning

Prior to Physical Completion, all geotechnical explorations shall be decommissioned, unless otherwise directed by the WSDOT Engineer. The Design-Builder shall decommission all geotechnical explorations and wells completed by the Design-Builder. WSDOT will decommission all geotechnical explorations and wells specifically indicated in the GDR or other Contract documents. For all WSDOT-installed wells that are not decommissioned prior to Notice to Proceed, the Design-Builder shall be responsible for contacting and coordinating with the WSDOT Engineer for decommissioning. The Design-Builder must provide a minimum of one month notice to WSDOT for decommissioning of WSDOT-installed wells.

The Design-Builder shall be responsible for decommissioning wells that are not decommissioned by WSDOT as follows:

1. For all undocumented wells where drilling reports are not available from the Washington State Department of Ecology. Decommissioning shall be performed in accordance with WAC 173-160-460(1).
2. For all documented wells where drilling reports are available from the Washington State Department of Ecology. Decommissioning shall be performed in accordance with WAC 173-160-460(2).

All decommissioning shall be completed in accordance with the Mandatory Standards and WAC 173-160-460. The Design-Builder shall provide the WSDOT Engineer with all Washington State Department of Ecology validated forms, including Notice of Intent, well logs, and decommissioning logs, for the construction and decommissioning of new wells and wells decommissioned in the course of their Work. The Notice of Intent shall be submitted to the WSDOT Engineer within 30 Calendar Days of well construction, and the remainder of the documentation referenced above shall be provided within 30 Calendar Days of decommissioning the well.

2.6.4.5 Subsurface Investigation Field Notes, Daily Drill Reports, and Final Exploration Logs

The Design-Builder shall prepare field exploration notes, inspector daily drill reports, and exploration logs in accordance with the WSDOT *Geotechnical Design Manual* for all field explorations. Final exploration logs, with a plan showing their locations relative to the Work, shall be included with all Final Design and RFC Submittal calculation packages and Geotechnical Recommendations prepared by the Design-Builder. Draft exploration logs shall be marked as draft and may be included with Preliminary Design Submittals.

Notice of Intent (NOI) and well tag identification numbers shall be provided on draft and final exploration logs as applicable, including, but not limited to, borings, piezometers, inclinometer, and seismic test hole logs.

2.6.5 *Geotechnical Analysis and Documentation*

2.6.5.1 Field and Laboratory Testing Requirements

Field and laboratory tests shall be conducted in accordance with the WSDOT *Geotechnical Design Manual*.

Laboratories conducting geotechnical testing shall be either AASHTO accredited for the testing being performed, or fulfill the requirements of AASHTO R18 for qualifying testers and calibrating/verifying of testing equipment for those tests being performed. All final laboratory test result sheets shall be included in the Design-Builder's calculations and the Final Geotechnical Documentation Package.

2.6.5.2 Geotechnical Analysis

Geotechnical engineering and analyses shall be based on the findings from subsurface field investigation explorations and laboratory tests performed by the Design-Builder and information contained in the GDR. All geotechnical calculations using spreadsheets or math software shall be checked with hand calculations to verify logic, look-ups, formulae, and calculations and shall be summarized in a calculation verification package. The spreadsheet files and hand calculations shall be included in the submitted design

calculation packages. Off-the-shelf, commercially available, geotechnical software will not require a hand calculation validation.

2.6.5.3 Geotechnical Recommendations

Prior to the preparation of any Geotechnical Recommendations or design decisions, the Design-Builder shall provide an outline or numbering system for the Geotechnical Recommendations, design decisions, and their supporting calculation packages so that the Geotechnical Recommendations and design decisions can be easily cross referenced to the supporting calculation packages and incorporated into the Final Geotechnical Documentation Package.

The Design-Builder shall provide a Final Geotechnical Documentation Package including all RFC Geotechnical Recommendations, design decisions, and their supporting calculation packages in accordance with this Section.

2.6.6 *Design Criteria*

2.6.6.1 Seismic Design

Where the WSDOT *Geotechnical Design Manual* identifies structures as Normal, Essential, or Critical they shall be treated as Ordinary, Recovery, or Critical (respectively), in accordance with the classifications in the WSDOT *Bridge Design Manual*.

For structures identified as Recovery or Critical in the Contract, the Geotechnical Engineer shall perform the geotechnical design necessary to support the appropriate seismic hazard level as defined in the WSDOT *Bridge Design Manual* and Section 2.13, *Bridges and Structures*. The requirements above apply to structures that are or that support Recovery or Critical structures, including but not limited to bridges, bridge approach slabs, bridge elements, retaining walls, and noise walls.

Walls supporting Recovery level bridges and bridge structure elements, including approach slabs, shall remain at full service level as defined by the WSDOT *Bridge Design Manual* and meet the serviceability requirements in Chapter 15-4.7 of the WSDOT *Geotechnical Design Manual* under the Functional Evaluation Earthquake (FEE) event.

Retaining walls supporting structures, including bridge approach slabs, shall be designed for liquefaction conditions regardless of the individual wall heights. If retaining walls are designed using reduced seismic k_h, any features, utilities, or structures supported by the wall, including, but not limited to, bridges, bridge approach slabs, retaining walls, and noise walls, must be able to tolerate the displacement assumed to reduce k_h.

A Peer Review shall be performed if the Design-Builder implements any of the following design procedures in the geotechnical seismic design:

- Site-specific hazard analysis
- Total and effective stress site specific response analysis
- Selection of seismic ground motions used for site specific response
- Effective stress analysis to determine the number of cycles or elapsed time for the onset of liquefaction
- Dynamic soil structure interaction modeling for geotechnical seismic design

- Effective stress analysis to determine the number of cycles to liquefaction initiation
- Any other proposed analysis methods that are not addressed in the Mandatory Standards or in the Contract

The Peer Reviewer shall at a minimum review the following aspects of the seismic design and analysis:

- Geotechnical data collected and reasonableness of the assumptions made by the Design-Builder to develop the geologic and geotechnical models used in the analyses.
- Soil and structure input parameters used by the Design-Builder in the ground response and soil-structure interaction response analyses.
- Computer software used by the Design-Builder for ground response and soil-structure interaction with respect to the ability of the software and constitutive models to incorporate non-linear soil effects, pre- and post-liquefaction stress-strain-strength relations, non-linear structure effects, and modeling methodology.
- Interpreted results and conclusions used by the Design-Builder for design.
- Appropriate combination of seismic inertial loading, kinematic inertial effects, and liquefied/reduced soil strength.

