

16.0 Structures

This Section includes the requirements for the Structures Work for the US 160 Elmore's Corner to Dry Creek Design-Build Project (Project). This Work shall be completed in accordance with the Contract Documents.

16.1 Structures Work

16.1.1 Bridges

Refer to Table 16-1 and this Section for the Work required on existing Bridges.

Table 16-1: Action for Existing Bridges

Milepost (MP)	Structure No.	Description	Work
93.8	P-05-BC	US 160 over Florida River	The existing Bridge shall be replaced. The new Bridge shall accommodate large mammal wildlife passage as well as hydraulic conveyance requirements.
97.43	P-06-AM	US 160 Bridge over Wildlife Underpass	Replace concrete Bridge rail and transitions to meet current standards.
97.43	P-06-AN	US 160 Bridge over Wildlife Underpass	Replace concrete Bridge rail and transitions to meet current standards.

Refer to Table 16-2 and this Section for new Bridge Structures to be constructed for the Project. General layouts are provided in the Reference Documents for information.

Table 16-2: New Bridges

Milepost (MP)	Structure No.	Approximate Length (ft)	Description
92.52	P-05-BD	106	US 160 over Mesa Wildlife Underpass
96.05	P-05-BE	83	US 160 over Valley Wildlife Underpass

16.1.2 Retaining Walls

Permanent retaining wall locations in the Basic Configuration are shown in the Reference Drawings. Final retaining wall types, sizes, and locations shall be determined by the Contractor. The Contractor may use the preliminary retaining wall locations in Table 16-4, subject to final detailed design, choose

alternative locations, or eliminate retaining walls if the grading requirements for the Project are met. Retaining walls shall be designed and constructed in accordance with the requirements of this Section.

Refer to Table 16-3 and this Section for the Work required on existing retaining walls.

Table 16-3: Action for Existing Retaining Walls

Milepost (MP)	Structure No.	Description	Work
n/a	n/a	n/a	No existing retaining walls present.

Refer to Table 16-4 and this Section for new retaining wall Structures that may be constructed.

Table 16-4: New Retaining Walls

Milepost (MP)	Structure No.	Approximate Length (ft)	Description
93.22	R160A093220LRA	360	Cut Wall along WB US 160
93.26	R160A093260RRA	360	Cut Wall along EB US 160

16.1.3 Minor Structures

Anticipated minor Structures include hydraulic Structures and small mammal pipe culvert crossings. Book 2, Section 13, includes small mammal crossing requirements.

16.1.4 Sign Structures

Refer to Table 16-5 for new sign Structures to be constructed on this Project.

Table 16-5: New Sign Structures

Milepost (MP)	Structure No.	Description
n/a	n/a	No new sign Structures are anticipated.

16.2 Administrative Requirements

16.2.1 Structure Numbers or Structure IDs

As required in the CDOT Bridge Design Manual (BDM), the Contractor shall obtain from the Colorado Department of Transportation (CDOT) the Structure numbers or Structure IDs for CDOT-managed structural assets and for new Structures added to the Project not included in Section 16.1. Location

changes for new Structures listed in this Section may require a new or revised Structure number or ID to be requested. Structure numbers or IDs shall be shown on the Released for Construction (RFC) Documents. Contractor shall maintain the list of Structure number IDs throughout the Project and shall coordinate with CDOT until Project Final Completion. Contractor shall also be responsible for installation of Structure ID signs per CDOT Standard S-614-12.

16.3 Design Requirements

16.3.1 Standards

The Contractor shall design and construct the Project in accordance with the Contract, the requirements of the standards in the BDM, the Standard and Project Special Provisions in Book 2, Section 21, and documents referenced in Book 3. The Contractor shall use the latest adopted edition at the time of the Proposal Due Date.

The BDM defines policy and procedures currently in effect for the design, rehabilitation, and repair of Bridges and other Roadway Structures on the Project. The BDM presents the minimum requirements for Structures, except as otherwise noted in this Section. Deviations from the BDM and this Section shall be submitted to CDOT for Approval prior to Acceptance of Final RFC Documents.

Table 16-6: Standards

Author or Agency	Title
American Association of State Highway and Transportation Officials (AASHTO)	Load and Resistance Factor Design (LRFD) Bridge Design Specifications
AASHTO	LRFD Bridge Construction Specifications
AASHTO	Guide Specifications for Design and Construction of Segmental Concrete Bridges
AASHTO	Guidelines for Steel Girder Bridge Analysis
AASHTO	Manual for Bridge Evaluation
AASHTO	AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals
AASHTO	Guide Specifications for LRFD Seismic Design
AASHTO	AASHTO/AWS D1.5 M- D 1.5, Bridge Welding Code
AASHTO	Guide for Development of Bicycle Facilities
AASHTO	Guide Specifications for Fracture Critical Non- Redundant Steel Bridge Members

