

15.0 Structures

The Contractor shall design and construct all of the Structures required to meet the Project criteria and make the Project fully functional in accordance with the Contract Requirements.

To advance longer-lasting highways, CDOT encourages using innovative technologies and practices to accomplish the fast construction of efficient and safe facilities. Consideration by the Contractor of state-of-the-art technologies and elevated performance standards that result in improved safety, faster construction, reduced congestion from construction, improved quality, and user satisfaction are encouraged.

15.1 Administrative Requirements

15.1.1 Standards

The versions of the referenced software, standards, data, and reports which are current at the time of the Proposal Due Date, including all interim revisions and updates, shall be used unless specified otherwise in this Section.

15.1.2 Software

The Contractor shall use industry standard software for connections to existing concrete structures and any other necessary structural designs.

15.2 Design and Construction Requirements

15.2.1 Materials

15.2.1.1 Concrete

Concrete incorporated into the project shall meet all requirements of Standard Specifications, Section 601. The proposed concrete mix design and procedures shall meet the above requirements and shall be submitted for Acceptance by CDOT at least three weeks prior to the anticipated concrete placement date.

The use of lightweight concrete will not be allowed.

Minimum and maximum design concrete strengths shall meet the requirements of Standard Specifications, Section 601.

15.2.1.2 Reinforcing Steel

Epoxy-coated reinforcing steel shall be used for any storage tanks that are selected to be constructed of concrete. All reinforcing shall consist of deformed bars only per ASTM A 615 and shall conform to the requirements of the Standard Specifications.

15.2.1.3 Structural Steel

Structural steel shall conform to AASHTO M 270, Grades 36, 36W, 50, 50W, 70 or 70W. Structural steel supplied for main load-carrying members or components in tension that are non-redundant shall be designated as fracture-critical, meeting the Charpy V-notch tests for Zone 2 in AASHTO M 222/M 222M and AASHTO M 223/M 223M.

All structural steel shall be galvanized per Standard Specifications, Section 509.

15.2.2 Design Parameters

15.2.2.1 General

The Contractor shall complete the design in accordance with the applicable.

No additional load shall be applied to the duct divider wall. The maximum capacity of the plenum floor to support additional loading of the pipe distribution network, any section valves, control valves, and sprinkler nozzles, etc., is provided in the Reference Documents.

The Tunnel Enhanced Fire Safety System installed within the tunnel plenum shall allow for continued access by EJMT maintenance staff. The ventilation system shall be validated by the Contractor to remain effective when all the Tunnel Enhanced Fire Safety System elements are installed and commissioned.

The Contractor shall submit the tunnel hanger system design to CDOT for Acceptance with the preliminary Design Package for each separate hanger type.

15.2.2.2 Loads and Forces

The Contractor shall design all Structures and connections, for loads and forces in accordance with the referenced design standards.

15.2.2.2.1 Live Loads

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.2.2 Dead Loads

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.2.3 Uplift

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.2.4 Thermal Forces

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.2.5 Seismic

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.2.6 Wind Loads

The Contractor shall design all Structures and connections for loads and forces in accordance with the referenced design standards.

15.2.2.3 Geotechnical Data

The Contractor shall determine the additional geotechnical information required and conduct supplemental investigations as necessary to complete the final design. Any boring logs or laboratory test results shall be presented in accordance with the referenced design standards.

Book 2 Section 15: Structures

If groundwater observation wells are necessary to monitor water level or water quality, it shall be the Contractor's responsibility to properly abandon, permit, or renew the permits of these wells in accordance with State Engineer's Office requirements.

15.2.2.4 Structure Foundation Analysis and Design Recommendations

The Contractor shall perform geotechnical analysis as required for the design of foundations for storage tanks, pumps, and other items necessary to complete the work. Design recommendations and substantiating analysis shall be documented in a Foundations Design Report as a part of the In-Process Design Packages for Structures as further described in this Section. If existing structures are used for supporting piping, utilities, etc. stamped calculations shall be provided showing they are adequate for additional loading.

