2.13 Bridges and Structures

2.13.1 *General*

The Design-Builder shall perform all Work necessary to complete the bridges and structures for the Project to satisfy the Basic Configuration requirements.

Elements of Work shall include the following:

- Bridge Removals:
  - Bridge No. 405/70N-E (northbound I-405 to eastbound SR 522)
  - Bridge No. 405/70N-W (northbound I-405 to westbound SR 522)
  - Bridge No. 522/30E-N (eastbound SR 522 to northbound I-405)
- New Bridges:
  - Pedestrian bridge over I-405 at Brickyard BRT Station
  - I-405 direct access bridge at SR 522
  - Northbound I-405 over Sammamish River and SR 522
  - Northbound I-405 off ramp to SR 522
  - 17th Avenue SE direct access bridge over northbound I-405 at SR 527 BRT Station
  - Fish Passage structures as listed in Section 2.30, *Water Crossings*
- Bridge Replacements:
  - Bridge No. 405/104P (pedestrian bridge over northbound and southbound I-405 to SR 527 BRT Station)
- Bridge Modifications:
  - Bridge No. 522/28N (westbound SR 522 over North Creek) to add pedestrian pathway and incorporate requirements in Section 2.15, *Roadside Restoration,* and *Transit Facilities Architectural and Urban Design Criteria* (Appendix S)
  - Bridge No. 405/70E (northbound I-405 over Sammamish River/SR 522, due to removal of existing Bridge No. 522/30E-N)
- Bridge Widenings and Seismic Retrofits:
  - Bridge No. 405/103E (northbound I-405 over 228th Street SE)
- Bridge Seismic Retrofits:
  - Bridge No. 405/64 (NE 160th Street over I-405)
  - Bridge No. 405/73 (NE 195th Street over I-405)
  - Bridge No. 405/103W (southbound I-405 over 228th Street SE)
- Bridge Joint Rehabilitations:

- Bridge No. 405/70W and 405/70E (southbound and northbound I-405 over Sammamish River/SR 522)
- Bridge No. 405/70S-E (southbound I-405 to eastbound SR 522)
- Bridge No. 405/103W and 405/103E (southbound and northbound I-405 over 228th Street SE)
- Bridge No. 522/28N (westbound SR 522 over North Creek)

- Bridge Deck Repair and Sealing:
  - Bridge No. 405/70W and 405/70E (southbound and northbound I-405 over Sammamish River/SR 522)
  - Bridge No. 405/70S-E (southbound I-405 to eastbound SR 522)
- Bridge Deck Overlay Replacement:
  - Bridge No. 405/103W and 405/103E (southbound and northbound I-405 over 228th Street SE)
  - Bridge No. 405/72 (northbound and southbound I-405 over North Creek)
- Permanent and temporary retaining walls, moment slabs, buried structures, noise walls, traffic barriers, sign structures, toll structures, lighting structures, detention vaults, and stormwater vaults.

The plans showing the existing bridges and other structures are located in the *As Builts* (Appendix N). The plans are not guaranteed to be dimensionally accurate or complete. The Design-Builder shall field measure and verify existing dimensions as required for their Work.

2.13.1.1 Forward Compatibility

The Design Builder shall illustrate the Forward Compatible concept in design drawings in plan, section, and elevation. Design calculations shall include design and analysis of the Forward Compatible concept. Forward Compatible walls shall be designed for the current and Forward Compatible conditions and shall satisfy global stability for both conditions. Structure layouts shall dimension clear zones and locations of Forward Compatible elements.

All new bridge widenings, modifications, and retrofits shall be designed and constructed so they are Forward Compatible with the Forward Compatible Plans (Appendix M), except Bridge No. 405/104P (pedestrian access over northbound and southbound I-405 to the Canyon Park BRT Station) which shall be Forward Compatible with the Interim Forward Compatible Plans (Appendix M).

All new retaining walls and noise walls shall be designed and constructed so they are Forward Compatible with the Forward Compatible Plans, except the following:

- Wall 22.35R
- Wall 22.49L
- Wall 22.82L

- Wall 23.02L
- Wall 23.15L
- Wall 23.32L
- Wall 23.54R
- Wall 23.72R
- Wall 23.80R
- Wall 24.83R
- Wall 26.02R
- Wall 26.11R
- Wall 26.34R
- Wall 26.74L
- Wall L1

The following new retaining walls and noise walls shall be designed and constructed so they are Forward Compatible with the Interim Forward Compatible Plans:

- Noise wall NW6
- Noise wall NW7

Future construction of an additional lane on northbound I-405 will require excavation at the face of Wall 23.28R to a future ground line. Wall 23.28R shall be designed for the Forward Compatible condition without demolition as an element of the widening shown in the Forward Compatible Plans.

Stormwater treatment vaults shall be designed and constructed so they are Forward Compatible, except the following:

- Detention vault along southbound I-405, near MP 26.45

Fish passage structures shall be Forward Compatible as described in Section 2.30, *Water Crossings.*

The Design-Builder shall include in the design, structural concept and analysis demonstrating Forward Compatibility requirements.

2.13.2 *Mandatory Standards*

The following is a list of Mandatory Standards that shall be followed for all design and construction 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 *Bridge & Structures Office Design Memoranda* (Appendix B)
4. WSDOT *Bridge Design Manual LRFD* M 23-50 (Appendix D)

5. WSDOT *Geotechnical Design Manual* M 46-03 (Appendix D)
6. *Sound Transit Design Criteria Manual* (Appendix S)
7. *AASHTO Guide Specifications for LRFD Seismic Bridge Design*
8. *FHWA Seismic Retrofitting Manual for Highway Structures: Part 1 - Bridges*
9. *AASHTO LRFD Bridge Design Specifications*
10. *AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges*
11. *FHWA Evaluating Scour at Bridges, HEC-18*
12. *AASHTO Manual for Bridge Evaluation*
13. WSDOT *Design Manual* M 22-01 (Appendix D)
14. WSDOT *Plans Preparation Manual* M 22-31 (Appendix D)
15. WSDOT *Construction Manual* M 41-01 (Appendix D)
16. *AASHTO LRFD Bridge Construction Specifications*
17. *AASHTO Guide Design Specifications for Bridge Temporary Works*
18. WSDOT *Materials Manual* M 46-01 (Appendix D)
19. Standard Plans M 21-01 (Appendix D)
20. *Qualified Products List* (QPL)

    https://wsdot.wa.gov/engineering-standards/construction-materials/qualified-product-list-qpl
21. *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*
22. *AWS Structural Welding Code - Steel* (AWS D1.1/D1.1M)
23. *AWS Structural Welding Code - Reinforcing Steel* (AWS D1.4/D1.4M)
24. *AASHTO/AWS Bridge Welding Code* (AWS D1.5M/D1.5)
25. *American Concrete Institute Code Requirements for Environmental Engineering Concrete Structures* (ACI 350)
26. *AASHTO LRFD Road Tunnel Design and Construction Guide Specifications*
27. *International Building Code (IBC) with local amendments*
28. *AASHTO LRFD Guide Specifications for Accelerated Bridge Construction*
29. *AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members*
30. *ASCE Pre-Standard for LRFD of Pultruded FRP Structures*
31. *National Cooperative Highway Research Program (NCHRP) Guidelines and Recommended Standards for Geofoam Applications in Highway Embankments (NCHRP Report 529)*

32. *AREMA Manual for Railroad Grade Separation Projects*
33. *AREMA Manual for Railway Engineering*
34. City of Bothell Municipal Code Chapter 20.04, Building Regulations and International Codes

Design shall comply with the codes and standards of the jurisdiction in which the structure resides. The codes and standards of the Authority Having Jurisdiction (AHJ) shall govern design to the greatest extent required by law and good engineering practice. The Engineer of Record shall address any conflicts as part of a Basis of Design and submit to WSDOT for Review and Comment.

Combined building and bridge structures or building and roadside structures shall be analyzed for *AASHTO LRFD Bridge Design Specifications*, the Mandatory Standards, and the *International Building Code* and be designed for the most stringent forces, deformations, and requirements. Pedestrian bridges shall be governed by these Mandatory Standards and design requirements of the AHJ and be designed for the most stringent.

2.13.2.1 Bridge Design Manual Rights and Responsibilities

The WSDOT *Bridge Design Manual*, as modified by the WSDOT *Bridge & Structures Office Design Memoranda*, allocates responsibilities as follows:

- Rights and Responsibilities - The following clarifies which rights and responsibilities discussed in the WSDOT *Bridge Design Manual* are applicable to the Design-Builder:
  - The Design-Builder shall complete all analyses, evaluations, load ratings, Plans, and specifications discussed in the WSDOT *Bridge Design Manual*. All Chapters of the WSDOT *Bridge Design Manual* shall be followed as a part of the Mandatory Standard.
  - All analyses, evaluations, load ratings, Plans, and specifications are subject to Review and Comment by WSDOT.
  - All references to WSDOT Sections, offices, and engineers shall mean WSDOT.
- Where the WSDOT *Bridge Design Manual* or the WSDOT *Bridge & Structures Office Design Memoranda* requires approval, the Design-Builder shall be responsible for obtaining approval from the WSDOT Engineer prior to proceeding with the design.

2.13.3 *Personnel Requirements*

The Design-Builder shall provide a Structural Lead Engineer (SLE) to manage, coordinate, and review all aspects of the structural Work completed for the Project. The SLE shall provide written certification that the design and construction of all permanent and temporary Work is in conformance with the Contract requirements and the Quality Management Plan for each structural drawing, calculation package, temporary structure package, working drawings, and design revision during construction.

The SLE shall have a minimum of 10 years of experience in the design of bridges, retaining walls, shoring and temporary walls underpinning bridges, and other highway related structures. This individual shall be a Structural Engineer.

The Engineer of Record (EOR) for all structural engineering Design Documents for significant structures described in RCW 18.43.020(12) and for all bridges shall have a minimum of 10 years of experience in the design of bridges, retaining walls, and other highway related structures. The EOR shall be a Structural Engineer.

The EOR for all structural engineering Design Documents for all other structures in the Project shall be a Professional Engineer or Structural Engineer.

The Design-Builder shall designate a Structural Engineer, geotechnical engineer, and lead field engineer to design, manage, and review all aspects of Work for installation of walls and shoring under existing bridges and structures, such as Work under Bridge No. 405/103E. They shall have completed at least five similar wall and shoring projects under existing bridges, within the last 10 years. The Design-Builder shall submit documentation demonstrating minimum qualifications for Review and Comment.

2.13.4 *Design Criteria*

The Design-Builder shall analyze and design all new permanent bridges and structures, and all existing or modified structural elements whose structure or load-carrying capacities or demands are altered by the Work, using Load and Resistance Factor Design (LRFD) as defined in the WSDOT *Bridge Design Manual* and the *AASHTO LRFD Bridge Design Specifications*.

The Design-Builder shall design and construct permanent bridges and structures to achieve a minimum design life of 75 years.

Minimum clearances shall be as follows and shall be maintained at all times during and after construction:

- New vehicular structures over a roadway shall provide a minimum vertical clearance of 16′ - 6″.
- New bike/pedestrian structures crossing a roadway shall provide a minimum vertical clearance of 17′ - 6″. The vertical clearance from the top of the walkway to overhead obstructions shall be a minimum of 9′ - 0″.
- New structures over the railroad adjacent to Woodinville Drive shall provide a minimum vertical clearance of 23′ - 6″ measured to the top of the rail, maintained over a minimum horizontal distance of 20′- 0″ from the center of track. If the top of rail elevation is unknown at the time of construction, it shall be coordinated with King County and the WSDOT Engineer.
- New overwater structures shall provide minimum clearances that meet the following, except as modified for culverts in Section 2.30, *Water Crossings*:

  - 3 feet of freeboard above the 100-year Mean Recurrence Interval (MRI) water surface to the lowest point of the spanning member, unless otherwise stated.
  - 6 feet above the thalweg taken perpendicular to the stream bearing to the bottom of the spanning member, unless otherwise stated.
  - New structures over the Sammamish River shall provide a minimum navigational opening as required by the United States Coast Guard bridge permit (Appendix P).