Request for Proposal
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Project No.: NHPP 1602-157 & FBR 1602-193
Sub Account No.: 20980 - COMBO
Book 2 - Technical Requirements
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Author or Agency	Title
AASHTO	Guide Specifications for Horizontally Curved Steel Highway Bridges
AASHTO	AASHTO LRFD Guide Design Specifications for Bridge Temporary Works
AASHTO	AASHTO M-203 Standard Specification for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement
AASHTO	AASHTO/NSBA Steel Bridge Collaboration Shop Detail Drawing Review/Approval Guidelines
American Society for Testing and Materials (ASTM)	ASTM A-416 Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete
ASTM	ASTM D-1143 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
CDOT	Bridge Design Manual
CDOT	Bridge Detail Manual
CDOT	Bridge Structural Worksheets
CDOT	Bridge Rating Manual
CDOT	Deck Geometry Manual
CDOT	Retaining & Noise Wall Inspection & Asset Management Manual
CDOT	Bridge Technical Memorandums
CDOT	Standard Specifications for Road and Bridge (Standard Specifications)
CDOT	Standard Special Provisions
CDOT	Survey Manual
CDOT	Roadway Design Guide
CDOT	Drainage Design Manual

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Author or Agency	Title
CDOT	Construction Manual
CDOT	Standard Plans, M & S Standards
CDOT	Sign Design Manual
CDOT	Supplement to Standard Highway Signs
CDOT	CDOT (BTE) Bridge & Tunnel Enterprise 100-Year Design Guidelines
Federal Highway Administration (FHWA)	Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Slopes
FHWA	Geotechnical Engineering Circular No. 10 - Drilled Shafts: Construction Procedures and LRFD Design Methods
FHWA	Geotechnical Engineering Circular No. 11 - Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes
FHWA	Geotechnical Engineering Circular No. 12 - Design and Construction of Driven Pile Foundations
FHWA	Geotechnical Engineering Circular No. 6 - Shallow Foundations
FHWA	Geotechnical Engineering Circular No. 7 - Soil Nail Walls Reference Manual
FHWA	Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems
FHWA	Micropile Design and Construction
FHWA	FHWA HI-95-038 "Geosynthetic Design and Construction Guidelines"
FHWA	FHWA RD-73-93, Analysis and Design Problems in Modeling Slurry Wall Construction
FHWA	Hydraulic Design Series (HDS) No. 4, Introduction to Highway Hydraulics

Author or Agency	Title
FHWA	FHWA-CFL/TD-11-003, Wildlife Crossing Structures Handbook, Design and Evaluation in North America

16.3.2 Software

16.3.2.1 Design

According to BDM Section 4.2, CDOT Staff Bridge does not support a preapproved list of software but reserves the right, at its sole discretion, to disallow any software on a regular or case-by-case basis.

16.3.2.2 Load Rating

The following software shall be used to load rate all major and minor Structures on this Project:

- AASHTOWare Bridge Rating (BrR). The Contractor shall confirm with CDOT which version to use.
- If a Bridge type is selected that cannot be rated using the above software package, the Contractor shall submit to CDOT a proposed alternate Bridge rating method for Approval prior to the preparation of Bridge or concrete box culvert ratings.

16.3.3 Materials

16.3.3.1 Concrete

Class B concrete shall be used for slope paving.

Class BZ concrete shall be used for drilled shafts.

Class DF concrete shall be used for conventionally reinforced Bridge decks, diaphragms, approach slabs, Bridge rails, and any element exposed to de-icing salts.

Class D concrete shall be used for abutments, piers, walls, and substructure elements outside of the splash zone and not exposed to de-icing salts.

Concrete mix classes may be substituted per the CDOT Standard Specifications and the BDM.

The use of lightweight concrete will not be allowed.

Reference Book 2, Section 11 for water-soluble sulfate percentages.

Proposed concrete mix designs and procedures shall be submitted to CDOT for Acceptance at least 15 Days prior to the anticipated concrete placement date.

16.3.3.2 Post-Tensioning Steel Systems

Corrosion protection shall be provided for the strands and shall consist of grout-filled galvanized or non-metallic ducts.

16.3.3.3 Structural Steel

Structural steel shall conform to AASHTO M 270, Grades 36, 50, or 70.

Weathering steel may be used for Bridge Superstructures. Weathering steel shall conform to AASHTO M 270, Grades 36W, 50W, or 70W.

The Charpy V-notch Impact Energy Requirements shall be for Test Zone 2.

Reference the GDR in Book 3 for soil properties that can contribute to corrosion of buried metal.

16.3.3.4 Steel Coatings

Florida River Bridge shall be MASH Bridge Rail Type 10. The structural steel components shall be galvanized structural steel, colored in accordance with Project Special Provision Section 522 - Environmental Stain (Galvanized), in Book 2, Section 21.

16.3.4 Loads and Forces

16.3.4.1 Live Load

Temporary Bridges shall be load rated for HL93 and CDOT permit vehicles.