15.2.3 Structure Aesthetics

The Aesthetic and Landscape Concept Plan shall include the necessary details and drawings to illustrate the proposed aesthetic elements identified by the Contractor for the visible Structures, including those meeting the requirements listed below and any additional proposed elements. The Aesthetics and Landscape Concept Plan must be Accepted by CDOT prior to beginning any construction Activities, including any early action items, unless the Activity is Approved by CDOT.

As part of the Concept Plan submittal, the Contractor shall include a visual graphic of each Structure (including components in the roadway spaces, structures, and tanks) to demonstrate aesthetic conformance to the United States Forest Service guidelines. The Concept Plan and associated graphics shall be submitted in both hard and electronic format. In all cases, graphics of proposed structure aesthetics shall include all visible surfaces, and shall be submitted to CDOT for Acceptance with the Contractor's proposed general layouts of each Structure. This submittal shall include drawings illustrating form, texture, and color.

All Structures with visible concrete surfaces, including those accessible by graffiti vandals, shall have a surface treatment of structural concrete coating.

Minimum Aesthetic elements for structures are described below.

15.2.3.1 Structures and Tanks

All walls and structures, including any above ground storage tank buildings, constructed as part of the project shall require Governmental Approval.

15.2.3.2 Components

15.2.3.2.1 Fixed Fire Suppression System (FFSS)

The Contractor shall design and construct the FFSS in accordance with all applicable standards.

15.2.3.2.2 Drainage

Drainage systems shall be designed in accordance with Book 2, Section 12.

15.2.3.2.3 Median

The median barriers at both tunnel approaches and portal areas shall be protected during construction.

15.2.3.2.4 Cast-in-Place Walls

Cast-in-place walls for concrete tanks and other structures shall be designed and constructed in accordance with current AASHTO LRFD Bridge Design Specifications and other referenced standards.

Book 2 Section 15: Structures

15.2.3.3 Removal of Existing Tunnel Components

Any existing components of the tunnels shall not be removed.

15.2.3.3.1 Tunnel Wall and Ceiling Panels

The Contractor shall reset any tunnel wall panels or tunnel ceiling panels removed during construction. Any panels broken due to the Contractor's Work, shall be replaced at the Contractor's expense. The porcelain ceiling panels may require specialized tools and/or techniques to drill through without damage.

15.2.4 Submittals and Reviews

15.2.4.1 Technical Concepts

The Contractor shall submit a Structural Concept Report, prior to proceeding with the initial design, for Acceptance by CDOT for any Structure that is proposed for the Project. Suggested submittal contents include elevation views and cross sections depicting structure components as the Contractor proposes. Also included shall be a maximum two-page description of type, materials, strategy for lateral loads, and design-life considerations for each proposed Structure.

15.2.4.2 Structural Concept Plans/Report Elements

15.2.4.2.1 Life Cycle Cost Analysis

The Contractor shall submit for Approval by CDOT, a 30-year life cycle cost analysis of the proposed FFSS. The cost analysis shall clearly state and justify (using historical data) the assumptions used in determining life cycle costs.

The life cycle cost analysis shall include construction cost and costs for scheduled maintenance and repair. The Contractor shall not include routine maintenance (testing, cleaning, flushing, etc.) or demolition and salvage at the end of the 30 years. Maintenance and repair costs shall include material and labor plus an additional 10 percent for traffic control if required for the Work. Items of maintenance and repair shall include, but not be limited to steel painting, refitting connections, nozzle replacement, and drainage systems.

Life cycle cost analysis shall be based on acceptable methods and procedures.

15.2.5 Design

15.2.5.1 Reviews

Reviews will be conducted in accordance with the Contractor's Approved Quality Management Plan. Shop drawings shall be submitted for review by the Contractor's Engineer. The Contractor is solely responsible for shop drawing accuracy.

Structure drawings shall conform to CDOT CADD Standards as described in the CDOT Bridge Detail Manual. Structure drawing standards shall be addressed in the Contractor's Approved Quality Management Plan.