The Design-Builder shall transmit the following information to WSDOT as they are developed for all Peer Reviews:

- Documents sent to the Peer Reviewer for a Peer Review
- The Peer Reviewer's comments
- Comment responses and resolution of the Peer Reviewer's comments
- Geotechnical Recommendations, letter, or memorandum carrying the Peer Reviewer's Professional Engineer's stamp and signature stating the Peer Reviewer's comments have been resolved. The Geotechnical Recommendations, letter, or memorandum shall also list the documents, including the document date, reviewed by the Peer Reviewer

The Design-Builder shall be responsible for addressing all comments made by the Peer Reviewer. The WSDOT Engineer shall be invited to attend all meetings between the Design-Builder and the Peer Reviewer. The Peer Review comments shall be resolved prior to the Geotechnical Recommendations, geotechnical report(s), and technical memorandum(s) being RFC. The Geotechnical Recommendations, letter, or memorandum from the Peer Reviewer shall be included as an appendix in all the RFC Geotechnical Recommendations that were subject to the Peer Review. Any added costs or schedule impacts resulting from addressing Peer Reviewer comments shall be borne by the Design-Builder.

2.6.6.2 Foundation Design

The Design-Builder shall meet the structure foundation design and performance requirements described in Section 2.13, *Bridges and Structures*.

2.6.6.3 Retaining Wall and Noise Wall Design

The Design-Builder shall be responsible for design of walls in accordance with the WSDOT *Geotechnical Design Manual*. The Design-Builder will not be responsible for internal design or structural design of Standard Plan walls.

All Standard Plan retaining walls are designed for specific design parameters, including soil strengths, ground conditions, surcharges, and geometry. The parameters used are defined by the Standard Plans, WSDOT *Geotechnical Design Manual*, WSDOT *Bridge Design Manual*, and this Section.

If parameters and requirements for Standard Plan walls cannot be fully met, The Design-Builder shall modify the Standard Plan retaining walls to meet Project requirements by providing special design analysis consistent with Section 2.13, *Bridges and Structures*.

Standard Plan retaining and noise walls have not been designed for liquefaction or liquefaction effects. If liquefiable soils are present, the Design-Builder shall not use Standard Plan retaining or noise walls unless the liquefaction is mitigated.

Policies and requirements regarding liquefaction for retaining walls are contained in the WSDOT *Geotechnical Design Manual*. Liquefaction policies for noise walls are not specifically addressed in detail within the WSDOT *Geotechnical Design Manual* or WSDOT *Bridge Design Manual*. The Design-Builder shall mitigate for liquefaction if liquefiable soils are present at a noise wall.

Noise walls contained in the Standard Plans, with two exceptions, were designed following the 2007 edition of the *AASHTO Standard Specifications for Highway Bridges* using 475-year event earthquakes with maximum peak seismic ground acceleration coefficient (A_s) equal to 0.35g. Current seismic design standards in the *AASHTO Mandatory Standards* for 975-year events will likely result in ground acceleration coefficients that exceed the value used for the Standard Plans. Standard Plan noise walls shall not be used if the Project peak seismic ground acceleration coefficient (A_s) exceeds the value in the Standard Plans.

Noise wall D-2.36 (Type 11) and D-2.46 (Type 14) were designed following the *AASHTO LRFD Bridge Design Specifications,* 6th Edition, 2012 and interims through 2013. Accordingly, the seismic design accelerations used in the design for the Type 11 and Type 14 noise wall are based on 975-year events.

All specially designed noise walls and retaining walls, including proprietary walls, nonstandard walls, and temporary walls, shall meet the requirements in the *AASHTO LRFD Bridge Design Specifications* including the provisions of the current *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, the WSDOT *Geotechnical Design Manual*, and the WSDOT *Bridge Design Manual*.

To ensure that existing WSDOT bridges supported on spread footings are protected from damage during construction of proposed retaining walls located beneath the existing bridge and adjacent to the spread footings supporting that bridge, the Design-Builder shall meet the following additional requirements:

1. All walls and shoring shall provide positive support through the utilization of tensioned elements.
2. Design and construction shall limit expected displacements of the existing piers to less than those identified in Section 2.13, *Bridges and Structures*.

2.6.6.3.1 *Seismic Design Requirements for Existing Retaining Walls*

- The existing MSE Wall, Wall 2185L-A at the Juanita Creek Culvert will require full or partial replacement to install the fish passage structure. Within a minimum lateral distance of 100 feet from the outer edges of this culvert structure, any remaining parts of existing wall 2185L-A shall meet all design requirements of this Contract, including seismic design.
- The existing MSE Wall at the Queensborough Creek crossing under SR 527 will require partial or full replacement to install the fish passage structure. Within a lateral distance of 50 feet from the outer edges of this culvert structure, all remaining parts of the existing MSE wall shall meet all design requirements of this Contract, including seismic design.

2.6.6.3.2 *Structural Earth Retaining Walls*

If the Design-Builder selects Structural Earth (SE) walls, they shall be pre-approved proprietary walls in conformance with the WSDOT *Geotechnical Design Manual*. If pre-approved proprietary walls as detailed in Chapter 15 and the Chapter 15 appendices of the WSDOT *Geotechnical Design Manual* cannot be used, special designed SE walls may be used. Special designed proprietary SE walls of the same pre-approved systems do not require special approval from the WSDOT Engineer. However, if the Design-Builder wants to use wall systems other than those that have been pre-approved in the WSDOT *Geotechnical Design Manual*, the Designer-Builder shall request approval from the WSDOT Engineer. The Design-Builder shall obtain approval before using a non-pre-approved system.

SE wall manufacturer submittals shall be reviewed by the GGM for consistency with the Geotechnical Recommendations and design decisions for the wall.

2.6.6.3.3 *Nonstandard, Nonproprietary Walls and Temporary Walls*

The Design-Builder shall be responsible for all geotechnical and structural design of nonstandard, nonproprietary noise walls; nonstandard, nonproprietary retaining walls; and temporary walls including shoring and cofferdams.

