POLICIES AND PROCEDURES

A. GENERAL POLICY

The Colorado Department of Transportation (CDOT) Bridge Design Manual (BDM) provides the policies and procedures currently in effect for the design, rehabilitation, repair of bridges/structures and for projects that use federal or state funds. This BDM is also recommended as best practice for any project that does not contain federal or state funds and other structures that are within CDOT right-of-way (ROW). This BDM presents the minimum requirements for structure projects including the structural staff, submittals, design and construction specifications, and project processes. The BDM shall be applied to structures that require special design (i.e., modified from the CDOT M & S Standards) with the exceptions noted in Part I Exceptions, Number 4.

The latest edition of *AASHTO LRFD Bridge Design Specifications* (AASHTO) with current interim revisions is the primary document guiding the design of highway structures. Other specifications may be required for structural design but only as referenced by this BDM or by AASHTO. This CDOT BDM supplements AASHTO, as well as other applicable AASHTO documents, by providing additional direction, clarification, and requirements. Where discrepancies arise between this BDM and applicable current AASHTO specifications, this BDM will control. The State Bridge Engineer (defined in Part D) shall resolve conflicting information between standards referenced herein or any other CDOT document.

All AASHTO specifications and codes and BDM revisions shall apply to any future design projects when they are officially issued. All projects should be evaluated to ascertain the effects of using the new requirements immediately for safety, design capacity, performance, schedule, cost, contractual and other implications. If implications are minimal, design projects that are in preliminary design stages should use the latest requirements. If implications are more substantial, Shelf projects, post-FIR projects, and those projects with contractual limitations may choose to continue with the previously issued LRFD requirements. Safety revisions or standards revisions, such as crash tested bridge rail, may be required to add at any stage of the project.

Using this BDM does not relieve the Engineer of their responsibility to provide high-quality deliverables or to exercise sound engineering judgment. The Engineer is to verify all figures. Figures are shown as examples only, but the design responsibility is that of the Engineer. Staff Bridge will consider variances from the policies presented in this BDM when warranted. If different interpretations of a given article arise, guidance shall be obtained from Staff Bridge. Unless otherwise specified, the Unit Leader in coordination with the Staff Bridge Senior Design & Construction Engineer must authorize any additional modifications and variances to the BDM. Variance request examples can be found on the Bridge website.

Thorough knowledge of the contents of this BDM is essential for anyone designing structures that meet the above defined criteria.

Previous editions of the BDM and Bridge Design Technical Memorandums are now void.

B. BRIDGE DESIGN MANUAL DISTRIBUTION AND MAINTENANCE

Copies of the CDOT BDM can be obtained from the CDOT website

The Office of the Staff Bridge Branch maintains the computer files containing this BDM, coordinates revisions, and makes updates available. The Staff Bridge Branch also maintains a revision log showing all the revision dates that have transpired for each section and the person who wrote the revision.

Before starting a structural design project, the Engineer shall obtain a copy of this BDM or if the Engineer already has a manual, they shall inspect the current table of contents to make certain their copy of the BDM is up to date.

C. REVISIONS

This BDM is intended to be dynamic. Revisions will be incorporated as new material is added and as criteria and specifications change. The State Bridge Engineer shall approve and publish all revisions.

Suggestions for improving and updating this BDM are encouraged. Anyone who would like to propose revisions should informally discuss changes with other Bridge Engineers to further develop and refine ideas. All suggestions shall be submitted to the Staff Bridge Manager of Policy and Standards, who then will present the State Bridge Engineer with a preliminary draft showing the developed concept.

On deciding to pursue the revisions, the State Bridge Engineer will assign them to an Engineer. The Engineer receiving the assignment is responsible for completing the final writing, distributing the revisions to all Staff Bridge personnel for their review and comment, making revisions as appropriate based on the comments received, and submitting the final draft to the State Bridge Engineer for approval.

When a revision is made, the entire section containing the revision will be reissued. The revision date is provided in the lower right corner of the page. Whenever revisions are issued, they shall be accompanied by a cover document signed by the State Bridge Engineer.

D. DEFINITIONS

Staff Bridge Managed/Tracked Structural Assets: Structures managed and assigned a structure number or structure ID.

All managed/tracked assets (bulleted items below) within CDOT ROW require a structure number. Outside of CDOT ROW, only vehicular bridges longer than 20' and tunnels require a structure number. A structure number does not denote CDOT ownership or maintenance responsibilities, only assets that CDOT manages or tracks. Structure numbers are used to track structures and for FHWA reporting requirements.

Refer to Part E2 of this Section for information about structure number assignment.

- **Major Structures:** Bridges and culverts carrying vehicular traffic with a total length greater than 20 ft. measured along the centerline of the roadway between the inside face of abutments, inside faces of the outermost walls of culverts, or spring lines of arches. Culverts with multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening shall be considered one structure. If the linear distance between the first culvert sidewall and the last culvert sidewall is greater than 20 ft., (See measurement A in Figure 1) the structure is considered a Major Structure. .

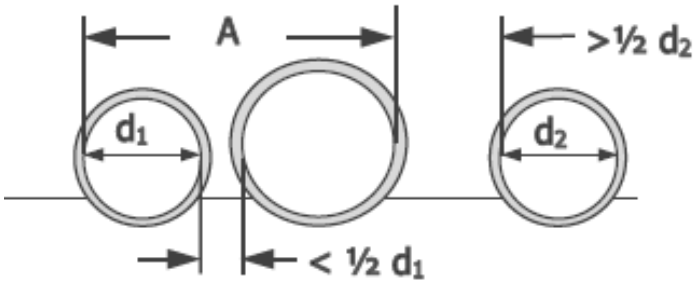


Figure 1: Multiple Pipes - Major vs Minor

In the Figure 1 above, the two pipes within dimension A will be considered one structure because the clear distance between openings is less than half of the smaller contiguous opening. If A is greater than 20 ft. measured along the centerline of the roadway the two pipes will be considered a Major Structure. If A is greater than or equal to 4 ft. and less than or equal to 20 ft. measured along the centerline of the roadway the two pipes will be considered a Minor Structure.

- **Minor Structures:** Minor Structures are bridges, culverts, or a group of culverts carrying vehicular traffic that have a total length greater than or equal to 4 ft. and less than or equal to 20 ft. measured along the centerline of the roadway between the inside face of abutments, inside faces of the outermost walls of culverts, or spring lines of arches. As shown in Figure 1, multiple pipes may be considered a single structure, and if distance A is greater than or equal to 4 ft. and less than or equal to 20 ft., the structure is considered a Minor Structure.