15.2.5.2 Progress Submittals

When requested by CDOT for review, the Contractor shall submit design packages for the Project in accordance with the Contractor's Approved Quality Management Plan.

15.2.5.2.1 Minor Structural Elements

The Contractor shall submit only a final design document package for minor structural elements.

Book 2 Section 15: Structures

15.2.5.3 Released for Construction, Revisions to Released for Construction and As-Built Documents

Drawings and specifications for each Structure shall be signed and sealed by the Contractor's Engineer of Responsible Charge in accordance with the laws for registration of Professional Engineers in the State of Colorado.

Copies in PDF and MicroStation electronic format shall be made of all plans for all Structures on the Project and submitted to CDOT on CD, DVD, or USB memory.

15.2.5.4 Documentation

Design and design-check calculations shall have pages numbered and shall include a table of contents. All calculations shall identify which code is utilized and shall reference the appropriate section in the right-hand column of each relevant page of calculations. References shall be included in the calculations to computer programs that were 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.

All calculations shall be signed and sealed by the Contractor's Engineer of Responsible Charge in accordance with the laws for registration of Professional Engineers in the State of Colorado. Copies in PDF format shall be made of all design and design-check calculations for the Project and then submitted to CDOT on CD, DVD, or USB memory.

All CAD data used to display information on official project plans must be supplied to CDOT at Project completion. This includes all plan sheet files and references used to display design information on the sheet. The data must be in a MicroStation DGN format, or any other CDOT Accepted format. All CAD data must comply with the CDOT CADD standards in place at the time that the final plans and specifications package is completed. The data must be supplied on CD, DVD or USB memory in a folder structure that is similar to that used by CDOT for project data organization.

15.2.5.5 As-Built, Falsework, Shoring, and Shop Drawing Plans

Falsework and shoring plans shall be signed and sealed by the Contractor's Engineer of Responsible Charge in accordance with the laws for registration of Professional Engineers in the State of Colorado. Shop Drawings and Working Drawings shall be reviewed and approved by the Contractor's structural design engineer, as evidenced by a formal stamp-and-sign procedure that is described in the Contractor's Approved Quality Management Plan.

The Contractor shall submit As-Built Drawings, with Shop Drawings and Working Drawings for each Structure, in accordance with the Contract Documents. The Contractor shall seal Shop Drawings in accordance with Table 105-1 of the Standard Specifications. Copies in PDF format shall be made of all As-Built and Shop Drawings, and Working Drawings for all Structures on the Project and submitted to CDOT on CD, DVD, or USB memory.

The Contractor shall follow the Shop Detail Drawing Review/Approval Guidelines generally used in the fire protection industry, or as referenced, for preparation of FFSS Shop Drawings. Shop Drawings shall be submitted to CDOT for information only. The Contractor is solely responsible for Shop Drawing accuracy.

Book 2 Section 15: Structures

15.2.5.6 Construction Requirements

CDOT shall be notified one week in advance of reductions in vertical clearances or when lane closures, or lane reductions are put into effect.

15.3 Deliverables

At a minimum, the Contractor shall submit the following to CDOT for Review, Approval, or Acceptance:

Table 15-1: Deliverables by the Contractor

Deliverable	Review, Acceptance, or Approval	Schedule
Concrete mix design and procedures	Acceptance	At least three weeks prior to the anticipated concrete placement date
Tunnel Hanger System	Acceptance	With the Preliminary Design Package for each separate hanger type
Aesthetic and Landscape Concept Plan	Acceptance	prior to beginning any construction Activities
Structure aesthetics graphic	Acceptance	With the Preliminary Design Package
Structural Concept Report	Acceptance	Prior to initial design for any proposed structure
Life cycle cost analysis	Approval	With the Structural Concept Plans/Report
Minor structural elements	Review	With the Final Plans and Specifications Package
Released for Construction documents and associated revisions	Acceptance	According to the Contractor's Quality Management Plan
As-Built Documents	Acceptance	According to Contractor's Quality Management Plan

All deliverables shall also conform to the requirements of Book 2, Section 3.