2.6.6.4 Slope Design and Rock Cuts (Temporary and Permanent)

All temporary and permanent slopes, including reinforced slopes and rock cuts, shall be designed in accordance with the WSDOT *Geotechnical Design Manual*.

2.6.6.4.1 *Stream 25 1.5H:1V Stabilized Slope Requirements*

In addition to meeting other Contract requirements, the slope stabilization design and construction for the slope south of Stream 25 shall allow tree planting and forest regrowth similar to that in the adjacent North Creek Forest park area.

2.6.6.5 Foundation Design for Illumination, Intelligent Transportation System, Traffic Signal, Overhead Sign Structures, and Toll Gantries

All foundations for the following illumination, ITS, traffic signal, overhead sign structures, and Toll Gantries shall be designed in accordance with the WSDOT *Geotechnical Design Manual*:

- Light standards

- ITS Closed-Circuit Television (CCTV) standards
- Cantilever traffic signal standards (for both traffic signal and ITS applications)
- Strain poles for span wire traffic signal systems
- Overhead sign structures (cantilever and bridge type). These include support structures for ITS VMS and TRS
- Toll Gantries

The standard foundation designs provided in the Standard Plans may be used if the minimum applicable soil and slope conditions are present at the Site. If soil/rock or ground conditions are not suitable for Standard Plan foundations, or if nonstandard loadings are present at the Site, or other Technical Requirements result in a nonstandard foundation, a site-specific analysis and special foundation design shall be completed. Design of these foundation elements shall be performed in accordance with the WSDOT *Bridge Design Manual* and the *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

2.6.6.6 Ground Improvement

Ground improvement design shall include a monitoring and testing program to be implemented during construction to confirm the performance of the ground improvement or to verify that design parameters are achieved during construction. Differential settlement between areas of improvement and areas without improvement shall be monitored to confirm differential settlement tolerances are not exceeded.

2.6.6.7 Settlement

The Design-Builder shall evaluate and quantify primary and secondary settlement for all embankments, bridge approach embankments, Structures, and Utilities as part of the design process. The Design-Builder shall ensure that Structures, WSDOT-owned lines (stormwater pipes, ITS conduit, etc.), and Utilities are designed to tolerate the anticipated settlements and satisfy all settlement requirements and limits contained in the Mandatory Standards and the Contract.

The following settlement criteria shall be met over the 75-year design life of the Project:

- For bridge approach embankments, new embankments, and widening of existing embankments:
  - Post-construction total settlement including both primary and secondary settlement shall not exceed 2 inches.
  - Post-construction differential settlement, including both primary and secondary settlement, shall not exceed the ratio or angular distortion equivalent to 1 inch over a distance of 100 feet longitudinally.
  - Post-construction differential settlement including both primary and secondary settlement shall not exceed 1 inch measured between the centerline of the roadway embankment and the shoulder (outer edge) of the embankment at any given station location.
  - To meet ADA requirements for sidewalks, post-construction differential settlement cannot result in greater than a ½-inch discontinuity for sidewalks on bridge approach embankments, new embankments, or widened

embankments or for transitions of sidewalks from new work to existing conditions.

- For all new construction where transitions between different wall types, different fill material, rapid changes in soil stratigraphy and/or transitions from ground improvement to no ground improvement exist:
  - Post-construction differential settlement, including both primary and secondary settlement, shall not exceed the ratio or angular distortion equivalent to 1 inch over 20 feet measured either longitudinally along or transversely across the roadway embankment.

The limits required herein are to meet geotechnical design requirements. More stringent settlement limits may be necessary to meet performance requirements for other Project elements as required elsewhere in the Contract or as required by the Design-Builder.

2.6.6.8 Area between MP 23.10 and 23.59, Design and Construction Requirements

The requirements in this Section apply to all temporary and permanent Work between MP 23.10 and 23.59 within the outline of the area provided in the GBR.

2.6.6.8.1 *Area between MP 23.10 and 23.59 Stratigraphy and Soil Properties*

Soils include Glaciolacustrine deposits as defined by Section 5.13.3 of the GDM. The Design-Builder shall use the stratigraphy and soil properties in this Section for all temporary and permanent Work, including, but not limited to:

- Stability of slopes
- Lateral earth pressures
- Lateral earth pressures developed from slope movement
- Axial foundation capacity

All ground anchors, including, but not limited to, tiebacks and helical anchors

2.6.6.8.1.1 Required Soil Units and Properties

Between MP 23.10 and 23.59, in the upper 50 feet, for all soils with clay fraction* greater than 20%, the Design-Builder shall use the values in the table below for Glaciolacustrine deposits.

Between MP 23.10 and 23.59, below the upper 50 feet, for all soils with clay fraction* greater than 20%, the Design-Builder shall use the values in the table below for Glaciolacustrine deposits.

The Design-Builder shall use the soil properties below for all temporary and permanent Works, including both static and seismic scenarios.

			Long-Term, Drained Analysis		Short-Term, Pseudo-static Analysis	
Soil Unit Description	**Depth to Top of Layer (feet)**	**Depth to Bottom of Layer (feet)**	**Friction Angle (degrees)**	**Cohesion (psf)**	**Friction Angle (degrees)**	**Undrained Shear Strength Ratio**
Glaciolacustrine deposits	0	50	22	0	22	N/A
Glaciolacustrine deposits	50	Bottom of Analyses	30	0	N/A	1.1

* Clay fraction is defined as the percent of material, by dry weight, less than 0.002 mm in size based on AASHTO T11/T27.

2.6.6.8.2 *Area between MP 23.10 and 23.59 Limitations on Open Cuts*

Between MP 23.10 and 23.59, all temporary and permanent excavations by the Design-Builder shall limit open face cut areas to a maximum of 4 feet high by 30 feet wide, with at least 30 feet of continuously supported face or existing slope between sections of open face. Cuts shall not be open more than 24 hours.

2.6.6.8.3 *Area between MP 23.10 and 23.59 Limitations on Retaining Walls and Anchors*

Anchored walls shall be limited to post-tensioned ground anchors. Ground anchors that develop resistance passively, such as, but not limited to, soil nails, shall not be allowed.

Design of gravity walls, including MSE walls, shall assume friction angles of the Glaciolacustrine deposits stated in this Section.

Gravity grouting methods shall not be allowed for any ground anchors used within the area.