- **Walls:** Retaining Walls, Noise Walls, and Non-qualifying Walls as defined below. Refer to the *CDOT Retaining and Noise Wall Inspection and Asset Management Manual* for more detailed information.

    - **Retaining Walls:** Any wall that retains fill and measures at least 4 ft. in height from finished grade to the top of the wall at any point along the length of the wall. Additionally, any wall which supports or protects a CDOT roadway or structure regardless of its height.

- **Noise Walls:** Noise Walls with structural elements including walls that do not typically retain soil. Refer to the CDOT Retaining and Noise Wall Inspection and Asset Management Manual if a Noise Wall retains backfill.
- **Non-qualifying Walls:** Walls retaining backfill measuring less than 4 ft. in height from the finished grade to the top of the wall at any point along the length of the wall and don't support or protect a CDOT roadway or structure. Previously and commonly referred to as Landscape walls.

Reinforced Slopes with no visible/inspectable facing elements are tracked under the Geohazard Program and would receive a tracking number from that group. Rock bolting although visible would also fall under the geohazard program.

- **Tunnels:** An enclosed roadway for motor vehicular traffic with vehicle access limited to portals, regardless of type of structure or method of construction. Tunnels are structures that may include lighting, ventilation, fire protection systems, and emergency egress capacity.
- **Ancillary Structures:** Ancillary structures are overhead signs, mast arm signals, and high-mast lights (height greater than 70 ft.). Cattle and deer guards are included in this category.
- **Other Structures:** A non-vehicular structure in CDOT ROW that does not fit into any of the aforementioned categories. Examples include overhead pipes, overhead cables, railroad bridges, pedestrian/bike structures, private drive structures, overhead conveyor belts, and overhead snow sheds.

Bridge and Tunnel Enterprise (BTE) Managed Assets: Major or minor structures owned by BTE. See above for structure definitions.

On-System / Off-System Bridges: Any bridge owned by a local agency (cities and counties) is considered Off-System with some exceptions. Any bridge owned by CDOT or BTE is considered On-System. A more specific definition can be found in *Colorado Off-System Bridge Program Description and Guidelines for Selecting Bridges for Rehabilitation or Replacement Funding*.

Design Life / Service Life: The design life is the period for which a component, element, or bridge is expected to function for its designated purpose when designed, constructed, and maintained as per standards. The service life is the period for which a component , element, or bridge provides the desired function and remains in service with appropriate preservation activities. This may also be called as useful life.

State Bridge Engineer: Chief Structural Engineer for the Staff Bridge Branch of the Colorado Department of Transportation. The State Bridge Engineer is responsible for structures within CDOT ROW and federally funded off-system projects and manages CDOT's Bridge Program, which includes Major Structures, Minor Structures, Tunnels, Walls, and other highway structures,

including all ancillary and miscellaneous structures on the state highway system and federally or state funded off-system projects.

Staff Bridge Manager of Policy and Standards: A CDOT Staff Bridge employee who reports to the State Bridge Engineer and manages the implementation of CDOT Bridge Design Policy and Standards used for the design of transportation structures (standards include this CDOT BDM and the documents defined in Part F). Staff Bridge Manager of Policy and Standards ensures that the Department's policy is clearly communicated, is readily referenced, and benefits the mission of the Department.

Staff Bridge Unit Leader: A CDOT Staff Bridge employee who reports to the State Bridge Engineer and manages the bridges and highway structures located in a geographical CDOT Transportation Region. Refer to the CDOT website for Region jurisdictions. Staff Bridge Unit Leader is also mentioned simply as Unit Leader in this manual.

Project Structural Engineer: A licensed professional engineer (by the State of Colorado), with structural design experience, acting in responsible charge of structural design work. Other than the sealing of plans and specifications, the activities described in this BDM pertaining to the Project Structural Engineer may be executed by a designee. There may be more than one Project Structural Engineer on a project as in the case where there is more than one structural design team working on separate Major Structures or for Design-Build where the Contractor will have a Project Structural Engineer for the Contractor's portion of the structural design work. For some Retaining Walls with significant geotechnical design issues, such as soil nail walls, tieback walls, and slurry walls, the Project Structural Engineer may be a Geotechnical Engineer.

Structural Design Engineer: A design engineer responsible for generating design calculations, construction plans, specifications, and reports. This person can be the Project Structural Engineer. The Structural Design Engineer may be referred to as the Designer or Engineer in this BDM.

Independent Design Engineer: A design engineer who develops an independent set of calculations based on the construction plans and specifications completed by the Structural Design Engineer. This includes vendor provided structural products signed and sealed by a Colorado Licensed Professional Engineer. This is a quality control task that is described in more detail in BDM Section 37.

Independent Technical Reviewer: A highly experienced engineer independent of the project team who conducts an independent technical review of the project deliverables focusing on general conformance with standard practice, AASHTO, and this BDM. This review does not involve development of detailed calculations. The review should consider other aspects of construction, such as interdisciplinary coordination, constructability, and biddability. The independent technical review is also known as an independent design review or a technical peer review. This is a quality control task that is described in more detail in BDM Section 37.

Constructability Reviewer: A construction engineer or licensed professional engineer with significant construction experience who reviews the project deliverables focusing on constructability and inspectability. This is a quality control task that is described in more detail in BDM Section 37.

CDOT Structural Reviewer: A CDOT employee with a professional engineer's license and structural design experience. This employee conducts the Department's structural design reviews on a Consultant project. The Structural Reviewer may delegate this task to a non-licensed engineer. This is a quality assurance task that is described in more detail in BDM Section 37.

Program Engineer: The immediate supervisor of the Resident Engineer.

Resident Engineer: The CDOT employee who is responsible for the administration of a project. The Resident Engineer, or their designee, can either be the preconstruction Project Manager or the construction Project Engineer, or both.

Project Engineer: As defined in CDOT's Standard Specifications for Road and Bridge Construction, the CDOT Chief Engineer's authorized representative who is responsible for the administration and satisfactory completion of a given construction contract.

Local Agency Project: Federally funded off-system transportation project executed by a public agency, local public agency, established publicly owned organization, or private interest that can legally enter into an agreement with CDOT.

Developer Project: A construction project within CDOT ROW sponsored and funded by either a private or a public entity other than Federal/State funds.