16.3.4.2 Uplift

Bridge spans shall be proportioned to avoid uplift at supports due to non-seismic loads.

16.3.4.3 Thermal Forces

Temperature ranges for cold climates shall be used per the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications.

16.3.4.4 Downdrag

The proposed designs shall consider downdrag forces as applicable per the AASHTO LRFD Specifications.

16.3.4.5 Ultimate Configuration Barrier

The proposed Florida River and Wildlife Underpass Bridges shall be designed to accommodate a future additional barrier load to account for a median barrier along the centerline of the structure.

16.3.5 Geotechnical

Geotechnical subsurface investigations conducted within the vicinity of the Structures are documented in the GDR in Book 3. Supplemental geotechnical investigations, per Book 2, Section 11, will be required for sign Structures and Structures in segments of the Project beyond the Base Configuration. Additionally, supplemental geotechnical investigations will be required for proposed Structure designs where the geotechnical investigation requirements of the BDM and AASHTO LRFD Bridge Design Specifications are not met by the GDR.

16.3.6 Structure Aesthetics Requirements

16.3.6.1 Aesthetic Requirements for Structures in General

New Bridges and walls, and existing walls, where indicated, require aesthetic treatments to match the corridor aesthetic scheme established by the previous CDOT U.S. 160 4th Lane at Farmington Hill Project (Grandview Interchange). The shapes, patterns, colors, and rustication shall match the style set by the Grandview interchange, considering potentially different Structure types. The limits of the aesthetic treatments are detailed in sections 16.3.6.2 and 16.3.6.3. As-Constructed drawings for the Grandview Interchange are included in Reference Documents, which provide details on the aesthetics constructed for the interchange. The mountain banner texture shown in these plans is not required.

For consistency within the Project limits, retaining walls within a common viewshed shall incorporate similar visual aesthetics.

Aesthetic refinements shall be submitted to CDOT for Acceptance prior to the Preliminary Design Plans submittal. The formliner pattern selection shall be submitted to CDOT for Acceptance prior to the Preliminary Design Plans submittal.

Structures with visible concrete surfaces shall have a surface treatment of structural concrete stain. This includes retaining walls, Bridge abutments and piers, Roadway and Bridge barriers, and slope protection.

Optional aesthetic features for this Project include partial-height precast panels in lieu of full-height precast panels and the inclusion of bridge monuments at the bridge corners.

16.3.6.2 Aesthetic Requirements for Bridges

16.3.6.2.1 US 160 over Wildlife Underpasses Mesa and Valley

Wingwalls shall meet the requirements of Section 16.3.6.3.

Structural colored concrete stain shall be applied to wingwalls, headwalls, Bridge rails, guardrails, and exterior and bottom faces of exterior concrete girders. Concrete surface finish shall be Class 1, except for Bridge rails that will be Class 2 finish. If Type 3 Guardrail is used, follow the requirements in Section 16.3.3.4 and Book 2 Section 14.

16.3.6.2.2 US 160 over Florida River

Designs should achieve a slender and well-balanced appearance. Piers shall be located in the center of the Bridge for a two-span Bridge option or symmetrically about the midpoint of the Bridge for a three-span option. To reduce debris accumulation, Bridge piers shall not be located within the low-flow channel, but shall be placed on banks or overbank areas. Discontinuities in the depths of girders from span to span will not be allowed.

Wingwalls shall meet the aesthetic requirements of Section 16.3.6.3.

Structural colored concrete stain shall be applied to wingwalls, curbs, barriers, and overhangs. Concrete surface finish shall be prepared per the Project specification requirements for structural concrete coating.

No formliners or rustications are required on Bridge Substructures.

The Contractor shall submit a Bridge Aesthetic Report to CDOT for Approval Prior to Preliminary Design Plans submittal. This report shall demonstrate to CDOT that the Structure meets a well-balanced appearance for CDOT Approval. In addition to the appearance, this report shall also demonstrate and document how all aesthetic requirements will be met.

Steel girders shall be weathering steel.

16.3.6.3 Aesthetic Requirements for Walls

Preliminary layouts of the walls are shown in the reference drawings. The Contractor shall choose wall geometries to blend with the topography as much as practical. Walls shall be tiered to avoid massive vertical or near-vertical faces. The height of walls or tiers shall be limited to 20 feet. A setback between faces of tiered walls shall be at least 6 feet.

Wall panels shall be cast-in-place or precast concrete, and the preference shall be full-height panels. All wall facing shall be of a consistent type (i.e., cast-in-place, precast facing, etc.) within any section of the Road. This includes surface treatment, pattern, texture, color, and jointing layout. Panel design and construction shall consider ease of replacement and/or repair.