2.6.6.8.4 *Area between MP 23.10 and 23.59 Requirements for Anchor Testing*

Post-tensioned ground anchors installed during construction shall be tested following procedures in Section 15-5.2.3 of the WSDOT GDM and the Contract documents, including prescribed adjustments to the testing for anchors in clays. Prior to construction, the Contractor shall perform a minimum of three performance tests for tiebacks installed in the area and where the Glaciolacustrine deposits, as described in this Section, contribute partially or completely to the bonded zone. At a minimum there shall be three tests per ESU. Disturbed and undisturbed Glaciolacustrine deposits shall be considered as separate ESUs. The tests for each ESU shall be spaced so that variation and uncertainty are addressed.

The performance tests shall follow procedures in Section 15-5.2.3 of the WSDOT GDM, however the 60-minute hold shall be extended to a 72-hour hold. Deformation readings for the first hour of the hold shall conform to the WSDOT GDM. Following the first hour deformation readings shall be taken once every hour.

2.6.6.8.5 *Area between MP 23.10 and 23.59, Limitations on Existing Slope Drainage System*

The existing slope drainage system installed as part of the historical slope remediation shall be left intact during all temporary and permanent Works or shall be repaired or replaced to the most rigorous of the original design or Contract requirements.

2.6.7 *Construction Criteria*

2.6.7.1 Performance Criteria

Criteria for allowable settlement and horizontal deformation of the retaining wall structures and bridge foundations are provided in Section 2.13, *Bridge and Structures*, the WSDOT *Geotechnical Design Manual*, and the WSDOT *Bridge Design Manual*. If any ground settlement occurs that is in excess of allowable limits, the Design-Builder shall cease all activities in the immediate area until the situation is fully assessed by the Design-Builder. The Design-Builder shall immediately contact the WSDOT Engineer and inform them of the situation. Before the Design-Builder returns to work in the immediate area of ground settlement, the Design-Builder shall implement stabilization measures to ensure further settlement is minimized. The Design-Builder shall provide a submittal of the ground stabilization measures with supporting calculations to the WSDOT Engineer for Review and Comment. The submittal shall include an assessment of the impact of the settlement upon the structures and repair procedures.

2.6.7.2 Slope Stability and Protection

The Design-Builder shall be responsible for slope stability throughout the Project. If any landslides develop during construction, or if indicators of potential landslide activity appear, such as ground cracking, leaning trees, or slumping, as well as other descriptors included in the referenced documents and in Chapter 13 of the WSDOT *Geotechnical Design Manual*, the Design-Builder shall cease all activities in the immediate area within and around the unstable ground until the situation is fully assessed by the Design-Builder. Before the Design-Builder returns to work in the immediate area of unstable ground, the Design-Builder shall implement temporary slope stabilization measures directed by the EOR to ensure the safety of the public and the Design-Builder's personnel, and to limit damage to WSDOT facilities and adjacent properties. The Design-Builder shall immediately contact the WSDOT Engineer and inform them of the situation and the temporary stabilization measures the Design-Builder plans to implement. The design of the permanent slope stabilization shall be submitted to the WSDOT Engineer for Review and Comment. The Design-Builder shall resolve all comments prior to implementation of the permanent slope stabilization measures.

2.6.7.3 Pre-Construction and Post-Construction Surveys

Damage to structures and facilities may be caused by vibrations, embankment-induced settlement, dewatering-induced settlement, physical impact, and other construction-related activities. Before construction operations that may cause damage to sensitive structures or facilities commence, the Design-Builder shall identify locations of sensitive structures or facilities, (including those in this Section), zones of influence, instrumentation types, critical readings, and frequency of readings in a GIP. For buildings not owned by WSDOT, and other structures and facilities, including private residences, businesses, streets, and Utilities within the Project area, the Design-Builder shall conduct

a pre-construction survey. This survey shall include video or photographic documentation of structure conditions, pavement conditions, utility conditions, internal and external building walls, and foundations. The pre-construction survey reports and GIP shall be submitted to the WSDOT Engineer prior to Work beginning in an affected area.

The Design-Builder shall perform Type 1 and Type 2 post-construction surveys as noted below:

Type 1

- All Sensitive Structures in Section 2.13, *Bridges and Structures*,

Type 2

- South Fork Perry Creek Culvert under 228th St SE and the 228th St bridge
- Woodcrest Estates neighborhood structures and infrastructure. Woodcrest Estates encompasses the area near and adjacent to Woodcrest Drive NE, and includes 117th Ct. NE, 118th Ct. NE, and multiple unnamed paved lanes
- NE Woodinville Drive and all utilities within the roadway prism and extending 20 ft left and right of the paved roadway, in the area 400 feet east and west of the current I-405 mainline and ramps
- Existing retaining wall 2185L-A at the Juanita Creek Fish Passage Structure
- Existing MSE retaining wall at the Queensborough Creek at 527 Fish Passage Structure

Type 1 and Type 2 post-construction surveys are defined as follows:

Type 1

If damage is reported by a facility or Utility owner, the Design-Builder shall perform a post-construction survey for the affected facility.

Type 2

After Substantial Completion, the Design-Builder shall perform a post-construction survey for all facilities for which a pre-construction survey was performed.

Post-construction surveys shall employ the same survey procedures described above and shall identify all changes found in the condition of the facility. Post-construction surveys shall be documented in a post-construction survey report and submitted to the WSDOT Engineer.

2.6.7.4 Fills, Retaining Walls, and Reinforced Slopes

Embankment fills, bridge approach embankments, retaining walls, and reinforced soil slopes shall be monitored for settlement as required by this Section and Section 2.13, *Bridges and Structures*. All estimates of primary consolidation settlement made during the design phase shall be field verified with instrumentation. The settlement monitoring data shall be provided to the GGM, the EOR, and to the WSDOT Engineer for Review and Comment. The EOR shall review the settlement monitoring data and provide final approval prior to the placement of the final wearing course pavement located within the footprint and the zone of influence of the new fills, retaining walls, reinforced soil slopes, ground improvements, and lightweight fill transitions. The final approval shall be in the form of a memorandum sealed and stamped by the EOR.

2.6.7.5 Geotechnical Instrumentation Plan

The GIP is not intended to cover geotechnical instrumentation used for Site characterization work (subsurface investigation). A GIP shall be developed, used, and followed when geotechnical instrumentation is required to monitor structures, facilities, utilities, other Project elements, or when Quality Assurance (QA) monitoring is required. When the EOR requires instrumentation and monitoring of the Work for construction purposes, the instrumentation shall be included in the GIP by supplement.