Stamped Documents & Disclaimers: Stamped documents required as part of this design manual are governed by applicable CDOT policies and State Law. Disclaimers accompanying any Professional Engineer's Stamp shall not limit CDOT's use of documents procured through CDOT contracts or for projects within or impacting CDOT assets or Right of Way. See Appendix B at the end of this Section for more information on what is required to be stamped.

E. STRUCTURES PROCESS

Design of structures involves compliance with the minimum requirements outlined in this BDM, as well as coordination with disciplines including, but not limited to, Survey, Right-of-Way, Utilities, Roadway Design, Traffic, Hydraulics, Geotechnical, and Environmental. The structures design process outlined in Appendix A of this Policies and Procedures section presents a diagram for the overall structure design and a more detailed breakdown of coordination with hydraulic design. For simplicity, the process diagram may not specifically address each aforementioned discipline; therefore, it is important to coordinate with each discipline throughout the entire project. Process diagrams for rehabilitation projects and overlays are found in Section 33. Projects involving railroad agencies will require additional submittals and longer review time.

Note that all CDOT projects and Local Agency projects with CDOT oversight are required to use CDOT ProjectWise© for storing all project files. Files shall be placed in CDOT ProjectWise within 2 weeks of any meeting, milestone or deliverable date. Files shall be in accordance with Section 6 Archiving.

1. Project Scoping for Major Structures, Walls, and Tunnels

Scoping: The Program Engineer and Resident Engineer will determine when to involve structural engineering staff in project scoping. To prevent later changes to the project scope, the Staff Bridge Branch should be involved in any scoping related to Major Structures, walls, and tunnels. When the project involves existing structures, the information available from Staff Bridge on these structures shall be used.

Project scoping should include a determination that a new structure is required or rehabilitation of an existing structure is feasible. This determination shall be confirmed during preliminary design.

On Consultant projects, CDOT's Structural Reviewer and the Consultant's Project Structural Engineer shall review the contract Scope of Work before signing the Consultant's contract. The structure activities in the Scope of Work shall be consistent with the requirements outlined in this BDM.

Schedule and Workhour Estimates: When preparing schedules and workhour estimates, the Resident Engineer shall obtain estimates for the structure tasks from the Project Structural Engineer concerning the level of work performed by Staff Bridge. The Resident Engineer shall obtain these work estimates from the CDOT Structural Reviewer on Consultant projects. The Resident Engineer will establish the final schedule and work hours; however, this decision is not to be made independent of information received from CDOT Staff Bridge.

Project Survey Request: The Project Structural Engineer shall participate in developing the project survey request to determine if any project-specific modifications to the basic information required by the CDOT Survey Manual are necessary.

2. Preliminary Design

The preliminary design for Major and Minor Structures, Pedestrian Structures, Walls, and Tunnels shall be conducted as outlined below to ensure that CDOT obtains a structure layout and type selection that achieves the project's objectives and minimizes revisions during the final design and construction phases. The Structure Selection Report presents the results of the preliminary design process. The report shall document, justify, and explain the Project Structural Engineer's structure layout and type selection. The Project Structural Engineer is responsible for ensuring that the following tasks are completed as appropriate:

a. Structure Number

All CDOT managed/tracked structural assets must be assigned a structure number. If the owner does not provide a number for a local-

agency owned structure, CDOT Bridge Asset Management Unit will assign a structure number. Tunnels, Major Structures, and other Ancillary or Miscellaneous structures are given a structure number based on the state grid system. Minor Structures and Walls are given a structure number based on highway and milepost. Structure numbers for mast arm signals are assigned based on milepost and quadrant. Any location changes for Walls (primarily the beginning) may require a new or a revised structure number. Locations should be finalized before obtaining a structure number, if possible, to minimize rework. Temporary structure numbers may be used before obtaining the final structure number, but plans issued for construction or advertisement shall use final structure numbers. For existing structures, the Project Structural Engineer shall obtain new structure number from Staff Bridge Asset Management Unit if not assigned before. For new structures, Project Structural Engineer or PM must provide structure information to CDOT Staff Bridge Asset Management Group as early as possible for the assignment of a structure number. This structure number shall be used on all subsequent correspondence and plan sheets to identify the structure. Structure numbers should be provided to the Project Engineer for inclusion into or updates of the SAP system.

The Bridge Asset Management Unit is responsible for assigning structure numbers and will make any decisions pertaining to structure numbers. To submit a request for a structure number, use the spreadsheet located on the CDOT website, Bridge Section, Forms and Form Letters. The following information, shown on the spreadsheet, is necessary before they can assign a number to a given structure:

(1) Geographical Location

- County, Highway Number (State),Milepost, Latitude, and Longitude (If Milepost is not known, Latitude and Longitude information may be substituted). For walls, Latitude and Longitude for the beginning (lowest mile point) of the wall is necessary.

- Feature Intersected (stream, river, highway, etc.), and facility carried.

(2) Project Number and Subaccount

(3) Existing Structure Number, if applicable

(4) Structure Information

- Type
- Material
- Bridge Typical Section
- How many spans
- Structure Length

- Width
- Designer
- Notes

b. Structure Data Collection

Obtain all data necessary for the layout and design of the structure, including, but not limited to, survey data, ROW restrictions, roadway geometry and safety criteria, utility information, hydraulic information, geotechnical recommendations, existing bridge data, accelerated bridge construction opportunities (include prefabricated items such as ACROW, InQuik, precast girders, etc.), life-cycle maintenance considerations, lighting/aesthetic requirements, and environmental clearance issues affecting the structure.

c. Foundation Investigation Request

Initiate the foundation investigation as early as practical by contacting CDOT Soils & Geotechnical Services and the Project Manager. An example format is provided in forms/form letters. On documents such as preliminary plans or aerial mapping, identify test holes with enough geometric information for the Geotechnical Engineer to locate the holes in the field. Consider the certainty of substructure and wall locations before initiating the request so that borings are located correctly and avoid additional drilling and changes to foundation recommendations. Consideration should also be given to locating borings in areas of suspected approach settlement and slope instability. See BDM Section 2.9 for more details.

d. Structure Layout and Type Selection

Compile all the site and structure data and design criteria to accomplish the following:

- Confirm that the scoping decision of constructing a new structure or rehabilitating an existing structure is still feasible
- Determine structure meets hydraulic requirements
- Determine structure type or rehabilitation type alternatives
- Evaluate layout alternatives
- Determine feasible foundation types
- Develop phase/stage construction methods
- Compute preliminary quantities and cost estimates per BDM Section 35
- Evaluate structure alternatives per criteria established in BDM Section 2
- Select the preferred alternative
- Prepare a general layout for the preferred alternative

e. Structure Selection Report

Prepare the Structure Selection Report to document and obtain approval for the preliminary structure design from the Unit Leader via the SSR QA Checklist. This report should summarize the site data and process used to select and lay out the structure. Structure Selection Reports are required for Major Structures, Minor Structures, Wall Structures, Pedestrian Structures, and Tunnels. The Structure Selection Report for a Minor Structure, Major or Minor Structure Widening, Non-qualifying and Noise Wall, or Pedestrian Structure are typically shorter since fewer items affect their selection. See BDM Section 2.10 and Appendix 2A for more detailed requirements for developing the report, report contents, submission, and approval by Unit Leader.