- New deck overhang structures over a roadway shall provide a minimum vertical clearance of 17′ - 6″.
- New structures over Sammamish River Trail shall provide a minimum vertical clearance of 14′ - 0″ over the trail and associated buffers. A horizontal buffer of 10′ - 0″ shall be provided from each edge of the paved trail.
- New pedestrian bridge at Brickyard BRT Station shall have a minimum walkway width of 10′ -0″. Vertical clearance from top of walkway to overhead obstructions shall be a minimum of 9′ - 0″.
- Pedestrian bridge (Bridge No. 405/104P) shall have a minimum walkway width to match the existing (10′ - 7″ minimum per the As Built drawings). Vertical clearance from top of walkway to overhead obstructions shall be a minimum of 9′ - 0″.
- For modified existing structures, the minimum vertical clearance shall not be less than the existing clearance.
- The new northbound I-405 over Sammamish River/SR 522 bridge north abutment shall be located no further south than the existing bridge north abutments for bridges 405/70E and 405/7W.
- Slopes in front of new bridge abutments or in front of retaining walls supporting bridge abutments shall provide a minimum of 13 feet of overhead clearance from top of slope to bottom of superstructures, except for the north abutment of the new northbound I-405 over Sammamish River and SR 522, and north abutment of the I-405 direct access bridge at SR 522.
- When multiple minimum clearances are listed, the required minimum vertical clearance shall be the greater value.

Minimum foundation cover requirements for scour shall be in accordance with the WSDOT *Bridge Design Manual*. Existing structure foundations including spread footings, pile caps, shaft caps (or bottom of seal if used), and wall elements (including fascia panels, lagging, leveling pads, and footings) affected by the Work shall meet the minimum foundation cover requirements or be protected against scour to that level.

Unless required elsewhere in the RFP, fall protection shall be provided at the top of all new structures, buried structures, retaining walls, and retaining wall terraces in accordance with Section 1060 of the WSDOT Design Manual. Fall protection

shall be a standard guardrail system (galvanized steel with black powder coated or vinyl coating), as described and in accordance with the requirements in the WAC 296-880-40005 and Appendix L. Fall protection shall have a top and middle rail. Timber, extended wall parapet, and wire rope shall not be used as a material type for standard guardrail. The Standard Plan Chain Link Fence Types 3 and 4, and Glare Screen Types 1 and 2 are not acceptable fall protection systems. Design calculations and/or product data shall be provided for all components and connections, including off-the-shelf fence connections, demonstrating design requirements are met. For fall protection features that are exposed to the public, design of railings shall be in accordance with Chapter 13 of the *AASHTO LRFD Bridge Design Specifications.* All fall protection exposed to the public shall be a minimum 54 inches in height, measured from the top of finished roadway, sidewalk, or platform.

The Design-Builder shall design and install all subsurface transit facility and BRT Station elements including foundation elements, anchors, conduit, junction boxes, sign attachments, and drainage. The Work shall be coordinated with local transit authorities and meet the requirements in Section 2.27, *Transit*; Appendix S; and this Section.

- All station elements shall be clearly laid out, detailed, and dimensioned in the structure design submittals to be locatable and installed in the future.
- Rebar clear zones shall be provided where future post-installed anchors are required. Clear zones shall be clearly defined and dimensioned in the structure design submittals to be locatable in the future.
- Utilities shall be concealed within the structures and penetrations through the bridge deck and structure shall be fitted with waterstop, gasket, or similar to ensure no passage of water.
- Conduits and drain pipes shall be capped with removable mechanical pipe plugs. Plugs shall be ABS plastic fitted with neoprene or rubber gasket capable of withstanding 5 psi. Conduit and drainpipes shall be left long protruding at least 2-feet above finish surface.
- All subsurface transit facility and station elements shall be protected and concealed beneath secured plywood covers that are marked with high visibility orange paint. The transit facility and station areas containing protruding subsurface station elements shall be completely cordoned off to prevent access with 4-feet high temporary chain link construction fence. Fencing shall be situated to maintain a minimum 6-feet wide public access past the areas.

2.13.4.1 Bridge Design Criteria

The following permanent bridge superstructure types are permitted for this Project:

- Prestressed concrete I Girders
- Prestressed concrete wide flange I Girders

- Spliced prestressed concrete girders
- Prestressed concrete tub girders
- Prestressed concrete wide flange thin deck girders (subject to limitations stipulated in the WSDOT *Bridge Design Manual*)
- Steel-plate girders
- Steel-box girders
- Post-tensioned concrete box girders
- Prestressed concrete slab girders for pedestrian bridges only

The Design-Builder shall not use steel trusses, rolled steel beams, prestressed concrete deck bulb-tee girders, tri-beam sections, and double tee girders for permanent bridge structures. Masonry or timber shall not be used as materials for permanent bridge superstructures or substructures.

For vehicular bridges, a minimum of three girder lines, with the exception of two girder lines for tub girders, shall be used to provide redundant load paths. Intermediate hinges shall not be used with permanent bridge structures.

Non-redundant, fracture critical pier caps shall not be used.

2.13.4.1.1 *Bridge Seismic Design Criteria*

The seismic analyses and design for all new permanent bridge elements shall be in accordance with the *AASHTO Guide Specifications for LRFD Seismic Bridge Design*, as modified by the WSDOT *Bridge Design Manual*, and the code-based response spectra and coefficients applicable to this Project as defined in Section 2.6, *Geotechnical*, and the WSDOT *Geotechnical Design Manual*.

All new, widened, modified, and seismic retrofitted bridges carrying I-405 mainline and ramps to and from I-405 mainline shall have an operational classification of Recovery as defined in the WSDOT *Bridge Design Manual*. All other bridges shall have an operation classification of Ordinary. Where the WSDOT *Geotechnical Design Manual* identifies structures as Normal or Essential, they shall be treated as Ordinary or Recovery, respectively, in accordance with the classifications in the WSDOT *Bridge Design Manual*.

The seismic design of Recovery level bridges includes bridge approach slabs and walls or other structures supporting bridge elements. Following a Functional Evaluation Earthquake (FEE) event, seismic settlements of bridge elements, approach slabs and structures supporting bridge elements shall not exceed the post construction settlement limits in Section 2.6, *Geotechnical*.

2.13.4.1.1.1 Liquefaction and Lateral Spread

All new and widened bridges shall be designed for the effects of liquefaction and lateral spreading in accordance with the requirements of the WSDOT *Bridge Design Manual*, WSDOT *Geotechnical Design Manual*, and Section 2.6, *Geotechnical.* Where the structural design cannot accommodate effects from

liquefaction or lateral spreading or meet settlement requirements, the Design-Builder shall provide mitigation of liquefiable soils.

2.13.4.1.2 *Bridge Widening Design Criteria*

The Work on bridges to be widened shall be in accordance with the WSDOT *Bridge Design Manual* and shall include the following analysis and retrofit criteria:

- Determination of minor and major modifications and widening projects as defined in the WSDOT *Bridge Design Manual*.
- Determination of strength Capacity to Demand (C/D) ratios for the existing and modified structure and determination of displacement C/D ratios for the existing and modified structure (such as deck slab, girders, crossbeams, columns, and footings) using the pushover method of analysis. A summary table of C/D ratios for all elements shall be provided for each structure.
- Elements of the existing structure with C/D ratios made worse by the Work or less than 1.0 shall be retrofitted to restore their C/D ratios to the greater of preconstruction values or 1.0. The Design Builder shall submit analysis and calculations evaluating the C/D ratios for all structural elements during all stages of Work to WSDOT for Review and Comment.
- Analysis and quantification of the seismic demand effects due to differential settlement, and liquefaction/lateral spreading.
- Analysis for seismic demand effects shall be separate from settlement due to liquefaction.

For Bridge No. 405/103E, the Work shall include the following seismic retrofit measures at a minimum:

- Provide infill shear walls between each column.
- Provide steel column jackets on each column as required.
- Provide crossbeam strengthening with bolsters at the intermediate piers as required.
- Provide full width transverse girder stops between each girder at each girder support.
- Provide seat extensions at the intermediate piers and abutments as required to meet seat length requirements.
- Provide foundation strengthening below top of existing footings to resist seismic inertial demands. Existing shallow spread footings at the intermediate piers shall be made continuous to form a catenary or deep beam across the pier.
- Ground improvements for liquefaction mitigation of the existing structure can be deferred to the Bridge Seismic Retrofit Program.

For all other bridges to be widened, the Work shall include the following seismic retrofit measures at a minimum:

- Provide steel column jackets on each column or infill shear walls.
- Provide crossbeam strengthening with bolsters at the intermediate piers as required.
- Provide full width transverse girder stops between each girder at each girder support.
- Provide seat extensions at the intermediate piers and abutments as required to meet seat length requirements.
- Provide foundation strengthening below the top of existing footings for Recovery level bridges.

All new structural elements required to retrofit existing structures shall be designed for HL-93 live load.

Foundations for widening of Bridge 405/103E shall use drilled shafts. They shall be designed to impose no load or deformation on the South Fork Perry Creek culvert and be a minimum of 8 feet clear of the culvert.

Seismic improvements of Ordinary bridge foundation elements below the top of the existing footing can be deferred to the Bridge Seismic Retrofit Program.

Hold points shall be provided upon exposing bridge foundation elements below bottom of spread footing and pile or shaft caps, and before the start of any bridge seismic retrofit work.

2.13.4.1.3 *Load Rating Report*

All new bridges, widened bridges, modified bridges, rehabilitated bridges, seismic retrofit bridges, and detour bridges that carry vehicular loads and are 20 feet or more in span length (measured from back-to-back of pavement seats along the centerline of the roadway) shall be load rated in accordance with the WSDOT *Bridge Design Manual*. Detour bridges, for the purpose of load rating, are defined as bridges that will be in place for more than 90 Calendar Days. The Design-Builder will not be required to retrofit the existing structures for a reduction in the load rating due to existing bridge overlay replacements, removal and replacement of traffic barriers, or both. However, the Design-Builder shall be required to retrofit the existing structures where load rating factors fall below 1.0 as a result of all other Work.

2.13.4.1.4 *Precast Prestressed Concrete Girders*

Precast prestressed concrete girders include both pre-tensioned and post-tensioned girders.

The Design-Builder shall provide continuity reinforcement at intermediate piers in the bridge deck to resist negative moments due to live load and superimposed dead loads. Prestressed concrete girders shall be designed as simple span for all single span and multi-span bridges.

2.13.4.1.5 *Steel Plate Girders and Steel Box Girders*

The main longitudinal load-carrying girders shall be cambered during fabrication. Heat cambered rolled girders shall not be used except as secondary members or temporary girders. Steel superstructures shall have a cast-in-place reinforced concrete bridge deck designed to be composite for live loads.

Drip plates shall be provided on the bottom flanges on the exterior side of the exterior steel plate girders to direct water runoff away from bearings and bridge seats.

Structural steel shall be painted in accordance with Section 6-07 of the Standard Specifications.

2.13.4.1.6 *Bridge Foundations*

The Design-Builder shall construct bridge abutments, wingwalls, and curtain walls with precast or cast-in-place reinforced concrete. Where structural earth walls adjoin bridge abutments or curtain walls, the joint shall be a single vertical joint full height to the bottom of the traffic barrier. Curtain walls at bridge abutment wall corners shall be cast-in-place walls integral with the abutment walls and extending at least to the back of the footings. All girder seats at abutments and pier caps shall be sloped transverse to the abutment or pier cap to drain moisture accumulation.

The Design-Builder shall use wingwalls, curtain walls, and retaining walls as required by slope geometry and under-bridge clearances. These walls shall prevent soil slopes from spilling onto girders and bearings. End slopes shall meet stability requirements defined in Section 2.6, *Geotechnical* and the WSDOT *Geotechnical Design Manual* and shall be no steeper than 1.5H:1V.

2.13.4.1.7 *Bridge Decks and Expansion Joints*

The Design-Builder shall design and construct all vehicular bridge decks using cast-in-place reinforced concrete or stay-in-place concrete deck panels in accordance with Section 15.5.5 of the WSDOT *Bridge Design Manual*. The bridge deck protection system for vehicular bridges, including bridge widenings, shall be in accordance with Section 15.5.5.D of the WSDOT *Bridge Design Manual*. Widened bridges with original concrete decks that do not meet a Type 1 Protection System, shall have a Type 1 Protection System on the new deck and shall have a Type 2 Protection System with a 1.5-inch concrete overlay on the existing deck, in accordance with Section 5.7.4B of the WSDOT *Bridge Design Manual*. Bituminous or bituminous-with-membrane overlays for permanent bridge deck construction on new vehicular bridges shall not be used.