No horizontal seams at grid line joints will be allowed for formliners. All joints shall occur per layout grids and shall be straight and clean. Joints or striations shall intersect within 0.25 inch at panel matches. Any horizontal banners, rustications, or straight-line elements found on retaining walls and Bridge abutments shall align correctly; lines that are visually intended to match up on a horizontal plane shall meet with no offset or irregular match, to within 0.25 inch. All cold joints shall have chamfered edges. All concrete surfaces that the structural concrete stain will be applied shall be prepared per the requirements of Project Special Provisions Revision of Sections 601 and 708 Structural Concrete Stain. The concrete walls, caps, coping, and adjacent barriers shall be covered with Structural concrete stain.

The Contractor shall submit to CDOT for Approval a visual graphic of each retaining wall prior to Preliminary Design Documents and report submittals. This graphic shall be submitted in both hard and electronic format. Proposed retaining wall aesthetics graphics shall include all visible surfaces, and slope protection shall be submitted to CDOT prior to the Preliminary Design Documents submittal. This submittal shall include drawings illustrating form, texture, and color.

The Contractor shall provide full-size mockups (4 feet x 4 feet minimum) for all surface treatments for texture, color, and quality for Acceptance by CDOT with the Preliminary Design Documents for each Structure.

16.3.7 Bridges

16.3.7.1 Geometry

16.3.7.1.1 Geometric Layout

Fill and cut slopes along the longitudinal axis of Bridges shall not be steeper than 2:1 (H:V) perpendicular to the abutment. A 2-foot minimum width berm shall be at the top of the slope at the front face of abutment, and a 2-foot minimum vertical dimension from the top of this berm to the bottom of girder. See the BDM Figures 11-1, 11-3, and 11-4.

A minimum of a 25 foot wide bench for large mammal wildlife shall be provided a under one of the spans of the Florida River Bridge. This bench shall be placed a minimum of 1 foot above the ordinary highwater mark to ensure the path is able to dry out following storm events.

The Florida River Bridge is anticipated to accommodate Elk and shall have a minimum vertical clearance of 13 feet per the requires of Book 2, Section 6.

16.3.7.1.2 Wildlife Underpasses

The minimum-sized opening for the wildlife underpass shall be 32 feet wide in accordance with Book 2, Section 6. The Mesa wildlife underpass shall require a minimum vertical clearance of 12 feet above the path as only deer are anticipated to use this underpass. The Valley wildlife underpass is anticipated to accommodate elk and shall be a minimum vertical clearance of 13 feet in accordance with Book 2, Section 6.

Wildlife underpasses shall be free draining. Standing and or ponding water is not allowed within or around the wildlife Structure.

16.3.7.2 Type

Bridge types shall follow the guidelines in the BDM unless otherwise specified in this Section. Alternate Bridge types will be allowed, but only if they have been accepted for general use by other US State Transportation Authorities for major Highways. The Contractor shall demonstrate that the design of the alternate Bridge types and components meet the Project Technical Criteria and perform well under the Project's environmental conditions, including frequent freeze-thaw cycles, anti-icing, and de-icing. Proposed Bridge types in the Structural Concept Plans/Report, historically not used by CDOT, shall be submitted for Approval prior to Structure Concept Plan and Report submittals.

Experimental Bridge types, timber Bridges, steel trusses, and masonry Bridges will not be allowed. An experimental Bridge type is a Bridge type that has not been accepted for general use by other US State Transportation Authorities. The use of structural-plate arches is allowed for wildlife underpasses and not allowed for water crossings. If structural-plate arches are used for wildlife underpasses, they shall have a moisture barrier per Section 515 of the CDOT Standard Specifications or as approved by CDOT.

16.3.7.3 Components

16.3.7.3.1 Bridge Rails

Bridge rail shall be FHWA MASH compliant, meeting the following requirements.

Bridge rail requirements are as follows:

1. Florida River Bridge shall be MASH Bridge Rail Type 10.
2. Wildlife underpasses rails shall be Guardrail Type 9 or Guardrail Type 3. Wildlife underpasses shall extend behind guardrail per CDOT Standard M-606.

Cover plates shall be used over the interior face of joints on concrete barrier and concrete Bridge rail curb to provide safety shape continuity across the joint. Bridge rails shall be used on approach slabs.

Conduits shall be provided in Bridge rails on the outside Shoulder of Bridges where conduit runs are required for the Project. Refer to Book 2, Section 20 for ITS conduit requirements. No additional spare conduits shall be provided through the Bridge Structures.

16.3.7.3.2 Fencing

Chain link fence shall not be used on Bridges or wingwalls.

16.3.7.3.3 Drop-Off Protection

Bridge walls and wingwalls that may be accessed from the Highway by descending from the edge of pavement shall be categorized as CDOT Maintenance Personnel Protection and be protected by safety rail (cable), pedestrian railing, or safety railing. When deer fence is designated to be installed adjacent to a wall, deer fence shall be used. All other walls shall provide, at a minimum, tie-off points to conduct routine maintenance.