The selection report should address any environmental concerns such as lead paint, hazardous materials, and safety concerns for designers or maintenance personnel.

When completed, place the structure selection report in ProjectWise.

f. Field Inspection Review (FIR)

On obtaining initial approval from the Unit Leader for the structure type selection and layout, the Project Structural Engineer shall submit the general layout for inclusion in the FIR plans. After the FIR, the general layout shall be revised as needed for final detailing.

Final approval should be obtained from the Resident Engineer for the revised general layout before proceeding with final design. The intent of this approval is to confirm design assumptions prior to final design to avoid costly re-designs at later design stages.

3. Final Design

The Project Structural Engineer shall ensure that the following tasks are completed after the FIR:

a. Revise Structure Selection Report as required

Submit a revised Structure Selection Report that incorporates comments received and accepted from the FIR submittal.

b. Perform Final Design Calculations

The Structural Design Engineer and Independent Design Engineer shall perform calculations for all structures not predesigned by M & S Standards supporting the contract documents in accordance with this BDM and noted standards. Design and independent check calculations should clearly state purpose, references, and assumptions. Ratings shall be completed during final design and checking.

c. Develop Construction Plans and Specifications

Develop Construction Plans in accordance with this BDM and the CDOT Bridge Detail Manual. The Project Structural Engineer is

responsible for ensuring that all CDOT Staff Bridge Worksheets and other standards are the current version before including them in the plans.

Construction items not adequately covered by the CDOT Standard Specifications for Road and Bridge Construction and applicable CDOT Standard Special Provisions for Road and Bridge Construction will require Bridge Project Special Provisions. CDOT Standard Special Provisions and Project Special Provision Worksheets are available at CDOT's website.

The design plans and specifications for the Release for Construction submittal shall not name sole source or proprietary products unless approved by Unit Leader. Sole source or proprietary products should only be used for innovative products.

d. Final Office Review (FOR)

Complete structural plans, Standard Special Provisions, and Project Special Provisions shall be submitted for inclusion in the FOR submittal. The Project Structural Engineer shall attend the FOR meeting to obtain review comments on the structural design. After the FOR meeting, the Project Structural Engineer shall ensure the plans and specifications are revised as needed and submitted for inclusion in the final plan set.

4. Final Design Submittal

Final design submittal documents, including the Final Design Submittal Checklist found in Appendix B, shall be submitted and placed in ProjectWise prior to advertisement, or before construction for Design-Build or CM/GC projects, unless otherwise approved by the Unit Leader. All PDF documents shall be in conformance with ISO PDF/A-1b archival specifications as described in section E.6 below. The final design submittal shall include the following:

a. Construction Plans and Specifications

(1) Plans shall be submitted in both PDF and native file format. For CDOT Projects, Microstation© files are required.

(2) Specifications shall be submitted in both PDF and Microsoft Word© format.

(3) Plans and specifications will be electronically sealed, per CDOT requirements but since this is a separate process, the record set will not be a structural final submittal requirement. The Project Engineer or Resident Engineer will send out the plan set and specifications for sealing for placement into CDOT ProjectWise.

b. Final Hydraulic, Geotechnical and Structure Selection Reports

The final Structure Selection Report shall include the signature of the CDOT Staff Bridge Unit Leader on in-house projects and by the CDOT

Structural Reviewer on Consultant projects to indicate concurrence that conclusions in the report meet project goals and requirements.

Final Hydraulic and Geotechnical Reports must be signed and sealed by a Colorado Licensed Professional Engineer (CO PE sealed). Since sealing is a separate process, sealed reports will not be a structural final submittal requirement although a stamped version is preferred.

Geotechnical Report requirements can be found in BDM Section 2.9.2. Hydraulic (Drainage) Report requirements can be found in BDM Section 2.11.

c. Design Calculations and Independent Design Check Calculations.

Prepare design calculations and Independent Design Check Calculations for submittal. Calculations shall be:

- Clear and legible
- Organized (indexed) so individual calculations are easy to find
- Easy to follow, i.e. calculations should provide inputs (givens) and results
  - Summary of purpose of calculation - project, background, logistic, theme and basics of the calculations
- Well documented (i.e. specification references for equations & values, sketches, etc.)
- When software output is included, all inputs (sketches, etc.) should be provided as well.
- Include all native software files including input files that support the calculations. Spreadsheets, Mathcad files etc. are required only if it is in the project scope, i.e. developed for the project. (Example Program Management projects). Native files for priorly created files are not required.
- Two PDFs, one consisting of the Design Calculations and the other for Independent Design Check Calculations. Design Calculations and Independent Design Check sets shall each be sealed by a Registered Professional Engineer in the State of Colorado and shall be submitted with the Final Design submittal.

Rating calculations or analysis for phasing shall be provided as a separate document and will follow the requirements shown above. This document is to verify the color code for the existing bridge is still applicable during phased traffic loading.

Quantity calculations shall be calculated and independently checked based on the requirements in BDM Section 35. A record set of final quantity calculations for all pay items shown on the Summary of Quantities shall be provided as a separate document. This requirement does not apply to Design-Build Projects. See BDM

Section 38 for more information about the differences for Design-Build projects.

d. Load Rating Package developed in accordance with the CDOT Bridge Rating Manual.

Load rating package is required for all Major Structures and pedestrian structures greater than 20 ft span which carry maintenance or emergency vehicles. It must be CO PE sealed. Ratings for all vehicles, including Colorado Permit vehicle must be ≥1 for all new structures.

e. Miscellaneous Information:

(1) Verify a copy of the existing bridge plans is available when requested. Due to availability of electronic records, a "field information package" is no longer required unless requested.

When items are to be removed or widened (bridges, expansion joints, bearings), verify the existing plans, shop drawings and working drawings are available. Project drawings should incorporate best available information. Existing plan sets are not necessary for overlay work.