Bridge deck texturing shall be in the longitudinal direction, except for bridge widenings, where the bridge concrete texturing shall match the existing bridge deck concrete finish adjacent to the widening.

The bridge deck for widened structures shall be continuous between expansion joints and shall match the existing expansion joint locations. Expansion joint

headers shall be re-built the entire width of the new and existing bridge deck. Strip seals and compression seals and any associated armoring or anchorages shall be removed and replaced with new seals, in one continuous piece, for the entire width of the new and existing bridge deck.

The Design-Builder shall not use steel finger expansion joints on new bridges. All expansion joints shall be watertight. Longitudinal expansion joints shall not be used on new bridges or widened bridges. The maximum skew for expansion joints on new bridges shall be 30 degrees as measured perpendicular to the centerline of the bridge deck. Longitudinal joints in overlays on existing bridges needed for construction staging shall be placed along permanent lane lines.

In addition to Hold Points in Section 2.28, *Quality Management Plan*, a Hold Point shall be provided upon completion of existing header concrete removal and prior to placement of new header concrete for expansion joint replacement.

2.13.4.1.8 *Slope Protection*

Slope protection shall reduce or eliminate the need for maintenance; lessen or eliminate negative visual impacts associated with soil erosion, weed growth, trash accumulation, and vandalism; and conform to the requirements described in the WSDOT *Bridge Design Manual*; Section 2.15, *Roadside Restoration;* and Appendix L. At a minimum, the Design-Builder shall provide concrete slope protection on slopes beneath new and widened bridges in accordance with Section 2.8 of the WSDOT *Bridge Design Manual* and Standard Plan A-30.10-00. Concrete slope protection shall be placed the full width of the bridge.

2.13.4.1.9 *Bridge Barriers and Railings*

All new bridge and structure traffic barriers and railings shall be designed in accordance with the WSDOT *Bridge Design Manual*. The minimum Test Level design criteria shall be set as TL-4, except where pedestrian barrier is required shall be set as TL-3. Existing bridge barriers requiring modification shall be replaced by removing the existing barrier to the next joint.

Unless stated otherwise in the RFP, bridges with pedestrian or bicycle access shall have: 1) 32-inch high pedestrian barriers with pedestrian context sensitive solutions (CSS) railing adjacent to sidewalks, BRT Platforms, or raised rockscapes, or 2) 42-inch high single-slope barrier with pedestrian CSS railing elsewhere. Barriers and pedestrian railings shall also meet the requirements of Appendices L, and Section 2.15, *Roadside Restoration*.

Pedestrian CSS railing shall be designed in accordance with Appendices L, Sections 15.10.5 and 10.5.1 of the WSDOT *Bridge Design Manual*, and meet the strength and detailing requirements of Bridge Railing Type BP. The aesthetic requirements of Section 2.15, *Roadside Restoration*, shall not adversely affect the strength, extreme, and service limit states and safety requirements for traffic barriers and railings.

At a minimum, the following criteria shall also be met:

- New pedestrian bridge at Brickyard BRT Station shall have 32-inch height pedestrian barrier, curvilinear CSS railing with throw fence, and canopy structure, in accordance with Appendix L and Appendix S. The throw fence shall be 7.5 feet above walking surface.
- On Bridge No. 522/28N, the existing precast median barrier shall be replaced with new permanent 42-inch cast-in-place single slope barrier with rectilinear CSS railing.
- The existing metal pipe rail on the south side of Bridge No. 522/28N shall be removed and replaced with a rectilinear CSS railing. All existing anchors shall be removed to provide 1.5-inch clear cover and repaired in accordance with Section 6-01.16(2) of the Standard Specifications. Groups of closely spaced anchors shall be repaired as one continuous repair.
- New 42-inch height barrier shall be provided as a part of the required reconstruction of Bridge No. 405/70E, due to removal of Bridge No. 522/30E-N. The outside face barrier treatment shall be fractured fin to match the existing.
- New pedestrian bridge at the SR 527 BRT Station shall have 36-inch height pedestrian barrier, curvilinear CSS railing with throw fence, and canopy structure to match the existing bridge (405/104P), in accordance with Appendix L and the Transit Facilities Architectural and Urban Design Criteria (Appendix S). The throw fence shall be 7.5 feet minimum above walking surface.
- The SR 527 BRT Station shall have 32-inch height pedestrian barrier along the transit platforms and 42-inch height single sloped barrier elsewhere, in accordance Section 2.31, *Vertical Construction*. Temporary fall protection railing shall be installed to provide a minimum combined height of 42-inch. Pedestrian railing shall meet the requirements in this Section.
- The 17th Avenue SE direct access bridge over northbound I-405 at SR 527 BRT Station and approach shall have 42-inch single slope barrier with pedestrian CSS railings, in accordance with Appendix L and Appendix S.

Transitions between barrier types and height shall be provided in accordance with this Section and Appendix L. Transitions shall be gradual and provide a seamless appearance.

The Design-Builder shall not use precast concrete barriers for permanent applications on bridges or bridge approach slabs. Permanent barriers shall be reinforced concrete cast-in-place in the final position.

The Design-Builder shall cast a minimum of two spare 2-inch-diameter conduit pipes with junction box pairs (one for each conduit pipe) spaced at 180 feet maximum into all new concrete bridge barriers for the full length of the barrier, including barriers on bridge approach slabs and barriers on walls that abut

approach slabs or bridges. Each conduit pipe shall terminate at separate Type 1 junction boxes within 15 feet of the exit from a barrier. The Design-Builder shall furnish and install conduit expansion, deflection devices, or both at all expansion joints, points where the conduit exits from the barrier and any other location where movement is expected. Additional conduit shall be installed as needed to meet the Project utility requirements. Conduit installed but not utilized for this Project shall be considered spare for future utility needs.

2.13.4.1.10 *Bridge Canopies*

Bridge canopies shall meet the requirements in Section 2.31, *Vertical Construction,* and the Transit Facilities Architectural and Urban Design Criteria (Appendix S).

2.13.4.1.11 *Bridge-Mounted Utilities*

Utility installation requirements on new and existing structures shall be in accordance with Section 2.10, *Utilities and Relocation Agreements,* Appendix L, and Section 15.10 of the WSDOT *Bridge Design Manual*.

2.13.4.1.12 *Temporary Structures*

Temporary structures refer to any temporary bridge, detour bridge, portion of a bridge, or buried structure that will not remain upon Physical Completion of the Project. Temporary structures shall accommodate vehicular and pedestrian traffic and meet the following criteria:

The Design-Builder shall design temporary structures in accordance with the WSDOT *Bridge Design Manual*, WSDOT *Geotechnical Design Manual*, *AASHTO LRFD Bridge Design Specifications*, and *AASHTO Guide Specifications for LRFD Seismic Bridge Design*. Welding on any steel elements shall be in accordance with AWS D1.5. Components of temporary structures that will be incorporated into the permanent structures shall meet the requirements for the permanent structures. All temporary structures shall be designed for live load deflection less than or equal to L/800 as defined by *AASHTO LRFD Bridge Design Specifications*. Temporary structures with vehicular traffic shall be designed for minimum 75 percent of the HL-93 live load as defined in the *AASHTO LRFD Bridge Design Specifications*, except when there is no practical detour route available for freight, then 100 percent of the HL-93 live load shall be used.

The driving surface of the temporary detour structure shall be durable and skid resistant as defined in Section 10.13 of the WSDOT *Bridge Design Manual*. Temporary traffic barriers shall be in accordance with Section 1610 of the WSDOT *Design Manual* and the WSDOT *Bridge Design Manual*.

The Design-Builder may use new and salvaged structure members for the temporary structure, but it shall be the responsibility of the EOR to ensure all members meet all appropriate material properties for their intended function, such as dimensions, yield strength, tensile strength, ductility, toughness, chemical

composition, weldability, and corrosion resistance. Material testing of the structure members may be required in order to provide assurance that the appropriate requirements of material properties have been met. For salvaged steel materials where the grade of steel cannot be positively identified, the design stresses for the steel shall conform to Section 6-02.3(17)B3 of the Standard Specifications. Salvaged structure members include previously used members from other bridges or structures, members that have been fabricated but never installed in a structure, and members from a prefabricated structural system designed specifically for repeated temporary use. Concrete girder design sheets shall be provided indicating concrete strength, strand type and pattern, shear reinforcement, and other pertinent information. The Design-Builder shall provide supporting documentation for all selected temporary members to the WSDOT Engineer for Review and Comment.

All foundations of the temporary structures shall be located outside the horizontal limits of the Ordinary High Water for the Sammamish River, Par Creek, North Fork Perry Creek, North Creek, Stream 25.0L, Juanita Creek, Queensborough Creek under I-405, and Queensborough Creek under SR 527, and the bottom of foundations shall be located a minimum of 2 feet below scour estimated for the 2-year MRI water flows. Before Substantial Completion of the Project, the foundations for temporary structures shall be completely removed.

Design Plans and specifications for all temporary detour structures shall be reviewed and approved by the SLE. Prior to opening to traffic, all temporary detour structures shall be reviewed in the field for compliance with the Plans and specifications by the SLE, who shall advise WSDOT of any deviations. The Design-Builder shall be responsible for the maintenance and removal of all temporary structures. Temporary structures shall be removed in accordance with 2-02.3(2) of the Standard Specifications.

2.13.4.1.13 *Bridge Security*

Bridges shall be designed for security in accordance with the WSDOT *Bridge Design Manual* and shall employ both the natural surveillance and territorial reinforcement strategy and the hard armoring strategy.

Alcove spaces and ledges within abutment-superstructure interfaces shall be omitted or completely sealed off between girders above the abutment seat to the deck soffit with bridge security fencing in accordance with Section 15.2.11 of the WSDOT *Bridge Design Manual*.

Abutments supported by mechanically stabilized earth walls (commonly referred to as perched abutments) and bent-type abutments shall include concrete enclosing fascia walls that extend to the bottom of the superstructure and infill between girders from bottom of girder to deck soffit. The design shall minimize any gaps in the enclosing fascia, such as those needed to allow bridge movements. Bridge security fencing, meeting the requirements of Section 15.2.11 of the WSDOT *Bridge Design Manual*, may be used to infill between girders above the

concrete enclosures in lieu. Inspection access and ventilation shall be provided and meet the requirements of WSDOT *Bridge Design Manual* 7.5.1.A.4.

Concrete enclosing fascia and bridge security fencing shall be designed in accordance with AASHTO *LRFD Bridge Construction Specifications* and the loads specified in Article 13.8.2 of that standard. The retaining wall and concrete enclosing fascia shall incorporate the aesthetic treatments for abutment walls in accordance with the *I-405, Brickyard to SR 527 Project Urban Design Criteria* (Appendix L).

The new NB I-405 over Sammamish River and SR 522 bridge shall meet the bridge security requirements stated above in this Section and shall also have 8-foot tall bridge security chain-link fencing installed to deny access to the area beneath span(s) north of SR 522 to the northern abutment. The bridge security chain-link fencing shall seamlessly interface with the wire mesh with vines on low wall behind the BRT transit stations shown in the *Transit Facilities Architectural and Urban Design Criteria* (Appendix S) to deny access. Widened bridges with a clear height of 10-feet or less on any side (measured from the ground line at face of abutment to girder seat) shall have 8-foot tall bridge security chain-link fencing, which shall deny access to spaces between girders at the abutment and areas where the superstructure is less than 10-feet from finished grade. Bridge security chain-link fencing shall terminate at the abutment, beneath the bottom flange of the exterior girders, and shall not extend in front of the exterior girder webs and curtain or wing walls. Bridge security chain link fencing shall be 9-gauge, 0.5-inch mesh, black vinyl-coated chain link fence fabric and shall have a continuous top pipe rail. High-security locking gates shall be provided as required for maintenance and inspection. The fencing shall be designed for the loads specified in Article 13.8.2 of *AASHTO LRFD Bridge Design Specifications*.