16.3.7.3.4 Approach Slabs

Approach slabs shall be a minimum of 20 feet in length measured along the centerline of the Bridge, except when other physical features of the Project preclude this minimum length.

The use of precast approach slabs shall be submitted to CDOT for Approval prior to Structure Concept Plan and Report submittals.

Bridge rails shall be connected to approach slabs.

Drainage and backfill behind the abutments and beneath the approach slabs shall be as shown on CDOT Bridge Structural Worksheet Backfill Drawings B-206-F1, B-206-F2, B-206-01, or B-206-M2.

Approach slabs shall not be used as jump spans.

16.3.7.3.5 Decks

Open or filled and partially filled metal grid decks, orthotropic steel decks, aluminum decks, fiber-reinforced polymer decks, and sandwich deck panels shall not be used.

Full-depth precast deck slabs shall have cast-in-place concrete joint closures, post-tensioning across joints, and an overlay.

Pretensioned, precast concrete deck forms shall be a minimum of 3-inches thick and have a full grout or concrete bearing. Full grout is defined as a 1-inch minimum thickness by 2-inch wide grout pad.

The use of concrete stay-in-place deck forms is optional and may be used for cantilevered portions of deck. Metal stay-in-place deck forms are prohibited from use. Precast double tees or precast box girders without a cast-in-place Bridge deck or concrete topping shall not be used.

16.3.7.3.6 Expansion Joints

Aluminum joints shall not be used.

If compression seal joints are used, they shall be the continuous elastomeric type and not the segmental foam seals.

The end dam on the approach slab shall be detailed to accommodate overlay.

Expansion joints shall be located at the Roadway ends of the approach slabs and not over the Bridge Substructure units.

16.3.7.3.7 Overlays

Bridge overlays shall be $\frac{3}{4}$ inch Polyester Polymer Concrete when the adjacent Roadway pavement is concrete.

16.3.7.3.8 Superstructures

Jointless construction shall be implemented as discussed in Section 14.4.1 of the BDM. The use of expansion joints at abutments and piers shall be submitted to CDOT for Approval prior to Structure Concept and Report submittals. Bridges shall be continuous over supports and shall not use intermediate hinges.

The minimum concrete strength ($f'c$) shall be 4.5 ksi for any cast-in-place concrete member that forms part of a deck.

Bridge deck drainage and anti-icing pipes shall not be located inside box girders.

Shear studs on steel girders shall be field welded in accordance with Section 509.20(h) of the CDOT Standard Specifications.

The use of pins and hangers will not be allowed. Category D or poorer weld details in tension zones subject to fatigue stress ranges shall be avoided.

Preparation of steel Shop Drawings shall follow the AASHTO/National Steel Bridge Alliance (NSBA) Steel Bridge Collaboration Shop Detail Drawing Review/Approval Guidelines.

Girders shall be lettered sequentially, starting with "A" for each Bridge Structure on the RFC Documents.

Jacking locations and required jack sizes for bearing replacement shall be shown on the RFC Documents. Bridges shall be designed to withstand anticipated applied loads and forces with the Superstructure jacked at the locations shown on the RFC Documents.

16.3.7.3.9 Abutments and Piers

The bottom of the abutment cap shall extend a minimum of 18 inches below the bottom of riprap or slope protection, as shown in Figures 11-1, 11-3, and 11-4 in the BDM.

Integral or semi-integral abutments with deep foundations shall be used wherever applicable.

Foundation design shall include foundation performance under total scour from long-term degradation, contraction scour, and abutment scour, and pier scour for the scour design flood (strength limit state) and scour check flood (extreme event limit state) without accounting for support from the hydraulic countermeasures.

Major Structures shall not be located directly over minor Structures, nor can the major Structure's foundation and stability rely on the performance of a minor Structure(s). Foundations must be designed to the 500-year event and address concerns with hydraulic piping.

16.3.7.3.10 Slope Protection

Riprap or an Approved alternative shall be on the sloped portions under Bridges and anywhere else that scour may be of concern under Bridges.

16.3.7.3.11 Bridge Deck Drains

No intermediate deck drains are allowed.

16.3.7.3.12 Barrier

Median barrier, if required, shall be Guardrail Type 9 Single Slope Barrier anchored to the Bridge deck and approach slabs.

If the Highway is divided at a wildlife crossing, an atrium shall be provided in the center median. There shall be a minimum 3-foot wall that runs perpendicular to the Roadway between the wildlife underpasses northbound and southbound Structures that protect the center atrium from snow and light pollution.

16.3.8 Retaining Walls

The Technical Criteria in this Section shall apply to permanent retaining wall Structures. Retaining walls that support traffic for interim phases of traffic and are left in place to become part of the final Structure shall be considered permanent retaining walls and be designed and constructed as such. The first and second phases of two-phase walls shall be considered part of a permanent wall and shall be designed and constructed as such.

The Contractor shall have sole responsibility for the type, Material, performance, and safety of temporary retaining wall Structures.