(2) For Deck Rehabilitation projects, a sketch of the plan view for each bridge shall be provided to the largest scale that will fit on an 11"X17" and shall be provided to the Construction Manager for delineating actual repair areas. Sketch shall include a 5' grid (horizontal and vertical) for aiding in delineating areas, north arrow and pier and abutment labels.

f. A Final Detail Letter by CDOT and "Consultant Final Submittal Letter" by Consultants verifying that the structural plans and specifications have been prepared in accordance with CDOT's current design standards and quality control/quality assurance procedures. An example letter can be found at https://www.codot.gov/library/bridge/form-letters

g. Inspection Sketches

(1) Plans shall be submitted in both PDF and native file format. For CDOT Projects, Microstation© files are required.

(2) Project Structural Engineer or Structural Design Engineer shall place files in the inspection folder under "HQ/Staff Bridge." If the Consultant does not have access to ProjectWise, then the CDOT Structural Reviewer shall move inspection sketches to the specified location.

h. Structure Asset Management (SAM) Plan

(1) Verify that SAM plan includes all structure treatments in projects using Construction Bridge Program (CBP), Construction Culvert Program (CCP), or Construction Wall Program (CWP) funds.

i. For Design-Builds, the Contractor shall provide an FHWA Bridge Replacement Cost Report for all bridges on the project. The report shall include element costs of the structure and the unit cost of the bridge as defined by FHWA. The report shall be submitted to CDOT for acceptance with the Released for Construction (RFC) submittal for the structure. https://www.fhwa.dot.gov/bridge/nbi/uc_criteria.cfg

j. Intergovernmental Agreement (IGA)

When agreements are made between or involve two or more governments a copy of the IGA is needed to determine ownership and who is responsible for the maintenance of bridges. Typically, this is necessary for all managed structures built within CDOT ROW. These agreements are extremely important for long term asset management and designers should request copies of these agreements from the Project/Resident Engineer.

5. Construction

The Project Structural Engineer or Structural Design Engineer shall be available to the construction Project Engineer for assistance in interpreting the structure plans and specifications and for resolving construction problems related to the structure. Any changes or additions to the structure, as defined in the contract documents, shall be communicated to the Project Structural Engineer. BDM Section 36 describes all other construction-related procedures.

The Local Agency or Design Builder shall provide quality assurance (QA) level fabrication inspection as defined in the Local Agency Manual or Design Build RFP (Request for Proposal) unless otherwise approved by the CDOT Fabrication/Construction Unit. The Fabrication/Construction Unit shall provide fabrication inspection services when CDOT provides the construction engineering, only on projects advertised for construction by CDOT. The responsibility for fabrication inspection shall be clarified before advertising a project.

A final inspection review (owner acceptance/final walkthrough) is required after construction. See Section 36.7 of this BDM for a description.

6. Archiving

The Project Structural Engineer shall archive all pertinent documents in ProjectWise when received or by Final Inspection/Owner Acceptance Walkthrough. All PDFs with text or numerical data shall be 300 dpi, page aligned, text searchable, compressed and in conformance with ISO PDF/A-1b archival specifications. The Project Structural Engineer or Structural Design Engineer is to make sure that all documents placed in ProjectWise have their attributes updated to include all known information. At a minimum, all documents shall include a Structure Number. A full list of attributes and documents can be found in the CDOT ProjectWise Reference Manual. CDOT employees are to refer to LMS My Learning for Smart Scanning training; all others are to contact DOT_Records_Mgmt@state.co.us for training on Smart Scanning and

Electronic Signatures. Repair and design build projects should also follow the archiving requirements listed. Refer to ProjectWise Reference Manual for the Bridge Project Folder Structure.

https://www.codot.gov/business/designsupport/cadd/projectwise-reference-manual/view

At a minimum, pertinent documents include:

a. Design Calculations and Independent Design Check calculations
b. Final Structure Selection Report
c. Load Rating Package, including the electronic bridge model file
d. Final Geotechnical Report
e. Final Hydraulics Report
f. Final bid documents, including Plans and Specifications in PDF format
g. Design Build RFP Structures Section
h. Design Build RFP Project Specials
i. Design Build RFP Alternative Technical Concepts (ATC) after award
j. MicroStation DGN files and related reference files. Verify that reference file association is working correctly before finishing archiving process. Provide cross-sections for walls in DGN format.
k. Final Design Submittal Checklist (by Unit Leader)
l. Correspondence directly affecting design and construction
m. Final Detail Letter & Consultant Final Submittal Letter (as applicable)
n. All construction documents, including, but not limited to, as-built drawings, working drawings, shop drawings, material certifications, and test reports
o. Inter-Governmental Agreements (IGA's) when applicable
p. Inspection Sketch
q. Software Input Files (Calculations & Ratings)
r. Bid Summary
s. FHWA Bridge Replacement Cost Report for Design-Build projects. Share with cost estimating group (EEMA).
t. SAM Plan verification of projects using CBP, CCP or CWP funds

F. CDOT STAFF BRIDGE PUBLICATIONS

Copies and revisions to these documents may be obtained from the CDOT website (https://www.codot.gov/library/bridge) or from the Office of the State Bridge Engineer.

1. CDOT Bridge Detail Manual

The CDOT Bridge Detail Manual provides the policies and procedures for developing and checking contract plans. For CADD information not covered by the Bridge Detail Manual, refer to CDOT's Office of CADD & ProjectWise Programs, and Highway Engineering Design Processes.

2. CDOT Staff Bridge Worksheets

General Use: The CDOT Staff Bridge Worksheets are pre-detailed drawings that include structure details for various bridge design policies. The details are directly applicable for most projects; however, they should be checked if project-specific modifications are necessary. The intent is to standardize details as much as possible among CDOT projects; however, it is important to understand that the accuracy and use of the drawings is the responsibility of the Project Structural Engineer. Any project changes to worksheets must stay in compliance with the specific worksheet design policy and other Staff Bridge requirements and practices. Typically, each sheet will note whether changes and which changes are acceptable without a variance. An example of this are the bridge rail worksheets. Some changes are expected depending on the deck details, but changes to the reinforcing, dimensions, and detailing of the bridge rail itself could affect their crashworthiness and requires a variance by the State Bridge Engineer in coordination with the Bridge Rail Subject Matter Experts. The worksheets do provide some minimum requirements, such as concrete footers for MSE walls, so any planned changes should be discussed with the Unit Leader in coordination with the appropriate Subject Matter Expert.