The GIP and all supplements to the GIP shall be prepared and submitted to the WSDOT Engineer for Review and Comment before deploying geotechnical instrumentation. Survey points to monitor deformations shall be considered to be geotechnical instrumentation. At a minimum, the Design-Builder shall install geotechnical instrumentation to monitor the following:

- Sensitive structures and facilities as identified in this Section
- Temporary shoring
- Settlement and settlement rates of embankments and structures where settlements are predicted to be greater than 1 inch
- Differential settlement and settlement rates of transitions less than 20 feet in length between different wall types, different fill material, rapid changes in soil stratigraphy and/or transitions to and from areas of ground improvement
- Pore water pressures for staged embankment construction
- Groundwater and settlement, if dewatering systems are used.
- Ground and structure vibrations when impact or vibratory methods are used for the installation of ground improvement, shaft casings or driving piling.
- Vibration levels for freshly placed concrete in conformance with Section 6-02.3(6)D of the Standard Specifications

Instruments that are damaged or fail for any reason of nonperformance shall be replaced immediately. If the instrumentation cannot be replaced immediately, construction activities within the zone of influence that were monitored by the instrumentation shall cease until the instrumentation is replaced and fully operable. New instruments shall be correlated with the previously acceptable data from the replaced instruments to develop continuous plots of instrumentation data, but with an arrow and note indicating the date of replacement on each instrument plot and data table. Instrument serial numbers and calibrations shall be provided in the GIP. If serial numbers and calibrations are not available at the time of GIP preparation, they shall be added to the GIP prior to being implemented in the field.

2.6.7.5.1 *Alert Levels, Action Levels, and Corrective Action Plans*

The Design-Builder shall identify alert and action levels for the instrumentation readings unless WSDOT has included specific alert and action levels in the Contract.

- Alert levels represent the reading where increased scrutiny of the element is warranted and when the frequency of readings shall be increased.
- Action levels represent the reading where corrective actions shall be implemented by the Design-Builder or the level where Work shall stop.

- Corrective Action Plans are measures that can rapidly be implemented by the Design-Builder to decrease or stop detrimental stresses, strains, or vibrations.

Alert and action levels shall be identified in the GIP for each instrument. The analysis performed by the Design-Builder to determine the alert and action instrumentation reading levels shall take into account the allowable limits for all of the existing structures and Utilities in the vicinity of the proposed construction.

Corrective Action Plans shall be developed and included in the GIP. Corrective Action Plans shall identify the steps to be taken if instrument readings reach an action level. These steps at a minimum shall include the following:

- Identify where Work operations contributing to the action level shall be stopped
- Notify the EOR
- Revise the Work plan
- Provide a revised Work plan to the WSDOT Engineer for Review and Comment
- Require the Work that resulted in the critical instrument readings shall not resume until receiving the EOR approval of the revised Work plan
- Identify circumstances where corrective actions may require modification of design or construction procedures
- Require that if the revised Work plan does not reduce the value below the critical instrument readings, all related operations contributing to the critical instrument reading shall cease and the process of developing a revised Work plan shall be repeated

If the recorded data from geotechnical instrumentation meets or exceeds the alert or action levels identified, the Design-Builder shall notify the WSDOT Engineer in writing within 24 hours that an alert or action level has been measured by instrumentation. The Design-Builder shall notify the WSDOT Engineer in writing within 24 hours of implementing the Corrective Action Plan identified in the GIP.

2.6.7.5.2 *Geotechnical Monitoring of Sensitive Facilities and Structures*

WSDOT has identified the following facilities and structures as being sensitive to potential damage by the Work:

- Facilities:
  - South Fork Perry Creek Culvert under 228th St SE and the 228th St SE bridge.
  - Woodcrest Estates neighborhood structures and infrastructure. Woodcrest Estates encompasses the area near and adjacent to Woodcrest Drive NE, and includes 117th Ct. NE, 118th Ct. NE, and multiple unnamed paved lanes.
  - NE Woodinville Drive and all utilities within the roadway prism and extending 20 ft left and right of the paved roadway, in the area 400 feet east and west of the current I-405 mainline and ramps
- Structures:
  - All Sensitive Structures in Section 2.13, *Bridges and Structures*,
  - Existing retaining wall 2185L-A at the Juanita Creek Fish Passage Structure

- Existing MSE retaining wall at the Queensborough Creek at 527 Fish Passage Structure

The Design-Builder shall prepare a GIP to monitor the facilities and structures identified by WSDOT as being sensitive.

The Design-Builder shall also identify facilities and structures in addition to those identified by WSDOT that have the potential to be damaged by the Work and shall prepare a GIP to monitor those facilities and structures.

2.6.8 *Special Inspection*

2.6.8.1 General

The Design-Builder shall perform special inspections and provide documentation during construction of the geotechnical types of Work listed in this Section. Documentation, requirements, and the frequency of special inspections shall be in accordance with the requirements of this Section and the Mandatory Standards. Inspections shall be performed by a GSI unless otherwise noted herein. Special inspections performed by a QA Inspection Technician shall be under the direct supervision of the GSI. QA Inspection Technicians providing special inspection for geotechnical works shall meet the requirements of Section 2.28, *Quality Management Plan*. In addition, QA Inspection Technicians shall have a minimum of 2 years of geotechnical experience with the specific type of inspection they will be performing or shall be trained by the GGM or GSI to perform the necessary inspections.

As part of the inspection process described subsequently, the GSI or QA Inspection Technician shall confirm and document that the subsurface conditions used for the design in the RFC documents are met. If the subsurface conditions encountered are different, the Work shall be considered non-conforming Work and shall immediately be reported in accordance with the QMP to the CQAM, the DQAM, the GGM, WSDOT, and the EOR.

Inspection documentation prepared by a QA Inspection Technician shall be submitted to the GSI. The GSI shall review the inspection documentation and finalize it with the QA Inspection Technician within 1 Calendar Day. Inspection documentation shall be compliant with the inspection documentation requirements in Section 2.28, *Quality Management Plan*. All inspection documentation prepared by the GSI or QA Inspection Technician, shall be provided within 2 Calendar Days to the GGM, Project Quality Manager, the EOR, the Construction Quality Assurance Manager (CQAM), and the Design Quality Assurance Manager (DQAM). All non-conforming Work shall immediately be reported in accordance with the QMP to the CQAM, the DQAM, the GGM, WSDOT, and the EOR.