16.3.8.1 Geometry

Retaining wall layouts shall address slope maintenance above and below the wall and provide returns into the retained fill or cut at retaining wall ends. Residual wall batter shall be into the fill or cut.

Lengths of walls without relief joints shall be limited to lengths that control the differential settlement.

16.3.8.2 Type

Retaining wall types shall follow the guidelines in the BDM unless otherwise specified in this Section. Other wall types will be allowed, but only if they have been accepted for general use by other US State Transportation Authorities. The Contractor shall demonstrate that the design of the retaining wall types and components meet the Project Technical Criteria and perform well under the Project's geotechnical and environmental conditions, including frequent freeze-thaw cycles, anti-icing, and de-icing. Proposed retaining wall types in the Structural Concept Plans/Report, historically not used by CDOT, shall be submitted to CDOT for Approval prior to Structure Concept Plan and Report submittals.

Experimental retaining wall types will not be allowed. Metal walls, including bin and sheet pile walls, recycled Material walls, Mechanically Stabilized Earth (MSE) block walls, and timber walls shall not be used for permanent retaining walls.

Permanent retaining walls and their associated structural support elements constructed for the Project shall be designed to resist corrosion or deterioration for a minimum service life of 75 years.

The latest FHWA geotechnical references and guidelines shall be used in conformance with the Contract and as provided at the following website:

https://www.fhwa.dot.gov/engineering/geotech/library_listing.cfm

Retaining wall installations shall provide for a positive drainage system of the Backfill. Backfill drainage outlets shall be shown on the plans. Retaining walls near irrigation lines for landscaping shall account for additional hydrostatic load due to a waterline break. Free draining Backfill Material and/or leak detection devices to reduce hydrostatic loads on retaining walls may be used.

16.3.8.2.1 Mechanically Stabilized Earth (MSE) Walls

The Contractor shall follow the FHWA Geotechnical Engineering Circular No. 11 - Design and Construction of Mechanically Stabilized Earth Walls as guidelines for the design and construction of MSE walls. MSE wall designs integrated with abutments shall account for thermal movement of the Bridge and approach settlement.

MSE walls near or in bodies of water shall account for soft saturated soils and scour and shall prevent fine washout between facing elements. MSE walls may be used in scour areas, provided the foundation of the wall is located below the scour level determined in accordance with CDOT Drainage Design Manual. MSE walls shall be designed for hydrostatic pressure or be constructed using a free-draining Material to account for water fluctuations, including rapid drawdown after flooding conditions, to prevent failure.

Soil reinforcement for MSE walls shall be galvanized or epoxy-coated steel, geogrids, or fabrics meeting creep requirements of AASHTO LRFD Bridge Design Specifications. The design shall account for any items projecting through the soil reinforcement. Placement of culverts and Utilities perpendicular to soil reinforcement within the reinforced soil mass shall be avoided. Metal portions of soil reinforcement shall be protected from corrosion due to stray electrical currents.

MSE wall panels shall be constructed of reinforced concrete and provide corrosion protection for prestressing or post-tensioning steel. The cover to reinforcing steel shall be a minimum of 2 inches. Wall panels in the splash zone shall use epoxy-coated reinforcing steel.

16.3.8.2.2 Soil Nail Walls

The Contractor shall follow the FHWA Soil Nail Walls Reference Manual and the BDM as guidelines for the design and construction of soil nail walls. Soil nail walls may only be used when top-down construction is warranted. The exposed surface of pneumatically placed concrete shall meet the requirements of this Section. Load Tests for soil nails shall be provided in accordance with the above FHWA guidelines.

16.3.8.3 Components

16.3.8.3.1 Fencing

Chain link fence shall not be used on retaining walls.

16.3.8.3.2 Drop-Off Protection

New retaining walls that may be accessed from the Highway by descending from the edge of pavement shall be categorized as CDOT Maintenance Personnel Protection and protected by safety rail (cable), pedestrian railing, or safety railing. When deer fence is designated to be installed adjacent to a wall,

deer fence should be used. All other walls shall provide, at a minimum, tie-off points to conduct routine maintenance. Reference Safety Railing section of the BDM.

16.3.9 Sign Structures

Major sign Structures and supports for Intelligent Transportation System (ITS) Equipment are not anticipated for this Project.

Minor sign Structures and supports shall be constructed in accordance with CDOT M&S Standard Plans.

16.3.9.1 Components

16.3.9.1.1 Foundations

Drilled Shafts shall be used to support overhead and cantilever sign Structures, as well as the ground-mounted Structures. The Contractor shall submit as part of the preliminary design plans submittal one general Project sign Structures foundation report for Acceptance. There shall be a minimum of 1 foundation boring within 10 feet of each single drilled shaft supporting large sign supports.

16.3.9.1.2 Connections

Connections shall be made with high-strength A325 bolts. Shop splices shall be made with full penetration butt welds. Base connections shall be made with full penetration shop butt welds. All sign connection hardware shall be galvanized with strengthened structural tubing at electrical connection openings.