All applications of these Worksheets shall originate from the file posted on CDOT’s website. Note that Worksheet numbers are for identification only and shall be removed at the same time the designer’s, detailer’s, and checker’s initials are placed on the sheet.

In general, the CDOT Standard Plans (M & S Standards) do not provide standard details used for bridges. There are exceptions to this. For this reason, and because structural details often depend on the roadway design standards, familiarity with the M & S Standards and the Staff Bridge Worksheets is essential.

Distribution and Maintenance: CDOT Staff Bridge maintains the master files, coordinates revisions, and posts them to CDOT’s website. Staff Bridge will maintain a revision log showing all the revision dates that have transpired for each Worksheet and the engineers and detailers who made the revisions. This information is available to anyone for reference.

Revisions: The CDOT Staff Bridge Worksheets are intended to be dynamic. Revisions will be incorporated as new material is added and as criteria and specifications change. The State Bridge Engineer shall approve all revisions to the master files.

Suggestions for improving and updating the Worksheets are encouraged. Anyone who would like to propose revisions should informally discuss the

changes with other bridge engineers and detailers to further develop and refine ideas. All suggestions shall be submitted to the Staff Bridge Manager of Policy and Standards. The State Bridge Engineer should then be presented with a preliminary draft showing the developed concept.

On deciding to pursue the revisions, the State Bridge Engineer will assign them to an engineer and a detailer. The Engineer receiving the assignment is responsible for completing the final design, distributing the revisions to all Staff Bridge personnel for their review and comment, making revisions as appropriate based on the comments received, and submitting the final draft to the State Bridge Engineer for approval.

Revised and new Worksheets shall have their effective date given in the upper left revision block of the drawing. On receiving new and revised Worksheets, Staff Bridge will update the master files and the revision log. The effective dates on the drawings and in the revision log provide a ready means to check if a given copy is up to date.

Engineers making revisions to the CDOT Staff Bridge Worksheets should submit design notes documenting their revisions to the Staff Bridge Manager of Policy and Standards. These notes shall describe the changes, identify why they were made, and provide supporting calculations as appropriate. The Structural Design Engineer and the Independent Design Engineer are to sign the notes.

3. Bridge Rating Manual

The Bridge Rating Manual and Bridge Rating Technical Memorandums provide the policies and procedures for performing and submitting the structural capacity rating of bridges.

4. Project Special Provisions

General: Contract documents primarily consist of plan sheets and construction specifications. Structural engineers are responsible for the construction specifications and the plan sheets, applicable to their structure. Construction specifications consist of the CDOT Standard Specifications for Road and Bridge Construction, the Standard Special Provisions, and the Project Special Provisions. See CDOT Standard Specification 101.72 and 101.73 for more information.

If there is a discrepancy with the plans and specifications, the order of precedence is as follows (see Standard Specification 105.09):

(a) Special Provisions

  (i) Project Special Provisions

  (ii) Standard Special Provisions

(b) Plans

  (i) Detailed Plans

  (ii) CDOT M & S Standard Drawings

(c) Standard Specifications for Road and Bridge Construction

Since the Standard Special Provisions and the Project Special Provisions take precedence over the plan sheets, the Project Structural Engineer carefully prepares and reviews them. The plans should refer to the Special Provisions where applicable.

Developing the Project Special Provisions is an integral part of the structure design. To assist design engineers, Staff Bridge makes available on the CDOT website the most commonly used Project Special Provisions related to structures. Chapter 16.1 of the CDOT Roadway Design Guide provides additional information on Project Special Provisions.

All structural-related Project Special Provisions should originate from the file located on CDOT's website if there is a provision covering the subject area. The master files shall not be modified without approval of the State Bridge Engineer in coordination with the Staff Bridge Manager of Policy and Standards.

Distribution and Maintenance: CDOT Staff Bridge maintains the master files, posts them to CDOT's website, and coordinates revisions to the master files. Staff Bridge will also maintain a revision log with each Project Special Provision.

The revision log lists all the revisions that have transpired for the Project Special Provision by showing the date and author of the revision, accompanied by a brief explanation of the revision. Where appropriate, the explanation includes instructions for using the Project Special Provision.

Revisions: Most Project Special Provisions kept on file require little or no revision for most projects (e.g., the Removal of Portions of Present Structure provision), while others are project-specific and require heavy revision (e.g., the Alter and Erect Structural Steel provision).

Revisions made to prepare a Project Special Provision for a specific project shall be made from the copy of the master file posted to CDOT's website. This is necessary to minimize errors and to account for the latest policies for the subject area.

Errors and omissions in the master files or needed improvements are to be reported to the Staff Bridge Manager of Policy and Standards. The State Bridge Engineer will assign the necessary changes to an engineer. The engineer receiving the assignment is responsible for completing the final writing, updating the revision log to include the information described above, and submitting the final draft to the State Bridge Engineer.

5. Deck Geometry Manual

The CDOT Bridge Geometry Program computes coordinates and elevations at various locations on the bridge deck and approach slabs used by the Contractor during construction. The point locations include edges of deck and approach slabs; bridge rail inside face; support centerlines and centerlines of bearing at support locations; and

centerlines of girders. Results are provided where girders intersect supports and fractional points along the girders. The bridge deck geometry program shall be used on all CDOT bridges unless the Unit Leader approves an alternate method for deck evaluation tabulation.

6. Staff Bridge Records

Existing structure records maintained by Staff Bridge Asset Management serve several functions for structural design. Bridge design engineers primarily use them to evaluate existing structures for rehabilitation, replacement, or impact to a project in which it is located.

Structure Folders: Every structure has a file whose contents include the bridge inspection reports, the Structure Inventory and Appraisal Report (SIA), and a summary of the structural capacity rating. CDOT personnel (and Consultants with Staff Bridge permission) may access these folders at: https://simsa.codot.gov/

As-built Construction Files: The project plans and other construction documents are stored on ProjectWise© for the life of the project but in OnBase for the life of the structure. If these files are not available on ProjectWise© or OnBase, contact Staff Bridge Asset Management.

CDOT Structure Inventory Coding Guide: This guide lists and explains the structure inventory and appraisal items.

7. Retaining and Noise Wall Inspection and Asset Management Manual

A manual describing the requirements for CDOT's Retaining and Noise Walls Inspection and Asset Management Program. The purpose of this program is to establish and maintain a comprehensive inventory of all wall assets that could potentially affect public safety, CDOT owned roads, and ROW. In addition, the program outlines inspection requirements, risk identifiers, and project funding and maintenance needs. The manual establishes consistent condition ratings and coding guidelines for the wall inventory.