2.13.4.1.14 *Bridge Seismic Retrofit Design Criteria*

Provided the bridges to be retrofit are not widened, the Work shall include seismic analysis and retrofit measures for the elements noted on the following bridges in accordance with Section 4.4 of the WSDOT *Bridge Design Manual*:

- Determination of strength C/D ratios for existing and modified structures and determination of displacement C/D ratios for all elements of the existing and modified structures (including crossbeams, columns, and footings) using the pushover method of analysis. A summary table of C/D ratios for all elements shall be provided for each bridge.

The Work on Bridge Nos. 405/64, 405/73, and 405/103W shall include the following seismic retrofit measures at a minimum:

- For Bridge No. 405/64, provide steel column jackets for the two southern columns at pier 2 (columns built prior to 1980).
- For Bridge No. 405/73, provide steel column jackets for the two center columns at Pier 2, 3, and 4 (columns built prior to 1980).

- For Bridge No. 405/103W, provide steel column jackets for the three western columns at Pier 2 and 3 (columns built prior to 1980).
- Provide crossbeam strengthening with bolsters at the intermediate piers as required.
- Provide full width transverse girder stops between each girder at each girder support.
- Provide seat extensions at the intermediate piers and abutments as required to meet seat length requirements.

All new structural elements for the seismic retrofit shall be designed for an HL-93 live load. Pedestals at the top of the footings shall be considered part of the columns for retrofit requirements and shall be retrofitted as required.

Seismic improvements of the existing foundation elements below the top of the existing footing can be deferred to the Bridge Seismic Retrofit Program.

Hold points shall be provided before placement of column jackets, bolsters or girder stops to assess conditions of the structure.

2.13.4.1.15 *Bridge No. 405/70E Modification Design Criteria*

Removal of Bridge No. 522/30E-N shall be considered a modification of the existing NB I-405 bridge (Bridge No. 405/70E). Analysis of the modified Bridge No. 405/70E shall meet the requirements of a bridge minor widening in accordance with the WSDOT *Bridge Design Manual*. The Design-Builder shall be responsible for determining the limits of removal of Bridge No. 522/30E-N, and elements of the existing structure with C/D ratios made worse by the Work or less than 1.0 shall be retrofitted to restore their C/D ratios to the greater of preconstruction values or 1.0. The Design-Builder shall submit analysis and calculations evaluating the C/D ratios for all structural elements of the existing and modified structure, and a summary table of C/D ratios for all elements shall be provided to WSDOT for Review and Comment.

At the location where the existing bridge superstructure will be removed as a part of the Work, the Design-Builder shall provide new concrete fascia to enclose all voids and enclose the end of the box girder along the full width of the bridge, and finish with a Class 2 surface finish and pigmented sealer to match existing. Concrete fascia shall be designed in accordance with AASHTO LRFD *Bridge Design Specifications* and the Mandatory Standards. Inspection access and lighting for any box girder cells to remain shall be provided and meet the requirements of WSDOT *Bridge Design Manual* 5.2.6.

New cast-in-place concrete barrier shall be installed on the bridge to close gaps left in the barrier from removal of Bridge No. 522/30E-N. New bridge drain inlets and downspouts shall be installed to eliminate any possible ponding that may occur as a result of the modification. Barrier scuppers and freefall of water to the ground below are not allowed.

Seismic retrofit of the existing structure below top of columns can be deferred to the Bridge Seismic Retrofit Program.

The modified bridge shall be load rated in accordance with this Section.

2.13.4.1.16 *Bridge No. 522/28N Modification Design Criteria*

Work on Bridge No. 522/28N shall incorporate aesthetic and landscape requirements of Section 2.15, *Roadside Restoration,* and Appendix L. Bridge analysis shall meet the requirements of a bridge widening in accordance with the WSDOT *Bridge Design Manual.* At a minimum, the Work shall include the following analysis and retrofit criteria.

- Determination of minor and major modifications and widening projects as defined in the WSDOT *Bridge Design Manual*. The Work may be considered a minor modification and widening provided the net mass increase is equal to or less than 10 percent of the original superstructure, and substructure and foundations are unchanged.
- Elements of the modified structure with strength and service limit states C/D ratios less than 1.0 shall be retrofitted to restore their C/D ratios to be greater than 1.0. Steel stresses at the applicable services limit states shall also be evaluated and control of cracking by distribution of reinforcement shall be met for a Class 2 exposure condition, in accordance with *AASHTO LRFD Bridge Design Specifications*. Where seismic evaluation is required, determination of displacement C/D ratios for all elements of the modified structures (including crossbeams, columns, and footings) shall be performed using the pushover method of analysis. A summary table of C/D ratios for all elements shall be provided for each structure.
- The Design Builder shall submit analysis and calculations evaluating the C/D ratios for all structural elements during all stages of Work, including, but not limited to, construction loading, and new hard-scaping placement to WSDOT for Review and Comment. Analysis shall evaluate the short- and long-term effects of added deadloads.

The landscaping, hardscaping, pedestrian path, bridge joints and waterproofing system components, shall be designed for HS-20 live load and pedestrian live load full width, barrier-to-barrier, in accordance with *AASHTO Guide Specification for Pedestrian Bridges*. Dynamic load allowance need not be considered for HS-20 live load.

All new structural elements required to retrofit existing structures shall be designed for HL-93 live load.

Seismic improvements of the existing foundation elements below the top of the existing footing can be deferred to the Bridge Seismic Retrofit Program.

The bridge shall be load rated in accordance with this Section.

A waterproofing assembly shall be provided in accordance with this Section.

Hold points as described in Section 2.28, *Quality Management Plan*, shall be provided before the start of any bridge seismic retrofit work.

2.13.4.1.17 *Bridge No 405/104P Design Criteria*

The existing portion of Bridge 405/104P structure may be left in place and incorporated into the replacement bridge structure provided that elements of the existing structure with C/D ratios made worse by the Work or less than 1.0 are retrofitted as required to restore their C/D ratios to the greater of preconstruction values or 1.0. Seismic analysis and design of the new and existing structure shall be in accordance with this Section.

The bridge shall maintain the same superstructure and substructure type as the existing portion and adhere to the requirements in Section 2.15, *Roadside Restoration*, and Appendix L. The overall appearance and geometrical dimensions shall be the same as those of the existing structure. Portions of unused structure shall be removed in accordance with the Standard Specifications.

2.13.4.1.18 *Bridge Drainage*

Where new bridge drain inlets, pipes, and downspouts are installed, they shall be placed to capture stormwater runoff on the bridge and shall meet the requirements in Section 2.14, *Stormwater*; Section 15.10 of the WSDOT *Bridge Design Manual*; and the following:

- Downspout parts shall be accessible for maintenance and cleaning.
- Drain pipes and drainage accessories shall not be installed within the bridge substructures elements, within box girder cells, within the box girder top flange or deck, or on the exterior (visible) sides of the bridge.
- Drain pipes and downspouts shall be located in accordance with Appendix L.
- Pipes and downspouts shall be ductile iron pipe.

All new drainage conveyance shall be supported in accordance with the requirements for utilities installed with new construction in Section 15.10 of the WSDOT *Bridge Design Manual*.

All new exposed drainage conveyance and associated supports attached to bridges shall be painted in accordance with Section 6-07 of the Standard Specifications and Appendix L.

Runoff shall be captured at each end of new and widened bridges. Approach drains shall be placed at each end of bridges to prevent stormwater from running onto the structure and where surface drainage is modified resulting in stormwater running onto the structure.

Refer to Section 2.31, *Vertical Construction,* for additional design criteria.

2.13.4.1.19 *Waterproofing Assembly for Bridge No. 522/28N*

The Design-Builder shall design, furnish and install a complete vertical and horizontal waterproofing assembly below all hardscaping and landscaping features on the existing Bridge No. 522/28N. The waterproofing assembly shall be continuous and extend full width barrier-to-barrier, over bridge joints, and

beyond each bridge approach slab, to provide a complete lateral conveyance system with positive drainage that discharges all subsurface flows off the bridge deck. The waterproofing assembly shall include, but not be limited to, surface conditioner, monolithic waterproofing membrane, prefabricated drainage mat, drainage course, filter fabric, separation layers and related cant strips, metal flashing and bridge expansion joint seals. The waterproofing membrane shall be a hot, fluid applied, self-healing, rubberized asphalt membrane. Base course and fill beneath hardscaping shall be closed-cell expanded polystyrene geofoam. Normal weight aggregate base course or soil shall not be used.

All waterproofing assembly components shall be obtained as a single-source from the membrane manufacturer to ensure total system compatibility, function, and integrity. Upon completion of the Work, the Design-Builder shall supply to the owner with a single-source 15-year total system warranty of United States origin direct from the manufacturer.

Penetrations through the waterproofing assembly shall not be allowed. However, foundations for illumination and sign poles may be attached directly to the existing bridge deck, and the waterproofing membrane and flashing/reinforcing shall extend up the sides of the element pursuant to the waterproofing manufacturer's recommendations and to ensure depth of subsurface water does not exceed the vertical height of the protection.

The prefabricated drainage mat and drainage course shall be sized to provide full lateral conveyance of all surface flows. The drainage mat and drainage course shall have sufficient compressive strength to support all overburden, including but not limited to hardscaping dead loads, pedestrian loads, HS-20 vehicular loads, and all other surface elements over the mat. Calculations and product documentation shall be provided for WSDOT Review and Comment.

Positive drainage shall be provided as flow transitions from the waterproof assembly to a conveyance system at the outside edges of all structures or retaining type elements. At these locations, the top of the conveyance system shall be located below the bottom of the prefabricated drainage mat. Clean-outs, accessible from the bridge deck, shall be provided at the inlet to each conveyance system. Backwater conditions resulting from this transition is prohibited.

The Design-Builder shall perform chain drag testing, ASTM D4580, Method B, across the entire bridge deck and approaches. Areas of spalling, delamination, unsound concrete, and rebar deterioration shall be documented in a Chain Drag Report (Appendix J) and submitted to WSDOT for Review and Comment at least 14 Calendar Days prior to installation of the waterproofing assembly. A Hold Point shall be provided prior to any further deck preparation and repair. The WSDOT Engineer shall approve the areas of the existing bridge deck requiring further deck preparation.

The Design-Builder shall include in their bid an area of further deck preparation equal to 25 percent of the area of the bridge deck. If WSDOT determines that the quantity of further deck preparation exceeds this area, additional compensation will be made in accordance with Section 1-04 of the *General Special Provisions*.

In addition to Hold Points in Section 2.28, *Quality Management Plan,* a Hold Point shall be provided upon completion of the repairs and prior to placement of the waterproofing assembly. A Hold Point shall be provided prior to placement of hardscaping elements on the bridge.

See Section 2.14, *Stormwater,* for additional conveyance requirements.

2.13.4.1.20 *Existing Bridge and Wall Demolition*

During all stages of demolition, existing structures (or portions of structures as applicable) shall remain stable and shall be removed in a controlled fashion that does not damage surrounding existing structures, roadways or utilities. The Design Builder shall submit structural stability analysis to support the selected demolition sequence.

Bridge and wall demolition plans and procedures, including falsework plans, shall be submitted to WSDOT for Review and Comment as Type 3E Working Drawings, and be prepared in accordance with the Standard Specifications and this Section.

Falsework and shoring used for demolition shall be designed in accordance with the requirements for falsework in the Standard Specifications.

2.13.4.1.21 *Barges, Flexi-Floats, and Crane Mats*

If barges, including flexi-floats, crane mats, and similar, are used to transport construction materials or demolitions debris, temporarily store and stockpile materials, or temporarily store or transport liquid or sediment removed during the Work, the work surface of the barge deck shall include containment to prevent any discharges into the Sammamish River. No rubblization, processing of material, or breaking down of any existing bridge or structural materials shall be allowed on vessel, barge, flexi-float, crane mats, or other Design Builder equipment used over existing waterways.

Barges shall not be allowed to ground-out during in-water construction. Barges and other floating equipment shall be operated so that there is a minimal suspension of sediments. Barges and walkways between barges shall be cleaned as necessary and kept free of material with the potential to enter waters of the State.

Should the Design-Builder choose to moor barges outside of the Project Limits, the Design-Builder shall obtain all necessary concurrence or approvals, or both, to do so in writing from the authority(ies) having jurisdiction. The Design-Builder shall provide copies of all such concurrences and approvals to WSDOT prior to mooring barges in the areas(s).

The use of barges shall be done in accordance with the requirements outlined in the applicable environmental permits, and the United States Coast Guard bridge permit.