2.6.8.1.1 *Responsibilities*

The GSI shall review the RFC Documents and Design Documents, including pertinent Geotechnical Recommendations and design decisions prior to the Work activity beginning. The GSI shall attend pre-construction meetings for all Work requiring geotechnical special inspection. The GSI shall monitor construction, provide special inspection for compliance with the Mandatory Standards, the Geotechnical Special Inspection Plan (GSIP), RFC Documents, and for Project elements identified in this Section. The GSI shall provide the inspection and documentation duties described in this

Section and Section 2.28, *Quality Management Plan*, during the construction of geotechnical features and elements in accordance with the GSIP.

2.6.8.1.2 *Changing Geotechnical Special Inspectors*

Qualified GSIs may be changed at any time prior to Work beginning on a Project element, provided another qualified GSI is utilized. If a GSI must be changed during a Work activity that has already started, another qualified GSI shall assume the duties, provided the replacement GSI has already inspected similar Work. If there is no available qualified GSI meeting the requirement above, the Work for that element shall stop until a qualified GSI is available.

2.6.8.2 Elements Requiring Special Inspection

Temporary and permanent Project elements listed in this Section shall be inspected and documented at the frequencies noted below. Additional geotechnical special inspection may be required by the EOR and shall be referenced in the GSIP.

2.6.8.2.1 *Soil Bearing Verification – Periodic Inspection*

For structures, materials at the bearing elevation shall be inspected to ensure that the materials meet the design and construction requirements. The GSI shall document observations regarding soil type, moisture conditions, and groundwater conditions as encountered at the bearing elevation in the associated excavation.

2.6.8.2.2 *Deep Foundations, Casings, and Sheet Piles – Continuous Inspection*

For deep foundations such as drilled shafts, caissons, driven piles, micropiles, and soldier piles, the GSI or a QA Inspection Technician shall inspect the Work to ensure that acceptance criteria are achieved.

For driven elements, including casings installed by vibration, impact, twisting, rotation, or oscillation, the GSI or a QA Inspection Technician shall observe and document the installation including: the methods used, equipment and appurtenances used, and equipment operational parameters. The rate of advancement shall be noted at a minimum every half hour and the timing and duration of all stoppages shall be documented, including the reason for the stoppage.

For drilled elements or elements constructed with grabs, chisels, down-hole hammers, and other similar methods, the GSI or a QA Inspection Technician shall observe and document the installation, including: the methods used; materials and groundwater conditions encountered; equipment and appurtenances used; equipment operational parameters; methods used to control loss of ground, groundwater intrusion, heave, and caving; conditions of the bottom of a drilled shaft; and penetration and tip elevation. The rate of advancement shall be noted at a minimum every half hour and the timing and duration of all stoppages shall be documented, including the reason for the stoppage.

2.6.8.2.3 *Field Testing – Continuous Inspection*

The following field tests shall be performed under the direction of a GSI or a QA Inspection Technician:

- All verification, performance, and proof tests of soil nails (all types), ground anchors (all types), pin piles, and micropiles

- Testing for pile acceptance or drivability, including Pile Driving Analyzer (PDA), Pile Integrity Testing (PIT), pile load tests, and Statnamic tests
- Plate load tests

2.6.8.2.4 *Non-destructive Testing of Drilled Shafts – Periodic Inspection*

The Design-Builder shall perform either Crosshole Sonic Log (CSL) or Thermal Integrity Profiling (TIP) testing of all structural drilled shafts in accordance with the Standard Specifications. The Design-Builder shall submit the results and analysis of the non-destructive testing for each shaft tested to the EOR for review. The EOR will determine final acceptance of each shaft, based on the CSL or TIP test results and analysis for the tested shafts. The test results and analysis and determination of Final Acceptance by the EOR shall be provided to the WSDOT Engineer for Review and Comment within 3 Calendar Days after receiving the test results and analysis.

All repair of defects, including coring and schedule impacts shall be the sole responsibility of the Design-Builder and shall be included in the Proposal Price.

2.6.8.2.5 *Soldier Piles, Ground Anchors, Soil Nails, Micropiles – Continuous Inspection*

The GSI or a QA Inspection Technician shall observe, verify, and confirm that design assumptions in the RFC documents are met, and document the following:

- Locations of the Engineering Stratigraphic Units (ESUs) encountered during construction
- Groundwater conditions during drilling; the types of equipment used to drill
- The drilling methods used, methods to remove cuttings from the hole, spoil volumes, rates of advancement and daily production rates
- Hole stability during construction and the use of casings
- Cleanliness of the bottom of drill hole
- Types, lengths, and dimensions of steel section, bars, tendons, and permanent casings placed in drilled holes
- Volumes and locations of Control Density Fill (CDF), concrete, and grout placed
- Caving, heave, settlement, or ground loss during construction

2.6.8.2.6 *Grouting Operations – Continuous Inspection*

The GSI or a QA Inspection Technician shall verify and document compliance of grout types used, mix designs, and batching/mixing equipment; and monitor and record grout pressures and volumes. The report may be prepared by the GSI or a representative of QA. The GSI shall review the information on a daily basis and the document shall be certified as complete and accurate by the preparer.

2.6.8.2.7 *Ground Improvement – Continuous Inspection*

Ground improvement methods and performance requirements are Work-specific. Accordingly, identifying geotechnical special inspection requirements shall be the responsibility of the Design-Builder and referenced in the GSIP.

2.6.8.2.8 *Dewatering System Construction – Continuous Inspection*

Dewatering systems, methods, and performance requirements are Work-specific. Accordingly, the GSI or a QA Inspection Technician shall observe, verify, and confirm that design assumptions in the RFC documents are met and document the following:

- Locations of ESUs encountered during construction of dewatering systems
- Groundwater conditions observed during system construction, and at the completion of construction for system components
- Drilling methods used, methods to remove cuttings from drill holes, spoil volumes, rates of advancement and daily production rates
- Hole stability during construction and the use of casings and screens
- Types, lengths, and dimensions of system components installed
- Volumes and locations of the various materials placed in wells, well points, and other system components
- Details of well development
- Water quantity and quality information
- Quantities and types of CDF, concrete, grout, sand, and bentonite placed
- Note all instrumentation installed and the appropriate calibration factors for the equipment, if applicable
- Caving, heave, settlement, or ground loss during construction
- Impact to adjacent structures

Additional geotechnical specific inspection requirements shall be the responsibility of the Design-Builder and referenced in the GSIP.