G. CDOT STANDARDS PUBLISHED OUTSIDE STAFF BRIDGE

Copies and revisions to these documents may be obtained from the CDOT website (https://www.codot.gov/).

1. CDOT Standard Specifications and Special Provisions

- CDOT Standard Specifications for Road and Bridge Construction
- CDOT Standard Special Provisions
- CDOT Project Special Provision Worksheets and Samples
- CDOT Design/Build Special Provisions
- CDOT Innovative Contract Provisions

2. CDOT Design and Construction Manuals

- CDOT Survey Manual
- CDOT Roadway Design Guide
- CDOT Materials and Geotechnical Documents
- CDOT Drainage Design Manual
- CDOT Construction Manual

3. CDOT M & S Standard Drawings

H. STANDARDS PUBLISHED OUTSIDE CDOT

- *AASHTO LRFD Bridge Design Specifications*
- *AASHTO Standard Specifications for Highway Bridges* (Note: This document is not permitted for design of new structures.)
- *AASHTO LRFD Bridge Construction Specifications*
- *AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges*
- *AASHTO Guide Specifications for Design and Construction of Segmental Concrete Bridges*
- *AASHTO Guidelines for Steel Girder Bridge Analysis*
- *AASHTO Manual for Bridge Evaluation*
- *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*
- *AASHTO Guide Specifications for LRFD Seismic Bridge Design*
- *AASHTO/AWS D1.5M/D1.5:2015 Bridge Welding Code*
- American Railroad Engineering and Maintenance-of-Way Association (AREMA) *Manual for Railway Engineering (MRE) (Current Edition)*

I. EXCEPTIONS

The following are exceptions to the policies above:

1. Structures (e.g., concrete box culverts) and sign bridges for which the Department's M & S Standards are used are excluded from the final design requirements previously described in Part E, Number 3, of the Policies and Procedures (i.e., final design calculations, developing plans and specifications). A bridge load rating sheet is still required for concrete box culverts that are major structures based on the information in the M & S Standards.

2. Sign bridges, cantilevers, and butterflies extending over traffic are excluded from the preliminary design requirements stated in Part E, Number 2, Items c through e (e.g., foundation investigations, structure layout, and structure type selection).

3. The requirements in this BDM apply to Design-Build projects, except the FOR tasks in Part E, Number 3, Item d (FOR meeting). In addition, the quantity calculation requirements in BDM Section 35 will not apply to the Contractor's design work. See BDM Section 38 for more information on the differences for Design-Build projects.

4. Exceptions for special design structures based on S-Standards that use BDM criteria include:

   a. Structure Type Selection reports are generally not required; however, a design memorandum is recommended to document how the structure differs from a standard design and to outline the design methodology

   b. Hydraulic and Geotechnical reports are only required based on design needs.

   c. Special design structures should be reviewed at project meetings.

J. LOCAL AGENCY PROJECTS, DEVELOPER PROJECTS, AND UTILITY AND SPECIAL USE PERMITS WITHIN CDOT ROW

1. General Services for All Local Agency Projects, Developer Projects, and Access Permits

For Local Agency projects, developer projects, and access permits with no federal or state funding within CDOT ROW, Staff Bridge will provide technical assistance, when requested, to Local Agencies, developers, Consultant design engineers, CDOT Regions, and Federal Highway Administration (FHWA). This assistance will involve answering specific questions and facilitating the use of CDOT structures-related documents. This assistance will be provided by the Staff Bridge PE II assigned to the Region where the project is located. This person will be the CDOT Structural Reviewer for the project.

2. Requirements for Local Agency Projects

The requirements in this BDM apply to all local agency projects using federal/state funds. In addition, Local Agency Checklist attached in Appendix C shall also be provided. For more information regarding Local Agency Projects, refer to the CDOT Local Agency Manual.

Staff Bridge will provide reviews of the structure plans and specifications to help ensure that the Department’s written minimum requirements for safety, inspection access, and geometry are satisfied and that the new construction has no adverse impact on CDOT facilities. For bridges off of the National Highway System, some CDOT practices may be omitted with CDOT approval, by the State Bridge Engineer, through the variance process. Currently these variances only consist of the requirements of approach slabs on dirt or gravel roads. Crash tested rail below the TL-4 level will be considered on a case-by-case basis. The review will include helping to ensure that CDOT’s written minimum requirements for structure durability are satisfied. Examples of these requirements include those related to corrosion protection and the use of bridge expansion devices.

A final inspection will be required for the structures that carry or could affect the highway system. See Section 36.7 for a description.

Submittals for archiving shall be as listed in section E of this chapter with the following exceptions. Any other exceptions will have to be approved by the Unit Leader.

- SAM plan is not needed.
- Electronic stamping is optional.
- The Final Bid Documents (Plans and Specifications) (CO PE sealed). Plans shall be submitted in both PDF and native file format. Microstation© files are preferred, but CDOT recognizes that many Local Agencies use AutoCAD© exclusively and, therefore, the latter is acceptable. Verify that reference file association is working correctly before finishing archiving process.

3. Requirements for Utility and Special Use Permits

Staff Bridge will provide reviews of the structure plans and specifications to help ensure that the Department's written minimum requirements for safety, inspection access, and geometry are satisfied and that the new construction has no adverse impact on CDOT facilities. A structure number is required for any structure within CDOT ROW except small cell structures. If the structure is owned and maintained by the Local Agency, their Structure Number may be used.

A preliminary plans/scope and/or design criteria submittal and concurrence from Staff Bridge is suggested to avoid any delays to the permit. The following are required to be submitted as a minimum for structures. Additional submittals and/or final walkthrough may be required based on the complexity of the project. Design documents shall be stamped by a Colorado licensed professional engineer. Unless the vehicular road is private, any structures supporting or extending over the vehicular road shall follow all requirements in section E with exceptions shown in section I. Selection reports are typically not required although they are preferred.

a. Stamped final plans and specifications

i. Stamped plans and specifications shall be submitted for all new structure(s) and any structure(s) being modified. Stamped Plans and specifications are not required for conduit placement based on electrical codes and manufacturer's recommendations. Addition of new utilities in existing conduits or replacement of existing utilities in kind do not require a PE Stamp.

b. Stamped design calculations

i. Stamped Design Calculations shall be submitted for new structure(s) and any structure(s) being modified. Calculations shall show design loads and codes used in the design. If an existing structure is modified, structural

analysis of the existing structure after modification shall be submitted.

ii. Stamped Design calculations are not required if designs are following M & S standards.

iii. Stamped Design calculations are not required for conduit support spacing provided by the National Electric Code, nor for anchors that meet the manufacturers published performance criteria and installation requirements. Tables showing conduit support spacing shall be submitted. Any anchors shall be submitted with manufacturer's embedment requirements or independent design calculations.

c. Stamped Geotech and Hydraulic reports (as applicable to and available for the project)

d. Load Rating package (If existing CDOT structure is modified causing 3% or more increase in operating rating or if the proposed vehicular structure crosses or supports a highway) For more details, see CDOT Rating Manual.

e. Provide as-built plans and construction drawings including working and shop drawings after construction for archiving purpose.