For permit requirements and commitments list, see Appendix P and Appendix C.

2.13.4.1.22 *Navigation Channel Requirements*

At the Sammamish River, the Design-Builder shall maintain a minimum navigation opening at all times during and after construction, as dictated by the United States Coast Guard Bridge Permit.

For permit requirements and commitments list, see Appendix P and Appendix C.

2.13.4.2 At-Grade Traffic Barriers

Refer to Section 2.11, *Roadway*, for design criteria regarding barrier type and height.

At-grade traffic barriers shall be designed in accordance with the WSDOT *Bridge Design Manual* and shall use the design criteria for TL-4, at a minimum. Existing barriers that require modification shall be replaced by removing the existing barrier to the next joint.

Where changes to the roadway beneath or adjacent to existing bridges results in abutments or piers located within the clear zone, as defined by the WSDOT *Design Manual* and *AASHTO Roadside Design Guide*, collision shall be addressed by either providing structural resistance or by redirecting or absorbing the collision load in accordance with Section 3.16.7 of the WSDOT *Bridge Design Manual*.

Traffic barriers with a grade difference greater than the Standard Plans shall meet requirements for both barriers and retaining walls, including slope stability, wall drainage, and horizontal bench requirements, in accordance with this Section; Section 2.6, *Geotechnical*; and the Mandatory Standards.

Traffic barriers along the eastern edge of northbound I-405 between MP 22.35 and 22.55 in the vicinity of the Brickyard BRT Station along the existing noise walls shall stand at least 2 feet clear of the existing noise walls, measured from back of barrier to face of existing noise wall. Where an offset of 4 feet or less is provided between the back of barrier and existing noise wall, the barrier shall be designed to transfer no collision load to the existing noise wall and its foundations. The barrier shall also be designed as a non-yielding retaining structure that restores the resistance at the existing noise wall foundation. The Design-Builder shall design the barrier and retaining structure for no deflection and at-rest earth pressures, as described in Section 15-4.8 of the WSDOT *Geotechnical Design Manual*.

2.13.4.3 Retaining Wall Design Criteria

The Design-Builder shall design and construct permanent retaining walls for the Project. Retaining walls shall be of the following types:

- Proprietary structural earth walls in accordance with Section 6-13 of the Standard Specifications.

- Standard permanent geosynthetic retaining walls in accordance with Sections D-3.09, D-3.10, and D-3.11 of the Standard Plans and Section 6-14 of the Standard Specifications.
- Standard reinforced concrete cantilevered retaining walls in accordance with Sections D-10.10 through D-10.45 of the Standard Plans and Section 6-11 of the Standard Specifications.
- Soil nail walls in accordance with Section 6-15 of the Standard Specifications.
- Soldier pile walls in accordance with Sections 6-16 and 6-17 of the Standard Specifications.
- Soldier pile tieback walls in accordance with Sections 6-16 and 6-17 of the Standard Specifications.
- Secant pile and tangent pile walls in accordance with Section 6-19 of the Standard Specifications

Rock walls, block walls, masonry walls, permanent shotcrete and gabion cribbing shall not be used for retaining earth or as retaining walls.

The Design-Builder shall design walls in accordance with Section 2.6, *Geotechnical*; the WSDOT *Geotechnical Design Manual*; the WSDOT *Bridge Design Manual*; and the *AASHTO LRFD Bridge Design Specifications*. The Design-Builder may modify the Standard Plan retaining walls to meet Project requirements, such as seismic design criteria and aesthetic requirements per Section 2.15, *Roadside Restoration,* by providing special design analysis. Aesthetic modifications shall not adversely affect the strength and safety requirements of the retaining walls. Special design retaining walls shall be stamped and signed by the EOR. Wall drainage, including cement concrete gutters, shall be provided for all walls in accordance with the WSDOT *Geotechnical Design Manual* and the WSDOT *Bridge Design Manual.*

The Design-Builder shall evaluate potential impacts to Utilities and other facilities (stormwater pipe, Intelligent Transportation System [ITS] conduit, etc.) crossing under proposed walls and bridges and incorporate mitigation measures to avoid conflicts and detrimental effects including, but not limited to, settlement and surcharge loading.

Walls supporting Recovery level bridges and bridge structure elements, including approach slabs, shall remain at full-service level as defined by the bridge seismic design criteria in this Section and the WSDOT *Bridge Design Manual.* They shall also meet the serviceability requirements in Chapter 15-4.7 of the WSDOT *Geotechnical Design Manual* and the post construction settlement limits in Section 2.6, *Geotechnical*, under the Functional Evaluation Earthquake (FEE) event.

2.13.4.3.1 *Retaining Walls Beneath Existing Bridges and Structures*

During all stages of temporary and permanent retaining wall and shoring construction under existing bridges, structural elements shall not be overstressed

with a C/D ratio of less than 1.0, or less than the C/D ratio of the existing structure. Design and construction staging shall be based on three-dimensional deformation-based analysis that provides predicted displacements of the structure during each stage of construction. The Design-Builder shall submit to WSDOT for Review and Comment structural and geotechnical analysis and calculations demonstrating existing structural elements are not overstressed during all stages of the Work. The analysis and calculations shall be submitted as a structure design submittal together with the design of the retaining wall or shoring. At a minimum, the analysis shall investigate the following:

- Deformations in all bridge structure and foundation elements caused by the Work at all stages.
- Short-term, long-term, and total and differential settlement and lateral movements.
- Any potential impacts to the bridge structure as a result of the Work.
- Geotechnical analysis required in Section 2.6, *Geotechnical*.

All structure design submittals for retaining walls beneath existing bridges shall include detailed plans, elevations, and section layouts of all existing and new structure elements identifying clearances and areas of potential conflicts. The Design-Builder shall submit Type 3E Working drawings detailing specific procedures for retaining wall and shoring installation and remedies for potential conflicts.

A pre-activity meeting with WSDOT and the Design-Builder shall be held at least 14 Calendar Days prior to beginning any temporary or permanent retaining wall Work under bridges. The conference will be used to discuss construction procedures, personnel and equipment to be used.

In addition to the Hold Points required in Section 2.28, *Quality Management Plan*, the following shall be provided:

- Prior to excavating below bottom of spread footing, or pile or shaft caps and within a zone sloping away from bottom of footing or cap.
- Upon exposing any foundation elements below bottom of spread footings or footing caps.
- Prior to placing any shotcrete facing.

2.13.4.3.2 *Temporary Retaining Walls*

Temporary retaining wall refers to any wall, portion of wall, or shoring that retains earth adjacent to public vehicular traffic and will not remain functional upon Physical Completion of the Project.

The Design-Builder may reuse structural components of temporary retaining walls as part of permanent retaining wall systems, provided all of the structural support elements and materials of the temporary retaining walls are in as-new condition and meet the requirements of the permanent structure standards. Timber piles will be allowed only as foundations for temporary retaining walls where

allowed by the Project's permits. Maintenance of temporary retaining walls shall be the Design-Builder's responsibility.

The Design-Builder shall remove all portions of temporary retaining walls before Substantial Completion of the Project.

2.13.4.4 Buried Structures Design Criteria

The Design-Builder shall use only cast-in-place or precast reinforced concrete, metal structural plate, or a composite arches system for buried structures.

Buried structures and associated headwalls, wingwalls and connected barriers shall be designed and constructed in accordance with the WSDOT *Geotechnical Design Manual*, WSDOT *Bridge Design Manual*, Standard Specifications, *AASHTO LRFD Bridge Design Specifications*, and the *AASHTO LRFD Bridge Construction Specifications*. The AASHTO operational classification load modifier for the buried structure shall be that for typical bridges unless noted otherwise.

Fall protection on buried structures and associated headwalls, wingwalls and connected barriers shall follow requirements in this Section.

Corrosion and abrasion shall be considered as specified in the WSDOT *Bridge Design Manual*.

The Structural Clear Span of a buried structure shall be used to determine the buried structure class. When supporting a Roadway, the Structural Clear Span shall be the widest horizontal opening from interior face to interior face of the end walls measured parallel to the roadway centerline. When not supporting a Roadway, the Structural Clear Span shall be the widest horizontal opening from interior face to interior face of the end walls measured perpendicular to the buried structure centerline.

Structure Class	Structural Clear Span
Class 1	Less than 20.0 feet
Class 2	20.0 feet and greater

Class 2 buried structures shall be considered bridges and satisfy seismic requirements for Ordinary or Recovery operational classifications, as defined in this Section. Class 2 buried structures and associated headwalls and wingwalls shall include seismic design and ground failure mitigation in accordance with the *AASHTO LRFD Road Tunnel Design and Construction Guide Specifications.* Seismic analysis shall include the loading effects resulting from ground shaking and ground failure. This includes, at a minimum, design for the seismic effects of transient racking, ovaling deformations, liquefaction, lateral spreading and lateral flow effects. The *AASHTO LRFD Bridge Design Specifications* exemption from seismic loading shall not apply.

Seismic Design need not be considered for Class 1 buried structures. However, wingwalls and headwalls shall meet the seismic design requirements in

accordance with the WSDOT *Bridge Design Manual*, WSDOT *Geotechnical Design Manual*, and *AASHTO LRFD Bridge Design Specifications.*

All buried structures and associated headwalls and wingwalls shall be designed for scour from the design flood (100-year flood event) and the check flood (500-year flood event) in accordance with the WSDOT *Bridge Design Manual* and the *AASHTO LRFD Bridge Design Specifications.* Channel migration shall be considered.

Headwalls are structure elements that are end treatments connected to buried structures, including, at a minimum, parapets, slope collars, cutoff walls and inverts. Headwalls shall be reinforced concrete.

Wingwalls are retaining wall structure elements adjacent to or above a buried structure end or headwall. Portions of wingwalls below the 100-year mean recurrence interval water surface shall be reinforced concrete or have a reinforced concrete fascia.

When supporting a Roadway, the Fill Depth shall be defined as the total backfill and surfacing depth above the top of the buried structure. When not supporting a Roadway, the Fill Depth shall be defined as the total backfill above the top of the buried structure.

Structural Earth Wall wingwalls shall not use metallic ground reinforcement below the 100-year mean recurrence interval water surface unless the pH of the water in front of the wall and of the groundwater are within the range of 5.0 and 10.0, in accordance with WSDOT Test Method T 417 in the WSDOT *Materials Manual*.

2.13.4.4.1 *Concrete Structures*

When the buried structure is located in a corrosive environment as defined in the WSDOT *Bridge Design Manual*, corrosion-resistant reinforcement as defined in the WSDOT *Bridge Design Manual* shall be used. The minimum cover requirements for direct exposure to salt water and coastal situations of the *AASHTO LRFD Bridge Design Specifications* shall apply.

When the Fill Depth of the buried structure is less than 2 feet at any point above the Structure, all reinforcement in the top slab shall be corrosion resistant as defined in the WSDOT *Bridge Design Manual* LRFD M 23-50. Reinforcement in the top slab need not be corrosion-resistant when a concrete deck meeting the requirements for a Type 4 Bridge Deck Protection System as defined in the WSDOT *Bridge Design Manual* is provided.

When the top of the buried structure is directly exposed to vehicular traffic (fill depth <2 feet), a concrete overlay or reinforced concrete deck shall be provided. HMA overlay is not allowed. For a reinforced concrete deck, the minimum concrete cover from the top surface of the buried structure to the top mat of reinforcement shall be 2 inches. For a concrete overlay over segmental units, a Type 4 Protection System shall be provided in accordance with the WSDOT

Bridge Design Manual. When the top of the buried structure is directly exposed to vehicular traffic (fill depth <2 feet), bridge approach slabs shall be provided.

All reinforcement in precast units shall be of the same type.

2.13.4.4.2 *Metal Structural Plate Structures*

Steel structural plate shall not be used in locations conforming to corrosive environments as defined in the WSDOT *Bridge Design Manual*. Galvanizing and zinc coatings shall not be used below the 100-year MRI water surface.

Where the buried structure supports a Roadway and the minimum Fill Depth is less than 8 feet, the Contractor shall provide protection against Roadway de-icing salts and chlorides by one of the following methods:

1. Providing an impermeable geomembrane with welded seams in the backfill over the Structure that is sloped to drain water away from the Structure. The membrane shall be a minimum 30 mil thick polyvinyl chloride, ethylene interpolymer alloy, or polyurethane polymer, or a combination of these polymers.
2. Preventing roadway drainage from entering into the fill above the buried structure.
3. Providing additional metal plate thickness.