16.3.9.1.3 Bridge-Mounted Signs

The Contractor shall not mount signs or brackets on Bridge Superstructures.

16.4 Submittals

Submittals shall be prepared, reviewed, and submitted in accordance with the requirements set forth in Book 2, Section 4.

16.4.1 Preliminary Design Documents

The Contractor shall submit Preliminary Design Documents for proposed major Structures and walls prior to proceeding to final design and preparation of the Pre-RFC Documents. The Preliminary Design Documents shall include Structure Concept Plans, Structure Concept Reports, and Preliminary Foundation Design Reports.

16.4.1.1 Structural Concept Plans

Structural concept plans shall include general layout drawings of proposed major Structures and retaining walls. Bridge plans shall be consistent with the Bridge Detail Manual for general layout drawings, as defined by the BDM. For proposed retaining walls, the general layout drawings shall provide plan, elevation, and typical section details like those provided for major Structures. The Contractor shall submit the plans to CDOT for Review as part of the Preliminary Design Documents submittal.

16.4.1.2 Structure Concept Reports

Structure concept reports shall be developed for the Structure type, Materials, foundation types, methods of accommodating differential settlement, design strategy for lateral loads, and design-life considerations for each major Structure. It shall also include a list of transportation authority's actual projects and references for all Bridges, and foundation types and retaining wall types not historically used by CDOT. Additional information provided for structures not historically used by CDOT. The Contractor shall submit the reports to CDOT for Review as part of the Preliminary Design Documents submittal.

16.4.1.3 Preliminary Foundation Design Report

A Preliminary foundation design report shall be submitted to CDOT for Review as part of the Preliminary Design Documents for each major Structure and minor Structure as required for the design of foundations for Bridges, retaining walls, and other Structures, in accordance with Book 2, Section 11. The report shall be in draft form and contain design recommendations and substantiating analysis for foundation elements, lateral earth load parameters, soil corrosivity analysis, seismic design parameters, and any other geotechnical design or analysis parameters necessary to complete the design.

16.4.2 RFC Documents

16.4.2.1 Pre-RFC Documents

Pre-RFC Documents shall be submitted for proposed CDOT-managed Structural assets. Pre-RFC Documents shall include plans and specifications; major and minor Structure load ratings; and the Foundation Design Report.

The Foundation Design Report shall be revised from the Preliminary Foundation Design Report and be the basis for the load analysis from seismic and earth loads and the basis for the design of foundation elements. Supplemental soil borings required for Structures design shall have been completed.

16.4.2.2 Final RFC Documents

The Final RFC Documents shall include resubmittal of the Pre-RFC Documents listed above with all comments addressed.

16.4.3 Final Design Documents

Final Design Documents shall include final plans and specifications for proposed CDOT-managed structural assets; design calculations and independent design calculations for major Structures; independent detail checks of the plans and specifications for major Structures; major and minor Structure load ratings, Foundation Design Reports, and a final submittal letter.

16.4.3.1 Final Plans and Specifications

The final plans and specifications for each Structure shall be signed and sealed by the Contractor's designer in accordance with laws for licensed Professional Engineers in the State of Colorado. Copies in .PDF and OpenRoads Designer or compatible electronic format shall be made of all plans for all Structures on the Project and submitted to CDOT for Acceptance.

16.4.3.2 Design and Independent Design Calculations

The design calculations or the independent calculations shall be prepared by, signed, and sealed by a Professional Engineer licensed in the State of Colorado. Copies in .PDF and electronic format shall be made of design and design-check calculations and submitted to CDOT for Acceptance as part of the Final Design Documents submittal.

Calculations shall be in English (Standard) units and identify which code is utilized and reference the appropriate section in the right-hand column. References shall be included in the calculations to computer programs used to do the calculations. Computer documentation shall include the name of program, vendor, version, and release date; record of software output and Verification of output with manual calculations or other recognized program; clear identification of input and output values and meaning; and check of input.

16.4.3.3 Load Ratings

A load rating package, as defined by the CDOT Bridge Rating Manual, shall be completed and submitted to CDOT for Acceptance as part of the Final Design Documents submittal for each major and minor Structure prior to the start of Bridge construction Activities.

16.4.3.4 Foundation Design Reports

The Foundation Design Reports shall be signed and sealed by the Contractor's designer in accordance with laws for licensed Professional Engineers in the State of Colorado. The foundation design reports shall be submitted to CDOT for Acceptance as part of the Final Design Documents submittal.

16.4.3.5 Final Detail Letter

The Contractor's designer shall submit a letter containing a Professional Engineer's stamp to CDOT for Acceptance as part of the Final Design Documents submittal certifying that Structure plans and specifications have been prepared in accordance with the current CDOT design standards. An example letter can be found at the CDOT's forms library.