2.6.8.2.9 *Dewatering System Operation and Maintenance – Periodic Inspection*

The GSI or a QA Inspection Technician shall verify and document that regular maintenance is occurring and shall record observations of pumping rates and discharge quantities. If groundwater monitoring is being performed, the GSI shall ensure the instrumentation is being monitored and reported as required; and monitor instrumentation, if required.

2.6.8.2.10 *Trenchless Technology (including directional drilling, micro-tunneling, ramming, jacking) – Continuous Inspection*

Trenchless technology methods and performance requirements are Work-specific. Accordingly, the GSI shall observe, verify, and confirm that design assumptions in the RFC documents are met, and document the following for trenchless technology methods greater than 12 inches in diameter:

- Locations of ESUs encountered during construction
- Groundwater conditions during construction; the types, methods, and operational parameters of the equipment used for construction
- Submit a specific drill path design and supporting calculations, including measures to prevent inadvertent drilling fluid returns (i.e., frac-outs).

- Drilling methods used, methods to remove cuttings from the hole, spoil volumes, rates of advancement and daily production rates
- Hole stability during construction and the use of casings, grouts, lubricants, and fillers
- Types, lengths, and dimensions of system components installed
- Quantities and types of CDF, concrete, grout, sand, and bentonite placed
- All instrumentation installed
- Appropriate calibration factors for the equipment, if applicable
- Caving, heave, or ground loss during construction
- All deviations from planned alignment, grade, and orientation

Additional geotechnical specific inspection requirements shall be the responsibility of the Design-Builder and referenced in the GSIP.

2.6.8.2.11 *Rock Slope Cuts – Periodic Special Inspection*

The Design-Builder shall provide inspection and documentation of field conditions during the construction of cuts in rock. Periodic special inspection for this item shall be performed on a daily basis during cut construction. This documentation shall include the following:

- Progress of cut construction at the time of observation
- Description and condition of soil and rock materials exposed in the cut including the orientation and condition of any observed discontinuities
- Presence of and volume of seepage in the exposed cut
- Any areas of instability or potential instability
- Geotechnical Recommendations for installation of supplemental drainage
- Geotechnical Recommendations for supplemental slope stabilization measures

All special inspection and related design services for this item shall be performed by an Engineering Geologist Professional Engineer with experience in the design and construction of rock cuts. The licensed professional performing this inspection may be required to generate supplemental designs for drainage, slope stabilization, or slope reinforcement as part of the Work. All designs shall be completed in accordance with the requirements of the Contract.

2.6.8.2.12 *Soil Slope Cuts – Periodic Inspection*

The Design-Builder shall provide inspection and documentation of field conditions for temporary and permanent slopes cut into soil. Periodic inspection for this item shall be performed daily during cut construction including, but not limited to, documentation of the following:

- Progress of cut construction at the time of observation
- Description and condition of soil materials exposed on, around, and above slopes, including all slumps, ground cracks, ground deformation, signs of structure or feature distress or cracking, and movement
- Presence of and volume of seepage on or above the slope
- Areas of instability or potential instability

- Geotechnical Recommendations for installation of supplemental drainage
- Geotechnical Recommendations for supplemental slope stabilization measures

All inspection and related design services for this item shall be performed by an Engineering Geologist registered in the State of Washington or a Professional Engineer with experience in the design and construction of soil cuts. The licensed professional performing this inspection may be required to generate supplemental designs for drainage, slope stabilization, or slope reinforcement as part of the Work. All designs shall be completed in accordance with the requirements of the Contract.

2.6.9 *Submittals*

2.6.9.1 General

All submittals, including those pertaining to changes during construction, shall be submitted to the WSDOT Engineer for Review and Comment in accordance with the requirements of Section 2.12, *Project Documentation* and Section 2.28, *Quality Management Plan*.

Project geotechnical submittals, at a minimum, include the following:

- Subsurface Investigation Plan (SIP)
- Geotechnical Instrumentation Plan (GIP)
- Geotechnical Special Inspection Plan (GSIP)
- Soil and Rock Properties for design
- Pre-construction and post-construction survey reports
- Peer Reviewer qualifications
- Calculation verification packages
- Technical memoranda and supporting calculations
- Geotechnical report(s) and supporting calculations
- Ground stabilization measures and supporting calculations.
- Design and supporting calculations for temporary works, including shoring, cofferdams, slopes, retaining walls, work access, and work platforms
- All Geotechnical Recommendations, technical reports, memoranda, calculations, and communications issued between the Design-Builder and the Peer Reviewer
- Non-destructive test reports and determination of final acceptance by the EOR
- Final Geotechnical Documentation Package

2.6.9.2 Geotechnical Design Submittals

Project submittals shall include, at a minimum, the required submittals in this Section.

2.6.9.2.1 *Preliminary Design Submittal*

The Design-Builder shall submit to WSDOT for Review and Comment preliminary documents and calculations in accordance with the WSDOT *Geotechnical Design Manual* and this Section.

2.6.9.2.2 *Final Design Submittal*

The Design-Builder shall submit to WSDOT for Review and Comment final design documents and calculations in accordance with the WSDOT *Geotechnical Design Manual* and this Section.

2.6.9.2.3 *Released for Construction Document Submittal*

The Design-Builder shall submit RFC Documents to WSDOT for all Work including reports and memoranda, design calculations, and supporting documents, along with verification that all written review comments for the Preliminary and Final Design Submittals have been resolved. The RFC Documents shall include the stamp and signature of the EOR in accordance with WAC 196-23-020.