2.13.4.4.3 *Composite Arch System*

Composite arch systems, also referred to as Composite Arch Bridge System (CAS), shall not be used in locations of high energy streams, where the supporting arches could be vulnerable to impact damage from large rocks, wood or flood debris. Composite arch systems shall not be used in locations that are exposed to significant wildfire hazard.

Composite arch systems shall maintain a Fill Depth of at least 3 feet.

Composite arches systems shall consist of a two component Superstructure placed on reinforced concrete foundations. The superstructure shall consist of fiber-reinforced polymer (FPR) composite hollow tubes, external reinforcement/stay-in-place forms filled with expansive self-consolidating concrete (ESCC), and supporting custom pultruded corrugated FRP deck panels retaining the structural backfill. The arches shall be supported by concrete foundations (cast-in-place or precast in sections and made continuous), requiring a cast-in-place encasement of the arch ends for anchorage to the foundations.

The composite arch system shall be designed in accordance with the *AASHTO LRFD Bridge Design Specifications*, the *AASHTO LRFD Guide Specifications for Design of Concrete-Filled FRP Tubes for Flexural and Axial Members*, the *ASCE Pre-Standard for LRFD of Pultruded FRP Structures*, and other applicable specifications.

The composite arch system structural components shall be designed, fabricated, and supplied by a single supplier as a complete system.

2.13.4.4.4 *Load Rating Report*

For a Class 2 buried structure supporting a Roadway, the Contractor shall submit a load rating report in accordance with the WSDOT *Bridge Design Manual*, except in the following cases:

- For a simple span (single barrel) buried structure, when the Structural Clear Span is less than or equal to 24 feet and the minimum Fill Depth is greater than 13 feet.
- For a simple span (single barrel) buried structure, when the Structural Clear Span is greater than 24 feet and the minimum Fill Depth exceeds the Structural Clear Span.
- For a multiple span (multiple barrel) buried structure, when the Fill Depth exceeds the Structural Clear Span.

2.13.4.5 Stormwater Vaults

New or modified stormwater vaults, vaults where the runoff volume is modified, and open top vaults shall be watertight and shall conform to the requirements for detention vaults in the WSDOT *Bridge Design Manual*. New stormwater vaults shall not be located in the roadway.

Stormwater vaults that may carry vehicular loads and that are 20 feet or more in span length (measured from inside face to inside face) shall be load rated in accordance with the WSDOT *Bridge Design Manual*.

Refer to Section 2.14, *Stormwater,* for additional design requirements.

2.13.4.6 Noise Wall Design Criteria

Noise walls shall be constructed of precast concrete or cast-in-place concrete. Masonry or block noise walls shall not be used. The Design-Builder may modify the Noise Wall Plans shown in the Standard Plans as required to meet Project-specific criteria by providing special design analysis. The special design noise walls shall be stamped and signed by the EOR. The Design-Builder shall design noise walls for all structural service limit state, strength limit state, extreme limit state, and safety requirements.

Noise walls (including doors and vehicular access points) shall be special designs in accordance with Exhibit 740-1 in the WSDOT *Design Manual*.

The Design-Builder may use the Standard Plan noise walls as a basis for special design noise walls to meet the aesthetic requirements for the Project in accordance with Section 2.15, *Roadside Restoration*. Aesthetic modifications shall not adversely affect the strength and safety requirements of the Standard Plan noise walls.

The Design-Builder may use the Standard Plan noise walls as a basis for special design noise walls to meet the seismic requirements for the Project in accordance with Section 2.6, *Geotechnical*. Structural modifications for seismic demand not

covered by the Standard Plans shall meet the strength and safety requirements of all noise wall design codes.

Grading at special design noise walls shall conform to the grading for Standard Plan noise walls.

The top of the noise walls shall be constructed to meet or exceed the top elevation of the noise walls shown in the Noise Wall Coordinates (Appendix O) with vertical steps and horizontal runs constructed in accordance with Section 2.15, *Roadside Restoration,* and Appendix L. The top of the noise wall shall be a minimum of 6 feet above the final ground line on the community side of the wall, or Right of Way fencing shall also be provided to obtain a combined minimum height of 6 feet above the final ground line.

New noise walls on top of retaining walls shall be limited to 14 feet above the top of roadway or finished ground behind the wall.

The Design-Builder shall provide fire hydrant access doors adjacent to fire hydrant locations. Doors shall be provided as specified in the Standard Plans and locations shall be easily accessible to both emergency vehicles and water supply service lines. Each access door shall have a deadbolt lock capable of accepting a Best CX Series Core. The Design-Builder shall furnish and install a spring-loaded construction core with each lock. WSDOT will furnish the permanent Best CX Series Core for the Design-Builder to install at the end of the Project. Fire hydrant signs shall be attached to all doors that provide access to fire hydrants.

Final alignment tolerances shall be 0.5 inches within any 10-foot length of wall.

Refer to Section 2.8, *Environmental* for additional noise wall requirements.

2.13.4.6.1 *Noise Barrier System on Median Barrier*

The noise barrier system on top of the median barrier at the Brickyard BRT Station shall meet the requirements of Section 2.31, *Vertical Construction*, and this Section.

The noise barrier system, median barrier, and associated foundations shall be a crash-tested system successfully tested to *Manual for Assessing Safety Hardware* (MASH) Test-Level 4 criteria. The system shall also be designed for all limit states in accordance with the Mandatory Standards. The Design-Builder shall submit to WSDOT for Review and Comment a crash-test report and the FHWA Eligibility Letter based on AASHTO MASH criteria. Technical Specification for the system shall be submitted with the Final Design Submittal.

2.13.4.7 Station Walls and Barriers

Brickyard Station walls and barriers, collectively referred to as Walls, shall include (but not be limited to) all walls and structure elements adjacent to or facing I-405 serving as noise barriers or I-405 partitions; supports for stairs, elevators, canopies, transparent noise panels, and other elements; storage and maintenance spaces; piers supporting the station pedestrian bridge; and traffic barrier. All station Walls with portions located within 4-feet of the front face of

barrier shall be designed to meet the requirements of this Section in addition to all other requirements in the Technical Requirements and Mandatory Standards.

- The Walls shall be crashworthy to TL-4 test specifications, inclusive of a TL-4 single slope safety shape and 42-inch-high barrier to contain the vehicle. Crashworthy, as defined in AASHTO LRFD, is a system that has been successfully crash-tested to a currently acceptable crash test matrix and test level or one that can be geometrically and structurally evaluated as equal to a crash-tested system. Elements supported on or by the Walls shall not affect their ability to be Crashworthy. Deviation from the requirements in this Section shall require the Walls and barriers be evaluated for crashworthiness and approved as Crashworthy by the WSDOT Engineer.
- The Walls and their foundations shall be designed to provide structural resistance elastically against vehicular collisions force (CT) under three (3) AASHTO LRFD Extreme Event II cases defined in the Table 1 below. The vehicular collision force (CT) is assumed to act in a direction (φ) with the edge of the pavement in a horizontal plane, and at a distance (H) above the ground, whichever produces the critical shear and moment in the Wall and the connection to the foundation. The design vehicular collision force for Extreme II-B and II-C shall be applied in accordance with AASHTO LRFD C3.6.5.1.

Table I – Extreme II Limit State Parameters

	Extreme II-A	Extreme II-B	Extreme II-C
Vehicular Collision Force, CT	AASHTO LRFD Appendix A13 for TL-4	600 kips	93.3 kips
Direction, φ		0 to 15 degrees	0 to 15 degrees
Distance, H		2.0 to 5.0 feet	5.0 to 14.0 feet

- The Walls shall be designed to prevent shattering. Two mats of reinforcement with a maximum spacing of 12-inches in each direction shall be provided. Concrete clear cover on the interior face shall not exceed 2-inches and areas of excess concrete cover and unreinforced concrete shall be avoided.
- Displacement of the Walls shall be evaluated at the extreme limit states. Elements attached to or supported on the Walls shall be designed to accommodate displacements without failure or damage, such as becoming projectile hazards during a crash. Bus platform shelters, signage, and other independent structures shall be offset 1.5 times the maximum displacement of the Wall under extreme limit states.
- Transparent noise panels mounted to the Walls shall be a minimum of 14-feet above ground measured from the final pavement surface at the front of the barrier. The transparent noise panel system, including the

panels, panel frames, posts, and all hardware shall be a complete system from a crash-tested system that meets the Noise Barrier System on Median Barrier requirements of Section 2.13 and Section 2.31. Rub rails are not required above 14-feet. Attachment and support of the transparent noise panel system to the Walls shall be designed and secured in a way that fragments do not fall when the system is deformed or broken in a design collision.

- Wall finishes above the barrier shall be in accordance with Appendix L. The thickest point of the finish shall not extend beyond the top face of barrier.

Station Walls with portions located greater than 4-feet from the front face of barrier and within the clear zone, as defined by the AASHTO Roadside Design Guide, shall be protected behind a minimum 42-inch-high MASH crash tested rigid TL-5 barrier. Such rigid barriers shall be structurally and geometrically capable of surviving the crash test for MASH test level 5, as specified in AASHTO LRFD.

2.13.4.8 Illumination, Intelligent Transportation System, Traffic Signal, Toll Gantries, and Overhead Sign Structures

Overhead sign structures include monotube sign structures, bridge mounted signs, monotube sign structures mounted on bridges, and their foundations. Overhead sign structures may support static signs, variable message signs (VMS), toll rate signs (TRS), or Toll Equipment (Toll Gantries).

Where light standards, ITS closed-circuit television (CCTV) standards, traffic signal standards (including for ramp meter systems), or overhead sign structures are mounted on bridges, the bridge structural elements shall be designed for the support reactions.

Overhead lighting, sign bridges, cantilever sign structures, signal bridges, and overhead cantilever traffic signals mounted on bridges shall be attached either to the bridge substructure elements (e.g., crossbeam extensions) or to the bridge superstructure at piers locations.

The Design-Builder shall design retaining walls and foundations to account for the placement of any illumination, ITS, traffic signal (including ramp meter), Toll Gantries, or overhead sign structure supports on or behind the retaining walls.

Handholes in closed members shall have reinforcement around the holes. Structural bolted splices or connections shall use ASTM A 325 high strength bolts. All fabricated structural components and hardware shall be galvanized after fabrication in accordance with AASHTO M 111. All bolts and related hardware shall be galvanized after fabrication per AASHTO M 232, except ASTM F 1554 GR 105 Anchor Rods shall be galvanized after fabrication per ASTM F 2329.

Overhead monotube sign structures shall be designed in accordance with the design criteria specified in the WSDOT *Bridge Design Manual*. Overhead monotube sign structure designs (including foundations) shall be stamped and

signed by the EOR. Span lengths, loadings, and conventional structural design information provided in Chapter 10 of the WSDOT *Bridge Design Manual* shall be design minimums. Where Bridge Design Office conventional sign structure and foundation design requirements, as listed in the WSDOT *Bridge Design Manual,* are not met, non-conventional designs shall be designed using *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, the WSDOT *Bridge Design Manual*, and this Section. The Design-Builder shall prepare and submit detailed structural design calculations and plans to the WSDOT Engineer for Review and Comment.

Foundations for illumination, ITS, traffic signal, Toll Gantries, and overhead sign structures shall be designed in accordance with Section 2.6, *Geotechnical* and WSDOT *Bridge Design Manual.*

Non-metallic support structures for illumination, ITS, traffic signal, Toll Gantries, or Toll Equipment shall not be used for permanent installations.

All attachments and accessories of unused signs, ITS equipment, and tolling equipment mounted to bridge elements shall be removed. Anchor bolts may be left in place with approval from the WSDOT Engineer.

Refer to Sections 2.15, *Roadside Restoration*; 2.18, *Intelligent Transportation Systems;* 2.19, *Signing;* and 2.26, *Toll Infrastructure*, for additional design and aesthetic requirements.

2.13.4.8.1 *Variable Message Signs*

VMS shall be supported on monotube sign bridges or monotube balanced tee cantilever sign structures.

The Design-Builder shall furnish and install all VMS. The Design-Builder shall design and construct all associated VMS housings, VMS mounting beams and brackets, maintenance walkways, support structures, and foundations (including all necessary hardware) to install and test VMS.