16.4.4 As-Constructed Documents

As-Constructed Documents shall be submitted for each proposed Structure in accordance with Book 2, Section 4.

16.4.5 Working and Shop Drawings

The Contractor shall submit Working and Shop Drawings in accordance with Table 105-1 of the CDOT Standard Specifications. Preparation of steel Shop Drawings shall follow the Shop Detail Drawing Review/Approval Guidelines developed by the AASHTO/NSBA Steel Bridge Collaboration G1.1-1999. Working and Shop Drawing accuracy is the sole responsibility of the Contractor. Working Drawings shall be submitted for information only. The approved Shop Drawings (by the Contractor's Engineer) shall be submitted prior to fabrication for Acceptance by CDOT.

16.4.6 Bridge Owner's Manual

A Bridge Owner's Manual shall be developed and submitted to CDOT for Acceptance with the Final Design Documents for the Florida River Bridge. The manual shall follow the Bridge and Tunnel Enterprise Owners Manual Template.

16.5 Construction Requirements

A technical representative shall be at the Project Site to assist the Contractor with the Approved QMP for Structures. The representative shall maintain a construction diary. The diary shall be submitted with the Final RFC Documents.

The Contractor shall notify CDOT 7 Days in advance of reductions in vertical clearances or when lane closures, lane reductions, or lane width restrictions are put into effect.

Falsework shall be designed in accordance with the AASHTO Guide Design Specifications for Bridge Temporary Works. Shoring areas that are considered a risk to the traveling public shall require an independent design check. Falsework or shoring carrying live traffic shall be submitted to CDOT for Acceptance 10 Days prior to construction.

Temporary retaining walls constructed of Materials not allowed for permanent walls may be abandoned and left in place. Temporary retaining walls left in place shall be completely covered by soil or construction Materials, so they are not visible. Structural components of temporary retaining walls may be reused as part of permanent retaining wall (two-phase walls) systems, provided all structural support elements and Materials of the permanent retaining walls meet the requirements of this Section.

Exposed concrete surfaces in the splash zone shall be sealed. The limits of concrete sealer shall be shown on the plans.

Concrete guardrails shall not be cast monolithically with integral pier caps.

Installers of prestressing, post-tensioning systems shall be Post-Tensioning Institute (PTI) certified.

16.6 Deliverables

The following Deliverables shall be submitted to CDOT for Review, Acceptance, or Approval:

Table 16-7: Deliverables

Deliverables	Review, Acceptance, or Approval	Schedule
Deviations from CDOT's Bridge Design Manual and this Section	Approval	Prior to Acceptance of Final RFC Documents
Alternate Bridge rating software	Approval	Prior to major and minor Structure ratings
Concrete mix design and procedures	Acceptance	Minimum 15 Days prior to the anticipated concrete placement date
Refinements to the Project aesthetic guidelines	Acceptance	Prior to Preliminary Design Documents submittal

Request for Proposal
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Deliverables	Review, Acceptance, or Approval	Schedule
Formliner pattern	Acceptance	Prior to Preliminary Design Documents submittal
Bridge Aesthetic Report	Approval	Prior to Preliminary Design Documents submittal
Retaining wall aesthetic graphics	Approval	As part of the Preliminary Design Documents submittal
Full-size mockup of all surface treatments	Acceptance	As part of the Preliminary Design Documents submittal
Bridge types historically not used by CDOT	Approval	Prior to the submittal of the Concept Documents and Report submittals
Use of precast approach slabs	Approval	Prior to Structure Concept Plan and Report submittals
Use of expansion joints at abutments and piers	Approval	Prior to Structure Concept Plan and Report submittals
Wall Structure types not historically used by CDOT	Approval	Prior to the submittal of the Concept Plans and Report submittals
Sign Structures Foundation Report	Acceptance	As part of the Preliminary Design Documents submittal
Structural Concept Plans	Review	As part of the Preliminary Design Documents submittal
Structure Concept Reports	Review	As part of the Preliminary Design Documents submittal
Preliminary foundation design report	Review	As part of the Preliminary Design Documents submittal
Final plans and specifications	Acceptance	As part of the Final Design Documents submittal
Design and independent design calculations	Acceptance	As part of the Final Design Documents submittal
Load ratings	Acceptance	As part of the Final Design Documents submittal

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Section 16 - Structures

Deliverables	Review, Acceptance, or Approval	Schedule
Foundation design reports	Acceptance	As part of the Final Design Documents submittal
Shop drawings	Acceptance	Prior to fabrication
Falsework or shoring plans carrying live traffic	Acceptance	10 Days prior to construction
As-Constructed Documents	Acceptance	In accordance with Book 2, Section 4
Bridge Owner's Manual for Florida River Bridge	Acceptance	As part of the Final Design Documents submittal
Construction diary	Acceptance	As part of the Final Design Documents submittal
Final detail letter	Acceptance	As part of the Final Design Documents submittal