Plans shall show CDOT ROW lines and any easements during construction.

K. UNUSUAL STRUCTURES

Structures with difficult or unique foundation problems, new or complex designs with unique operational or design features, bridges with exceptionally long spans, bridges designed with procedures that depart from currently recognized acceptable practices such as cable-stayed, suspension, arch, segmental, movable, truss bridges etc., will require federal oversight and approval at the preliminary design phase. These structures shall be identified early in the design process especially for design-build contracts. State Bridge Engineer approval will be required as well.

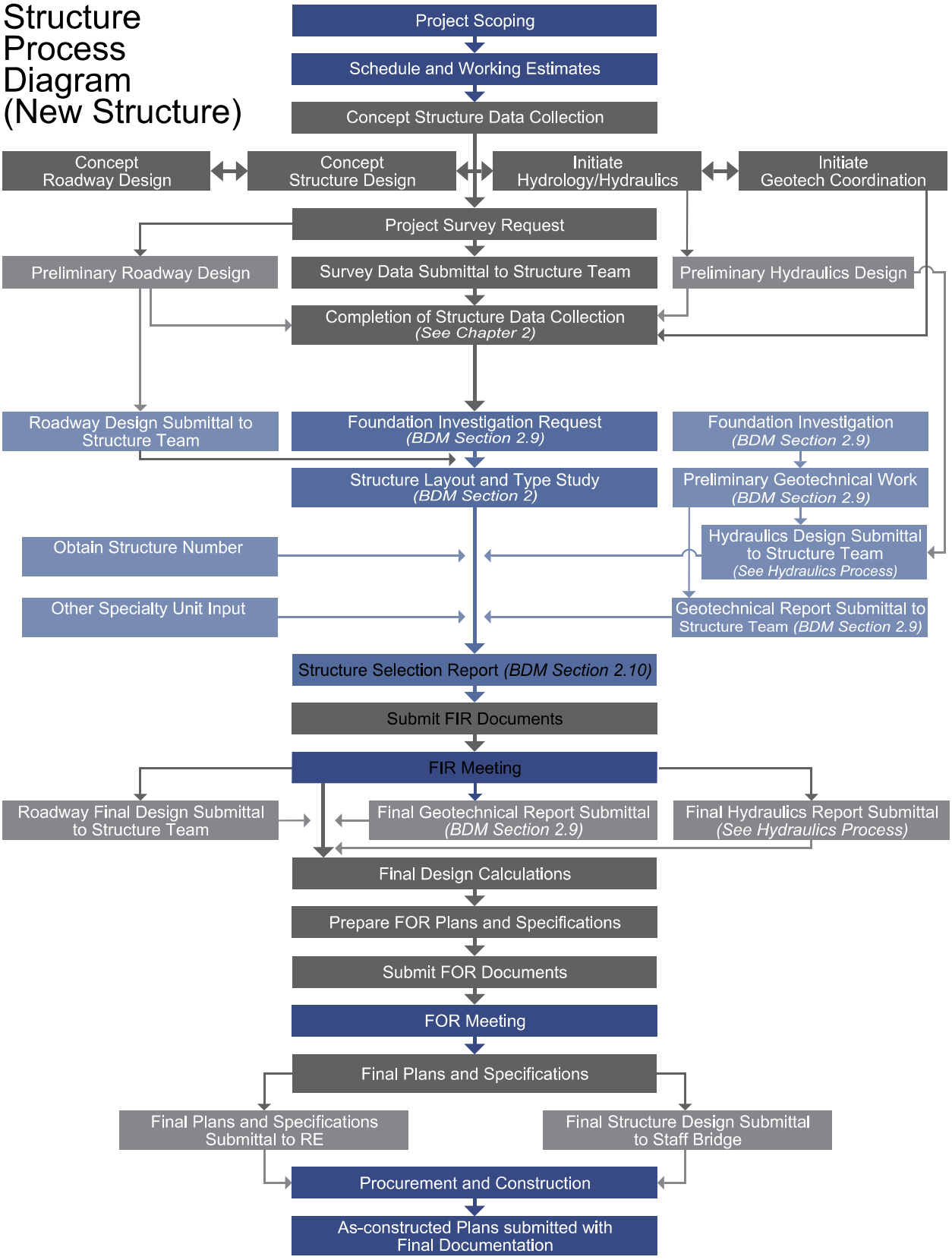
L. REFERENCES

FHWA, Bridge Preservation Guide, Spring 2018.

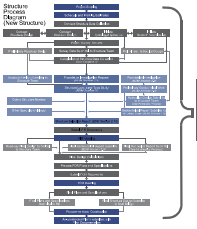
https://www.fhwa.dot.gov/bridge/unusual.cfm

APPENDIX A - STRUCTURES PROCESS DIAGRAM

Structure Process Diagram (New Structure)



Hydraulics Coordination Process



See Structures Process Diagram

Foundation Investigation

Preliminary Geotechnical Work *(BDM Section 2.9)*

Project Scoping *(Including Survey)*

Survey for Hydraulics

Preliminary Hydrology

Preliminary Hydraulics

Bridge Hydraulics Field Review

Joint Hydraulics/Bridge Memo of Understanding

Final Hydrology

Hydraulics Design

Scour Design Meeting *(Bridge, Hydraulics and Geotech)*

Scour Design

Bridge Hydraulics Report Submittal to Structure Team

Submit FIR Documents

FIR Meeting

Finalize Hydraulics Report including Scour

Submit Bridge Hydraulics Plan Sheets to Structure Team *(See Hydraulics Process)*

Submit FOR Documents

FOR Meeting

Hydraulics Sign-off *(CDOT Form 1048)*