The VMS housing structural framing, face covering, and mounting members shall be designed to withstand a wind velocity of 115 mph and shall otherwise comply with the requirements of the *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

Prior to fabrication, the Design-Builder shall prepare and submit detailed structural design calculations and Plans for all associated VMS housings, VMS mounting beams and brackets, maintenance walkways, support structures, and foundations (including all necessary hardware) to WSDOT for Review and Comment.

2.13.4.8.2 *Toll Rate Signs*

TRS shall be installed on monotube sign bridge structures, unless noted otherwise. The Design-Builder shall furnish and install all TRS. The Design-Builder shall design and construct all associated TRS sign housings, TRS

sign mounting beams and brackets, support structures, and foundations (including all necessary hardware) to install and test TRS.

The TRS housing structural framing, face covering, and mounting members shall be designed to withstand a wind velocity of 115 mph and shall otherwise comply with the latest requirements of the *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

Prior to fabrication, the Design-Builder shall prepare and submit detailed structural design calculations and Plans for all associated TRS housings, TRS mounting beams and brackets, maintenance walkways, support structures, and foundations (including all necessary hardware) to WSDOT for Review and Comment.

2.13.4.8.3 *Closed-Circuit Television*

Where pre-approved CCTV support structures are not used, the analysis and design of CCTV camera support structures shall comply with the requirements of the WSDOT *Bridge Design Manual*. Fatigue design shall conform to Section 11 of the *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals using* Fatigue Category III.

2.13.4.8.4 *Toll Gantries*

Toll Gantries shall use monotube sign structures as supports and shall not support any other overhead signs or equipment other than tolling equipment. Toll Gantries shall be designed within the design criteria specified for monotube sign structures in accordance with the WSDOT *Bridge Design Manual*. Limits for span lengths and loadings shall be as shown in the Monotube Sign Structure Plans and notes in the WSDOT *Bridge Design Manual*. All proposed Toll Gantry plan sheets shall include details for the toll reader equipment cabinet and associated conduit, as well as vertical clearances over the center of each lane and shoulder.

Toll Gantry analysis and design shall conform to the following additional criteria:

- Toll Equipment is assumed to have the following properties per tolled lane and per adjacent shoulder, including wiring, attachments, cameras, sensors, and other appurtenances:
  - Weight 1,500 pounds
  - 750 pounds centered over shoulder (where shoulder >6 feet wide)
  - Surface area of 20 square feet
- Limit the natural vibrational frequency of any element that supports the equipment support frame to less than 150 hertz.
- Limit displacements of the structure when the wind speed is equal to 30 mph, so that:
  - Movement of any point along the structure shall not exceed 0.7 inches relative to the position of any other point along the structure, and the maximum displacement of any point shall not exceed 0.7 inches.

- Rotational displacement of any point shall not exceed 8 milliradians (0.47 degrees) relative to the rotational orientation of that point at rest, in all three rotational axes.

- Limit displacements of the structure when the wind speed is equal to 70 mph, so that maximum movement of any point shall not exceed 1.4 inches.

See Section 2.26, *Toll Infrastructure*, for additional requirements of Toll Gantries.

Existing Toll Infrastructure shall be decommissioned and removed in accordance with Section 2.26, *Toll Infrastructure*.

2.13.5 *Construction Criteria*

Construction equipment exceeding the legal load shall not be operated on structures without WSDOT's written approval. Refer to Section 1-07 of the *General Provisions* for additional requirements.

2.13.5.1 Structure Monitoring Program

All new and existing bridges, retaining walls, and other structures that have the potential to be damaged by the Work shall be considered Sensitive Structures. The Design-Builder shall identify all new and existing structures that are considered Sensitive Structures based on the proposed Work and develop a monitoring program. Sensitive Structures shall also follow the requirements in Section 2.6, *Geotechnical*, for Sensitive Facilities and Structures. Sensitive Structures shall include at a minimum the following:

Existing Bridge Nos.

- 405/70W
- 405/70E
- 405/70N-E
- 405/70N-W
- 522/30W-S
- 522/30E-N
- 405/70S-E
- 522/30E-S
- 405/103E
- 405/103W

Culverts:

- South Fork Perry Creek culvert

Walls

- Existing retaining Wall 2185L-A at Juanita Creek Fish Passage Structure

- Existing MSE wall at Queensborough Creek at SR 527 Fish Passage Structure

The monitoring program shall be used to assess the stability and safety of the structure for public use by comparing baseline measurements to routine monitoring measurements after commencement of construction activities within the Project limits. The monitoring program and associated analysis shall be submitted to the WSDOT Engineer for Review and Comment with the Final Design Submittal of the structure or adjacent Work.

The monitoring program shall include the following elements for a pre-construction condition survey and routine monitoring of the structure:

Pre-construction Condition Survey: There shall be two baseline Structure surveys. The first survey shall be performed at least 14 Calendar Days prior to commencement of any construction activities (soil/rock removal, pile driving, structural Work, etc.) for the Work within the greater of the zone of influence or 50 feet of the structure. The second survey shall be performed 24 hours prior to starting the construction activities in order to verify stability of the baseline measurements. Both surveys shall document visible cracks, defects, and any unusual conditions. Baseline measurements shall include estimated effects due to temperature, traffic impacts, etc. on the displacement measurements. The first survey shall include installation of survey targets on the structure to track permanent displacements.

- Bridge Surveys shall be performed on all spans and piers of the bridge and shall provide a geometric baseline for the bridge deck and the location and elevation of bridge piers. At a minimum, survey targets shall be located on each column of interior piers, within 2 feet vertical distance below the top of each column, and within 2 feet vertical distance above the existing ground line or top of exposed footing. At bridge abutments, survey targets shall be located directly below the centerline of each exterior girder and spaced no greater than 25 feet apart along the abutment wall length and within 2 feet of the top of wall.
- Retaining Wall Surveys shall be performed at the wall ends and intervals no greater than 50 feet along the wall length. Survey targets shall be located within 2 feet of the top of wall.
- Culvert Surveys shall be performed along its length beneath work-zones and excavations.

Routine Monitoring: Monitoring of the survey targets on the structure shall start within 24 hours after commencement of any construction activities, then continue at least each Calendar Day until the structure is no longer in service to the public, vehicular and pedestrian traffic is shifted to the temporary detour alignment, and construction activities adjacent to the structure that impact the stability are completed. Monitoring shall include surveying the target locations (x, y, and z values) a minimum of once per Calendar Day and uploading the survey data the same day to an online database. Access to the online database shall be provided to WSDOT up to Substantial Completion of the Project. Surveys shall monitor

existing visible cracks, defects, and any unusual conditions identified in the preconstruction condition survey and document any new conditions found.

The Design-Builder shall define the trigger, maximum, and repair displacement threshold levels based on their design and structural analysis. The values determined define the threshold levels to implement additional monitoring requirements and adjust construction practices as required. The Design-Builder may adjust the threshold levels depending on the results of the Pre-construction Condition Survey. The Design-Builder shall define threshold levels 24 hours prior to starting construction activities. Threshold levels are compared to the resultant combination of vertical and horizontal displacements of the survey targets. Displacement measurements shall be taken to a precision of 0.01 feet.

Damaged, missing, or non-functioning survey equipment or targets shall be replaced and re-baselined within 24 hours. The Design-Builder shall develop a Corrective Action Plan describing specific actions to be taken if permanent displacements exceed the threshold levels given above. This plan shall be submitted to the WSDOT Engineer for Review and Comment at least 14 Calendar Days prior to any construction activity, as part of the monitoring program.

Structural damage to the structure caused by the Design-Builder's construction activities and creating safety concerns for public use on the structure shall be repaired regardless of the measured displacement levels. The Design-Builder shall be responsible for all associated design and repair costs, and implementation of repairs to restore stability and safety to the structure for public use.

The monitoring program shall include the following elements:

- All elements required in the preconstruction condition survey

The Design-Builder shall perform remedial measures for each threshold level as described below:

- Trigger Level: Notify the WSDOT Engineer the same Calendar Day that the trigger level has been exceeded. Report displacement measurements to the WSDOT Engineer until it is verified that movement has stopped. Increase frequency of future monitoring for each affected survey target to two readings daily with a minimum of 6 hours between readings, and also monitor the adjacent targets at the same frequency until movements have stabilized. Implement procedures to limit additional movement and protect the affected facility.
- Maximum Level: Verify measurements and notify WSDOT immediately if the maximum level has been exceeded. Increase frequency of future monitoring for all survey targets to three readings daily with a minimum of 4 hours between readings. Report displacement measurements to the WSDOT Engineer until it is verified that movement has stopped. WSDOT may suspend associated ground disturbing activities and require the Design-Builder to submit alternative proposals for minimizing further movement. If Work is suspended, the Design-Builder shall obtain approval prior to restarting ground disturbing activities.

- Repair Level: All construction activities affecting the structure shall be suspended immediately and WSDOT shall be notified immediately to assess the stability risk and safety of the structure for public use. The Design-Builder, SLE, and WSDOT Engineer shall determine the extent of temporary repairs required for the structure before construction activities are allowed to resume. Structural repairs shall be designed and constructed by the Design-Builder and SLE to restore stability and safety of the structure for public use.

2.13.6 *Bridge Maintenance Requirements*

2.13.6.1 Existing Bridge Expansion Joint Rehabilitation

The Design-Builder shall field measure all existing expansion joints requiring replacement. The expansion joint headers and expansion joint materials of the existing bridge expansion joints shall be removed for the full width of the bridge. The expansion joint headers shall be reconstructed with either elastomeric concrete or polyester concrete. Where an expansion joint is installed within the monolithic bridge deck and a separate concrete header is not specifically defined, the header width shall be taken as defined in the WSDOT *Bridge Design Manual* Section 5.5.5 or greater as required to ensure joint durability and performance. The joint shall be replaced with an expansion joint system designed for the gap and motion range of the joint. Strip seals, compression seals, and associated anchorages and armoring shall be removed and replaced with new seals, in one continuous piece, for the entire width of the new and existing bridge deck. New HMA overlay shall not be installed across the expansion joints. Transverse joint seals at the back of pavement seat and end of bridge approach slab shall be constructed in accordance with Standard Plan A-40.20.

At Bridge Nos. 405/70E, 405/70W, and 405/70S-E, the existing bolted down panel joints shall be replaced with strip seals using special anchorage per the WSDOT *Bridge Design Manual* 9.1.4.B, and an allowable 4-inch motion range to match existing.

Bridge expansion joints shall be designed in accordance with the WSDOT *Bridge Design Manual*, and calculations shall be submitted to the WSDOT Engineer for Review and Comment.

2.13.6.2 Bridge Inspection and Maintenance Access

The Design-Builder shall design, detail, and construct all bridge superstructures, joints, and bearings to be accessible for WSDOT inspection and maintenance. Inspection access and ventilation designs for enclosed spaces, such as isolated abutment concrete enclosures or box girders, shall be designed in accordance with the WSDOT *Bridge Design Manual*. Inspection and access plans for enclosed spaces shall be submitted to the WSDOT Engineer for Review and Comment.

The Design-Builder shall design, detail, and construct all joints and bearings to be replaceable. All bearing locations shall be designed with jacking points and

adequate clearances to facilitate future bearing replacement. Jacking points shall be designed to support 200 percent of the calculated lifting load.

All exterior surfaces of superstructures, including bearings and between girders, shall be accessible by an Aspen Aerial A-62 Under Bridge Inspection Truck, a 40-foot bucket truck, or a 15-foot ladder. "Accessible" is defined as within arm's reach of an inspector. Technical details including the flight path for an Aspen Aerial A-62 can be located on the Aspen Aerials website.

Pipe railing shall be provided along steel plate girder webs for future maintenance and inspection access and shall be located and detailed in accordance with sheet 6.4-A9 of the WSDOT *Bridge Design Manual*.

For box girders where permanent access is provided, access doors shall be provided at both ends of the bridge.

For steel box girders with permanent access, the Design-Builder shall paint the interior of steel box girders the color white (SAE AMS Standard 595, Color No. 17925) and shall provide LED inspection lighting and electrical power. Lighting fixtures, light switches and duplex receptacles shall be located inside the steel box girders in a manner consistent with the WSDOT *Design Manual*.