2.6.9.3 Subsurface Investigation Plan

The Design-Builder shall develop a SIP. The SIP, at a minimum, shall include the following:

- A narrative of the reasons for the exploration and goals to be achieved
- A narrative of how proposed explorations meet WSDOT *Geotechnical Design Manual* requirements and all requirements in these Technical Requirements.
- A map or aerial photo with the proposed exploration type, location, and depth shown
- Identification of in-situ field tests to be performed and their frequency
- Identify type and depth interval of sampling.
- Identify type and frequency of field and laboratory tests.
- Instrumentation to be installed in explorations, installation procedures, and monitoring schedule
- Weekly progress reporting procedures and forms that will be provided to WSDOT regarding: the identification of explorations started, the identification of explorations completed, depths footage drilled for each exploration, all Washington State Department of Ecology validated forms, including Notice of Intent, well logs, and decommissioning logs, for the construction and decommissioning of new wells and wells decommissioned in the course of their Work. Weekly reports are to be provided to WSDOT 3 Calendar Days after completion of the work week.
- Temporary Traffic Control Plan in accordance with Section 2.22, *Maintenance of Traffic*
- Site access plans and right of entry permits
- Environmental considerations (spoil containment and removal) and Best Management Practices Plan, Vegetation Protection Plans
- A Schedule showing all investigation activities and their logical connection to associated design activities
- Utility locate information
- Emergency procedures and contacts

2.6.9.4 Geotechnical Instrumentation Plan

The Design-Builder shall develop a GIP to describe the instrumentation program. The GIP at a minimum shall:

- Establish the tolerable levels of vibration, settlement, and deformation of sensitive structures and facilities as performance criteria, including alert and action levels.
- Identify zones of influence for each instrument. The zone of influence is the three-dimensional space (X, Y, and Z) to which the instrument's readings apply.
- Identify instrumentation make, model, serial number, and calibration documentation.
- Contain frequency and duration of readings for all instruments.
- Identify alert and action levels for all instruments.
- Include notification plans to inform WSDOT and sensitive structure and facility owners if alert or action levels are exceeded.
- Contain Corrective Action Plans.
- Identify critical instrument readings and threshold levels as well as maximum allowable levels for all instrumentation.
- Describe reporting requirements which, at a minimum, shall include the following:
    - Frequency of monitoring (for all instruments)
    - Personnel (with their qualifications) who will perform the monitoring
    - Frequency and schedule (elapsed time after measurement) of initial instrumentation data reporting
    - Format of the data in the initial instrumentation data report
    - Required review of the initial instrumentation data report by the GGM
    - Schedule and format of the GGM review of the initial instrumentation data report
    - Schedule and format of the final (and any interim) summary instrumentation data report(s)
    - Schedule and format of the GGM review of the final data (and any interim) summary instrumentation data report(s)
    - Vibration levels that, if exceeded, could be potentially damaging
    - Settlement levels that, if exceeded, could be potentially damaging

The instrumentation program shall provide a means of monitoring the field conditions and comparing those conditions to the performance criteria established in the GIP.

The GIP shall contain the requirement that all instruments shall be installed and operated in conformance to the manufacturer's requirements. The manufacturer's minimum calibration requirements for the instrumentation systems shall be maintained at all times during the monitoring program.

2.6.9.5 Soil and Rock Properties for Design

Prior to beginning geotechnical design for the Work, the Design-Builder shall submit the following items to the WSDOT Engineer for Review and Comment:

- The approach that will be used to determine the design soil and rock properties for the Project (e.g., property correlations, lab test results, back-analysis based on measured performance). Also identify how variability and uncertainty in the properties will be assessed and taken into account in the design.
- Soil property correlations that will be used to determine soil properties for design, if correlations are used.
- For a correlation not specifically cited in the WSDOT *Geotechnical Design Manual*, supporting documentation for the correlation that provides information on the development, applicability, and variation of the correlation.

At the beginning of geotechnical design for a Project-specific element or group of common elements, the Design-Builder shall define the ESUs to be used for design of those elements. The Design-Builder shall determine the properties for each ESU in accordance with the WSDOT *Geotechnical Design Manual* and the soil and rock properties for design submittal, and shall utilize an over-the-shoulder review process with WSDOT to discuss the properties that will be used in the design. The Design-Builder shall not modify or use different properties for Final Design without an over-the-shoulder review of the changes. During the course of the Project, the Design-Builder may obtain additional information through field exploration, laboratory testing, or back analysis, which could change the design properties for an ESU. Should this occur, the changes to the design properties for an ESU shall be carried forward in all calculation packages that postdate the change.

After the design is complete and RFC Documents prepared, the GGM shall review calculations for temporary works during the construction phase. If the GGM identifies soil or rock properties that are significantly different from those used in the RFC design, the GGM shall work with the Project Quality Manager to ensure that the temporary works will perform as intended and are compatible with the permanent Work.

2.6.9.6 Geotechnical Special Inspection Plan

The Design-Builder shall develop, implement, and maintain a documented GSIP intended to validate geotechnical design assumptions and requirements of the Work through inspection and documentation. The GSIP shall be included in the Design-Builder's QMP and shall include items requiring special inspection as detailed in this Section. The following shall be included in the GSIP:

- Qualifications and expertise of firms or corporations providing special inspection services, including the following items:
  - A listing of firms and how they meet the minimum requirements in this Section
  - List the type(s) of expertise of each firm
  - Provide an organization chart of the proposed team and include the respective roles that each firm will provide for the team.
- Qualifications and expertise of individuals providing special inspection services, including the following items:
  - Individuals providing special inspection services and show how they meet the minimum requirements in this Section
  - If licensed, provide the license information for the individual

- An itemized list of special inspection items or elements to be inspected while performing the Work to satisfy the requirements of this Section and Section 2.28, *Quality Management Plan*.
- Identify Hold Points in accordance with the requirements of this Section, Section 2.28, *Quality Management Plan*, and the RFC Plans.

2.6.9.7 Final Geotechnical Documentation Package

The Design-Builder shall prepare a Final Geotechnical Documentation Package that includes all final field notes, field testing, instrumentation data, laboratory results, Geotechnical Recommendations, and calculation packages. The Final Geotechnical Documentation Package shall be stamped and signed by a Professional Engineer.

The Final Geotechnical Documentation Package shall be provided with all supporting calculation packages cross referenced to individual sections so that it can be easily determined which calculation packages apply to which section(s) or design elements.

The Final Geotechnical Documentation Package shall be submitted for Review and Comment with the Final Design Documents in accordance with Section 2.12, *Project Documentation*. This package shall also be provided in electronic format (PDF), with bookmarks and hyperlinks from the table of contents to specific design reports.

2.6.9.8 Miscellaneous Submittals

This Section is intentionally omitted.

End of Section