The Design-Builder shall notify WSDOT 30 Calendar Days prior to any new bridge or buried structure being open to traffic, so that WSDOT can schedule an inventory inspection by the WSDOT Bridge Preservation Office.

2.13.6.3 Bridge Deck Overlay Replacements

Bridges that require existing overlay to be replaced shall follow requirements in the WSDOT *Bridge Design Manual* and Standard Specifications. At a minimum, Work shall include the components detailed below.

Bridges No. 405/72, 405/103E and 405/103W shall replace existing HMA bridge overlay. At a minimum, Work shall include the following:

- Full depth removal of existing HMA surfacing on the bridge deck by scraping.
- Chain Drag Testing, ASTM D4580, Method B, shall be performed across the entire bridge deck and approaches. Areas of spalling, delamination, unsound concrete, and rebar deterioration shall be documented in a WSDOT Chain Drag Report form (Appendix J).
- Further deck preparation in accordance with the Standard Specifications
- Placement of waterproofing membrane on exposed concrete deck
- Placement of new 0.25 feet of HMA overlay

If the Design-Builder elects to open the bridge to traffic after the existing bridge deck has been scarified, live traffic will be allowed to drive on the scarified surface for a maximum of 5 Calendar Days before the bridge deck overlay is installed in the exposed section.

For grade-controlled structures, a Hold Point shall be provided for verification of final grade profile and/or removal depth.

A Hold Point shall be provided for the identification of all bridge deck and approach slab areas requiring further deck preparation and repair. The documentation of the chain drag testing shall identify all locations requiring further deck preparation, areas of exposed or damaged reinforcing, and all patching, spalling, and delamination quantities. The documentation shall be submitted to WSDOT using the WSDOT Chain Drag Report form (Appendix J). A hold point shall be provided prior to any further deck preparation and repair. The WSDOT Engineer shall approve the areas of the existing bridge deck requiring further deck preparation.

The Design-Builder shall include in their bid an area of further deck preparation equal to 25 percent of the area of the bridge decks. If WSDOT determines that the quantity of further deck preparation exceeds this area, additional compensation will be made in accordance with Section 1-04 of the *General Provisions*.

A Hold Point shall be provided upon completion of the repairs and prior to the placement of the new overlay.

All reinforcing steel damaged due to the Design-Builder's operations shall be repaired by the Design-Builder.

Where concrete overlay is used to provide rigid side support for expansion joints, following the WSDOT *Bridge Design Manual* Section 15.9.1, such modified concrete overlay headers shall be reinforced.

The transverse joint between the new bridge overlay and adjacent pavement shall be sealed full width, in accordance with Standard Plan A40.20-04.

2.13.6.4 Bridge Deck Repair and Sealing

Bridge Nos. 405/70E, 405/70W, and 405/70SE and their approaches shall receive bridge deck repair and bridge deck sealing using high molecular weight methacrylate (HMWM) penetrating sealer. The Design-Builder shall include in their bid an area of bridge deck repair equal to 10 percent of the area of the bridge deck. If the area of bridge deck repair identified by the Design-Builder exceeds 10 percent of the bridge deck area, WSDOT will determine, at its discretion, whether more bridge deck area will be approved for repair. Payment for additional Work to repair more than 10 percent of the bridge deck area will be addressed in accordance with Section 1-09 of the *General Provisions*.

The bridge deck repair and sealing shall conform to the requirements of Bridge Deck Repair and Sealing Specification (Appendix B). The Design-Builder shall submit a Type 3 Working Drawing containing a Bridge Deck Repair Plan and HMWM Penetrating Sealer System Plan. The Bridge Deck Repair Plan shall include:

- Chain Drag Report identifying areas requiring bridge deck repair

- Repair material product data, mix design, and test data in accordance with Standard Specifications
- Detailed procedure and requirements for surface preparation, equipment used, and methods of containment
- Bridge deck repair concrete curing

The HMWM Penetrating Sealer System Plan shall include:

- Product data and material safety data sheets; manufacturer's specifications and installation requirements; samples of the HMWM system
- Schedule of work for each bridge
- Detailed procedure and requirements for surface preparation, equipment used, and methods of containment
- Description of equipment and process for applying HMWM resin
- Description of process to verify application rate
- Description of process to change application rate
- Range of gel time and final cure time for HMWM resin
- Description of equipment for applying and removing excess sand
- Procedure for removing HMWM resin, including equipment
- Storage and handling of HMWM resin components
- Disposal of excess HMWM resin and containers

2.13.7 *Submittals*

2.13.7.1 Structure Design Submittals

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

2.13.7.1.1 *Preliminary Design Submittal*

The Design-Builder shall submit to WSDOT for Review and Comment preliminary design drawings on WSDOT standard sheets in accordance with the WSDOT *Bridge Design Manual* Preliminary Plan Checklist for all bridges and structures. The Design-Builder shall submit design calculations and supporting reports for all bridges and structures. The stamp of the EOR shall be applied in accordance with WAC 196-23-020.

2.13.7.1.2 *Final Design Submittal*

The Design-Builder shall submit to WSDOT for Review and Comment final design drawings on WSDOT standard sheets in accordance with the WSDOT *Bridge Design Manual*. The Design-Builder shall submit final Technical Specifications, design calculations, monitoring programs and supporting reports

for all bridges and structures. The stamp of the EOR shall be applied in accordance with WAC 196-23-020.

2.13.7.1.3 *Released for Construction Document Submittal*

The Design-Builder shall submit Released for Construction (RFC) Documents to WSDOT for all structural Work related to bridge and structures construction, including drawings, Technical Specifications, design calculations, and supporting reports, 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.

2.13.7.1.4 *Design Calculations*

The Design-Builder shall submit to WSDOT for Review and Comment complete sets of legible calculations to support all structural engineering designs described in this Section. Complete sets of calculations shall be included with each design review Submittal.

All RFC calculations shall include the stamp and signature of the EOR in accordance with WAC 196-23-020.

All calculation sets shall include the following:

- Cover Sheet - The name of the Project, structure name, designer/checker names, date (month, day, and year), and supervisor's name shall be listed. The stamp and signature of the EOR shall also be included.
- Index Sheets - These shall include an index by subject with the corresponding design calculation sheet numbers.
- Design Calculations - Design calculation sheets shall be numbered. The calculations shall include design criteria; loadings; structural analysis; results; member capacities; geotechnical calculations; horizontal and vertical settlement calculations; deflection diagrams; long term creep diagrams for horizontal flexural members; and all computer input and output data (reduced to an 8.5 by 11-inch sheet size). In addition, all electronic files of spreadsheets, computer models, analysis, design files of spreadsheets and computer input/output files used to support the design calculations shall be submitted. All structural calculations using spreadsheets or math software shall be checked with representative hand calculations to verify logic, procedure, look-ups, formulas, and calculations. All variables, formulas, and assumptions shall be clearly defined and shall be documented with references. Off-the-shelf, commercially available software will not require a hand calculation validation.

2.13.7.2 Working Drawings

All Working Drawings shall be submitted to WSDOT, in accordance with Section 1-05.3(5) of the *General Provisions*, and Section 2.28, *Quality Management Plan*, unless otherwise noted.

2.13.7.2.1 *Shop Drawings*

The Design-Builder shall submit to WSDOT shop drawings for all steel elements, precast concrete elements, post-tensioning reinforcement, bearings, expansion joints, railings, barriers, luminaires, drainage structures, reinforcing steel, waterproofing assemblies and piles/drilled shafts prior to implementing Work based on the shop drawings. The EOR shall review all shop drawings prior to Submittal to WSDOT for Review and Comment as Type 3 or Type 3E Working Drawings. The Design-Builder shall submit the final approved shop drawings prior to Physical Completion as part of the As Built Plans in accordance with this Section. The shop drawings shall include, at a minimum, the following information:

- Size of member and fasteners
- Length dimensions
- Finish, such as galvanizing, anodizing, and painting.
- Weld size and type and welding procedures
- Strand or steel reinforcing bar placement
- Post-tensioning reinforcement tensioning procedure, stress calculations, and elongations
- Post-tensioning anchorage details
- Fabrication-reaming, drilling, and assembly procedures
- Wall penetrations
- Erection procedures for steel elements
- Handling and erection procedures for precast concrete elements, including complete details of all temporary supports, bracing, and inserts placed for lifting, assembly, and erection.
- Material specifications
- Waterproofing assemblies shop drawings and installation procedures

2.13.7.2.2 *Falsework, Forms, and other Temporary Structures*

The Design-Builder shall submit to the WSDOT Engineer for Review and Comment Type 3 or Type 3E Working Drawings with supporting design calculations for falsework, forms, construction work bridges, temporary retaining walls, shoring, temporary bridges, and other temporary structures.

The Design-Builder shall submit to WSDOT for Review and Comment as Type 3 or 3E Working Drawings procedures and Working Drawings with supporting design calculations for critical construction processes. Critical construction processes include, at a minimum, bridge removal, bridge approach demolition, jacking pits, and excavation and shoring beneath bridges and structures.

All Final Design Plans and calculations for the falsework, forms, construction work bridges, temporary retaining walls, temporary bridges, other temporary structures, demolition, erection, and installation shall bear the stamp and signature of a Professional Civil or Structural Engineer.

2.13.7.2.3 *Shaft Construction Submittal*

The Shaft Construction Submittals shall be submitted to the WSDOT Engineer for Review and Comment as Type 3 or Type 3E Working Drawings.

2.13.7.3 Plan Revisions During Construction

The Design-Builder shall incorporate calculations for revisions made during construction into the design/check calculation file when construction is completed. All revisions to design calculations and RFC plan sheets shall be stamped and signed by the EOR in accordance with WAC 196-23-020 prior to incorporating them into the Project. The SLE shall certify that all revisions to structural calculations and plan sheets are in conformance with the Contract requirements. Whenever new plan sheets are required as part of a Contract revision, the information in the title blocks of these sheets shall be identical to the title blocks of the Contract they are for. Every revision shall be assigned a number. The assigned number shall be located both at the location of the change on the sheet and in the revision block of the plan sheet along with an explanation of the change.

2.13.7.4 Load Rating Report

The Design-Builder shall complete and submit a load rating report as described in Section 15.12 of the WSDOT *Bridge Design Manual* to WSDOT for Review and Comment at least 90 Calendar Days before a structure is opened to vehicular traffic.

2.13.7.5 End of Project Submittals

All Design Documents overseen by the SLE shall be submitted prior to Physical Completion and shall bear the stamp and signature of the SLE except as otherwise required in this Section.

2.13.7.5.1 *Plans*

The Design-Builder shall prepare As Built Plans for bridges and structures on WSDOT standard sheets in accordance with the WSDOT *Bridge Design Manual*. Plans shall be submitted on 11 by 17-inch PDF and as electronic CADD files in accordance with Section 2.1, *General Information* and this Section. Final approved shop drawings for structures shall be included in the As Built Plans.

2.13.7.5.2 *Calculations*

The Design-Builder shall revise all calculations as necessary for the design covered by the scope of Work to accommodate field changes. The calculations

shall include all the items listed under "Design Calculations" previously specified in this Section.

2.13.7.6 Cost Reporting for Permanent Noise Barrier

The Design-Builder shall submit a report documenting the actual construction costs for all permanent noise barriers constructed as part of the Contract. The report shall be submitted no later than 60 Calendar Days after completion of all permanent noise barriers. For each noise barrier constructed, the report shall include the following information:

Barrier Description:

- Region
- City or County
- Interstate
- Begin/End MP Direction
- Contract Number
- Barrier Material
- Barrier Type (1, 2-retrofit, or State legislative funded noise protection)
- Year of Construction
- Length (ft.)
- Height (ft.)
- Total s.f.
- Cost

The report shall include final As Built Plans for the noise barriers, including plan, profile, and typical section views.

The cost reported shall include all expenditures for the Work directly associated with the construction of the noise barriers including, but not limited to, clearing, grading, temporary and permanent fencing, and landscaping required solely for the noise barrier construction, foundations, fabrication and installation, including all costs for Working Drawing preparation and review. For all Work described above, the cost reported shall include direct and indirect costs. Direct costs include, at a minimum, labor, equipment, materials, supervision, and field engineering. Indirect costs include, at a minimum, overhead, profit, bonds, taxes, and insurance.

2.13.7.7 Miscellaneous Submittals

This Section is intentionally omitted.

End of Section